1992

On trade and economic growth: further evidence

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THE UNIVERSITY OF WOLLONGONG

DEPARTMENT OF ECONOMICS

ON TRADE AND ECONOMIC GROWTH: FURTHER EVIDENCE

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Working Paper 92-7

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Working Paper Production & Administration: Robert Hood
Northfields Avenue, Wollongong, NSW 2522 Australia
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ISSN 1035 4581
ISBN 0 86418 228 7

ABSTRACT

The relationship between exports and economic growth occupy pivotal positions in current policy discussions. In view of the diametrically opposite results obtained by Bahmani-Oskooee *et al.* (1991) and Axfentiou and Serlitis (1991) the relationship remain largely unsettled. We have tried to resolve the growth-trade nexus by studying twelve countries of South Asia, Far-East and Australia. Utilising the Granger concept of causality, and using the Finite Prediction Error (FPE) and Hocking's S_p criterion of model selection we were able to find substantial evidence in favour of the hypothesis that trade causes economic growth. This result was achieved by using a different data source and model selection criteria from those mentioned in the above studies.

I have benefitted enormously from discussions with D.P. Chaudhri, Clive Granger, Amnon Levy and Ed Wilson. However, I am alone responsible for the errors.

1. INTRODUCTION

The recent publication of two papers by Bahmani-Oskooee *et al.* (1991) and Afxentiou and Serletis (1991) respectively have resurrected the empirical efforts to test the growth-exports nexus. Using identical methodology, the conclusion reached in the above-mentioned papers were opposite to each other. Afxentiou and Serletis (1991) used the Summers-Heston (1988) constant international price data package and data from International Financial Statistics to examine the causal relationship between exports and GNP in sixteen industrial countries over the period 1950-1985 and found *no causal* relationship between exports and GNP. Bahmani-Oskooee *et al.* (1991) studied twenty LDCs with annual data from the International Financial Statistics and found *some support* in favour of the export-led growth hypothesis. The conclusions from these studies are perplexing and it is not clear whether the sources of data or the nature and structure of the economies or the model selection criteria[1] contributed to such divergent results.

The focus of this study is to expand the issue to include trade, exports in conjunction with imports, and seek to study the interrelationship, or the lack of it, with GNP. Failure to include imports along with exports may not explain the reality and may lead to biased conclusion. Past empirical work concentrated on correlations between exports and income (Emery, 1967; Maizels, 1968; Kravis, 1970) and progressed to studies determining the statistically appropriate variables to be correlated (Michaely, 1977; Heller and Porter, 1978). This was followed by studies where exports are incorporated as an explanatory variable in the aggregate production function (Tyler, 1981; Feder, 1982) because of the spread effects of export growth in the development process as analysed in various studies (Keesing, 1967; Bhagwati, 1978; Krueger, 1978). Recent attempts to examine the causality (in the Granger sense) between exports and GNP have been done by different authors (Jung and Marshall, 1985; Chow, 1987; Afxentiou and Serletis, 1991; Bahmani-Oskooee *et al.*, 1991) with mixed results. Trade — exports and imports together — received inadequate attention in the literature mentioned above. The present study fills this gap by considering trade explicitly and focusses upon the relationship between economic growth and trade.

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1 Bahmani-Oskooee et al. (1991), used the FPE criterion while Afxentiou and Serletis (1991) used the Schwarz criterion for model selection. Each of these statistics is based on some optimality property and are some function of the residual sum of squares.

The objective of the paper is two-fold: (a) to conduct the Granger causality test using Akaike's Finite Prediction Error (FPE) model selection criterion to select the optimal lag lengths. As an alternative, Hocking's (1976) Sp model selection criterion is also used to compare the results obtained with the FPE criterion. The Sp criterion is chosen because it is robust to model misspecification; (b) to test Bhagwati's (1958) "immiserizing growth" paradox if the causation runs from trade to GNP.

The structure of this paper is as follows. The next section examines the time properties of the variables as these properties determine the shape taken by the statistical test. Specific tests on integration and co-integration are conducted to purge spurious relationships. The data series used in this study are taken from the World Tables 1990-91 published by the World Bank. They are annual data set covering the period 1968-1989. The econometric analysis and its interpretation follow in section III. Section IV summarises the paper's main findings.

2. INTEGRATION AND CO-INTEGRATION

Testing for Stationary Series

A simple, asymptotically valid method of testing for stationarity and unit roots in the process is to employ the 'augmented Dickey-Fuller (ADF) regression' specified in the note in Table 1. The test statistic, associated hypotheses and the asymptotic critical values are reported in Table 1.

Based on the test results we see that both the series are stationary in their first differences, indicating that the series are non-stationary in their levels over the sample in this study. In sum, the evidence suggests that the series is integrated of order one.

Since a unit root has been confirmed for the two series, it is important to find out if there exists some long-run equilibrium relationships between log(GNP) and log(TR). The concept of co-integration deals with the analysis of long-run equilibrium relationships between non-stationary time series. Engle and Granger (1987) proposed seven asymptotically valid test statistics for testing the null hypothesis of non-co-integration against the alternative of co-integration. Test 3, the augmented Dickey-Fuller (ADF) test, is used here because " ... the augmented Dickey-Fuller test ... has nearly as good observed power properties in most comparisons, and is therefore the recommended approach' (Engle and Granger, 1987:269).

Table 1 *Test for Stationarity*

Country	*Variable* (y_t)	ϕ_2
Australia	log GNP	8.83
	log TR	7.60
China	log GNP	4.35
	log TR	10.43
India	log GNP	8.32
	log TR	5.90
Indonesia	log GNP	8.13
	log TR	12.97
Japan	log GNP	12.64
	log TR	6.16
Malaysia	log GNP	10.16
	log TR	5.73
Nepal	log GNP	8.87
	log TR	5.34
Pakistan	log GNP	8.84
	log TR	4.75
Philippines	log GNP	4.76
	log TR	4.77
Sri Lanka	log GNP	12.68
	log TR	8.22
South Korea	log GNP	6.37
	log TR	6.64
Thailand	log GNP	6.38
	log TR	4.83

Note: The augmented Dickey-Fuller (ADF) test is based on the following regression:

$$\Delta y_t = \beta_0 + \beta_1 t + \alpha_1 y_{t-1} + \alpha_2 \Delta y_{t-1} + e_t.$$

ϕ_2 is based on the test of hypothesis $\beta_0 = \beta_1 = 0$ and $\alpha_1 = 1$. The critical ϕ_2 values are 4.67; 5.68 and 8.21 at the 10%, 5% and 1% level for n = 25 (Dickey and Fuller, 1981: 1063 Table V).

Table 2 *Test for Cointegration*

Country	γ_0	γ_1	R^2	$t_{\hat{\phi}}$
Australia	5.02 (30.96)	0.28 (2.04)	0.179	-1.81
China	7.80 (57.31)	0.79 (13.43)	0.905	-4.55
India	8.91 (25.68)	0.81 (5.28)	0.595	-0.70
Indonesia	11.39 (41.16)	0.87 (3.10)	0.336	-0.76
Japan	13.18 (16.85)	0.62 (1.24)	0.075	0.47
Malaysia	3.89 (60.82)	1.82 (6.01)	0.655	-1.11
Nepal	3.76 (23.30)	0.53 (5.52)	0.616	-0.54
Pakistan	6.36 (16.73)	0.78 (2.91)	0.309	-0.39
Philippines	6.17 (20.98)	0.82 (3.07)	0.332	-0.96
Sri Lanka	4.55 (37.27)	0.68 (4.45)	0.511	-0.56
South Korea	11.23 (72.87)	1.56 (6.55)	0.692	-0.69
Thailand	7.55 (39.96)	1.43 (6.68)	0.702	-1.61

Note: γ_0 and γ_1 denote the OLS estimates from the cointegration regression: $\log GNP_t = \gamma_0 + \gamma_1 \log TR_t + u_t$. Numbers in parentheses are t-values.
The augmented Dickey-Fuller (ADF) regression:

$$\Delta u_t = -\phi u_{t-1} + \sum_{i=1}^{m} \delta_i \Delta u_{t-1}$$

for m = 2. The choice of ADF regression is recommended over the DF statistic if the coefficients δ_i are non-zero or there is a possibility of cyclical pattern or dynamics.

The t-ratio of the OLS estimate of ϕ in the above regression will be equal to the Dickey-Fuller statistic for the test of non-cointegration between log GNP and log TR. The critical values of this statistic for 1%, 5% and 10% levels are 3.73; 3.17 and 2.91 respectively for n = 100 and m = 4. (Engle and Granger 1987:270 Table III.)

The ADF test statistic for the test of non-co-integration is carried out in two steps:

1. Run the 'co-integrating regression' of log(GNP) and log(TR) with an intercept term and save the residuals (u_t) from this regression.

2. Run the ADF regression: $\Delta u_t = -\phi u_{t-1} + \sum_{i=1}^{m} \delta_i \Delta u_{t-1}$. The t-ratio of the OLS estimates of ϕ will be equal to the Dickey-Fuller statistic for the test of non-co-integration between log(GNP) and log(TR). The order of m is set equal to 2 to conserve degrees of freedom. The results from the two stage estimation is reported in Table 2.

Based on the ADF test statistic we cannot reject the null hypothesis of no co-integration and we can conclude that the two series do not co-integrate. Hence, modeling in first differences can be justified and is considered appropriate here.

3. ECONOMETRIC ANALYSIS: TESTING FOR GRANGER CAUSALITY

Conceptual Framework

In this paper we adopt the familiar concept of causality as proposed by Granger (1969). Granger proposed, for a pair of linear covariance-stationary time series *x* and *y*, that *x* causes *y* if the past values of *x* can be used to predict *y* more accurately than simply using the past values of *y*. Formally, *x* is said to cause *y* if $\sigma_1^2 (y_t: y_{t-i}, x_{t-j}) < \sigma_2^2 (y_t: y_{t-j})$ where σ^2 represents the variance of forecast error and $i, j = 1, 2, 3, \ldots k$.

We adopt the following equation specifications for $t = 1, 2, \ldots T$:

$$y_t = \sum_{i=1}^{m} \alpha_i y_{t-i} + \sum_{j=1}^{n} \beta_j x_{t-j} + \varepsilon_{1t} \qquad (1)$$

$$x_t = \sum_{i=1}^{p} \gamma_i y_{t-i} + \sum_{j=1}^{q} \delta_j x_{t-j} + \varepsilon_{2t} \qquad (2)$$

to formally test the hypotheses:

$$H_0^1 : \beta_j = 0 \qquad \forall_j = 1, 2, \ldots n$$

$$H_0^2 : \gamma_i = 0 \qquad \forall_i = 1, 2, \ldots p$$

This gives the following:

Case 1 Unidirectional causality from y to x occurs if:

$$\beta_j = 0 \qquad \forall_j = 1, 2, \ldots n \qquad \textit{and} \qquad \gamma_i \neq 0 \qquad \forall_i = 1, 2, \ldots p.$$

Case 2 Unidirectional causality from x to y occurs if:

$$\beta_j \neq 0 \qquad \forall_j = 1, 2, \ldots n \qquad \textit{and} \qquad \gamma_i = 0 \qquad \forall_i = 1, 2, \ldots p.$$

Case 3 Feedback or mutual causality occurs if:

$$\beta_j \neq 0 \qquad \forall_j = 1, 2, \ldots n \qquad \textit{and} \qquad \gamma_i \neq 0 \qquad \forall_i = 1, 2, \ldots p.$$

Case 4 Independence occurs if:

$$\beta_j = 0 \qquad \forall_j = 1, 2, \ldots n \qquad \textit{and} \qquad \gamma_i = 0 \qquad \forall_i = 1, 2, \ldots p.$$

Determination of the Optimal Lags

(a) Search Procedures

Given the above specifications of the model and hypotheses, we now wish to consider how the four lag lengths (m, n, p and q) are determined. This is very important since it has been shown that the results from the Granger approach are sensitive to these lag lengths.

A popular procedure suggested by Hsiao (1981) involves a two-stage conditional sequential search. This procedure is detailed in the cited work and is mentioned here in the barest. For example, in equation (1) above, the first stage estimates the autoregressive relationship in y_t only. This is repeated for different lag lengths until the m^* is found that minimises a selected criteria, which is usually a function of the residual sum of squares (RSS). In the second stage, the optimal lag length n^* is found for x_t by minimising the same criterion, conditional on the optimum lag length m^*.

(b) Test Criteria

Of the numerous criteria which can be used to obtain the optimum lag lengths m^*, n^*, p^* and q^* we will only consider two in the interest of parsimony. They are Akaike's (1969, 1970) Final Prediction Error (FPE) which is equivalent to Amemiya's (1980) prediction criterion (PC): $\frac{\text{RSS}}{\text{T}}\left(\frac{\text{T+k}}{\text{T-k}}\right)$ and Hocking's Sp criterion: $\left(\frac{\text{RSS}}{\text{T-k}}\right)\left(1 + \frac{\text{k}}{\text{T-k-1}}\right)$ as detailed in Breiman and Freedman (1983). Judge *et al.* (1985:869) clearly show how the most common criteria not considered here, are variations of one another and are asymptotically equivalent, whilst Maddala (1992:498-502) shows how they are all flawed to varying degrees.

We shall restrict our comments to the FPE which is popular despite using an upwardly biased estimate of the variance of the regression and generally overestimating the order of the lags ($k=m+n$). It also assumes that one of the nested models is the true model and the regressors are nonstochastic. On the other hand, Hocking's S_p criterion does not assume a correctly specified model exists and is more robust to model misspecification.

The hypothesis tests are usually performed using the statistic:

$$\lambda_F = \left(\frac{(RRSS - URSS)/n}{URSS/T-k}\right) k = (m+n)$$

where, RRSS = Restricted residual sums of squares;

URSS = Unrestricted residual sums of squares.

The problem with using this statistic is that it is biased by sample size. As Maddala (1992:500-502) argues, the critical *F* value is inversely related to sample size which implies we must ultimately accept (reject) Ho as the sample size decreases (increases)! He calculates the following critical *F* values (λ_c) for the following Wald type *F* tests:

Akaike's FPE: $\lambda^c_{FPE} = \frac{2T}{T+m}$

and Hocking's Sp: $\lambda^c_{S_p} = 2 + \frac{n+1}{T-k-1}$ (k=m+n)

Finally, since: $\lambda^c_{FPE} < \lambda^c_{S_p} < \lambda^c_{F\text{-}n,T\text{-}k}$ the FPE (traditional F) critical value will tend to increase (decrease) the probability of a type I error, relative to Hocking's Sp critical value.

Estimation

Because the data series log(GNP) and log(TR) are non-stationary and they do not co-integrate, modeling in first differences is appropriate, and it is possible to test for causality in the growth rates of GNP and TR. Therefore, the following regression equations are employed:

$$\Delta\log(GNP) = \alpha(L)\, \Delta\log(GNP) + \beta(L)\, \Delta\log(TR) + u_t \quad (3)$$

$$\Delta\log(TR) = \gamma(L)\, \Delta\log(GNP) + \delta(L)\, \Delta\log(TR) + v_t \quad (4)$$

where, GNP = real GNP;
TR = real trade figures; and
u_t, v_t are random errors with zero means.

The terms $\alpha(L)$, $\beta(L)$, $\gamma(L)$ and $\delta(L)$ are polynomials in the lag operator *L*. Thus, $\alpha(L)$, $\beta(L)$, $\gamma(L)$ and $\delta(L)$ are defined as $\sum_{i=1}^{m} \alpha_i L^i$, $\sum_{j=1}^{n} \beta_j L^j$, $\sum_{i=1}^{p} \gamma_i L^i$ and $\sum_{j=1}^{q} \delta_j L^j$ respectively, where, *m*, *n*, *p*, and *q* are assumed to be finite for empirical purposes.

The results of the causality tests based on FPE and S_p model selection criteria respectively are shown in Table 3 and 4. The optimal lag structure is determined according to the two-stage procedure outlined earlier.

Based on the results in Tables 3 and 4, we can do hypothesis testing. Table 5 summarises the results of the test of significance at the 1 per cent level, except where conclusions differ at the 5 per cent level of significance. It is worth noting that the significance level of F-S_p in Table 4 is 'much higher' than the conventional 5 per cent level of significance (Maddala, 1992:502). From Table 5, we can see that nearly 75 per cent of the countries exhibit unidirectional causality from trade to GNP growth, according to the FPE model selection criterion. By the same token, China, Japan and the Philippines (at 5 per cent level of significance) exhibit feedback relationship between trade and GNP growth. Only the Philippines show a unidirectional causality from GNP growth to trade at the 1 per cent level of significance. Lastly, three countries (Australia, Nepal and Sri Lanka) exhibit no causality between GNP growth and trade.

Table 3 *Optimal Lags and Results of Granger Causality Test based on FPE Criterion*

Country	m	n	F computed	F critical 1%	F critical 5%	q	p	F computed	F critical 1%	F critical 5%
Australia	6	1	1.16	9.33	4.75	7	1	0.79	9.65	4.84
China	3	5	75.84	5.06	3.11	5	1	15.18	8.86	4.60
India	1	4	6.06	4.89	3.06	6	2	3.56	6.93	3.89
Indonesia	7	1	13.37	9.33	4.75	6	2	1.46	6.93	3.89
Japan	6	2	21.92	6.93	3.89	6	2	4.50	6.93	3.89
Malaysia	4	4	6.39	5.41	3.26	5	3	2.95	5.95	3.49
Nepal	5	2	5.76	6.70	3.81	2	1	2.58	8.40	4.45
Pakistan	3	5	7.29	5.06	3.11	5	1	0.18	8.86	4.60
Philippines	1	2	4.55	6.11	3.59	6	2	23.72	6.93	3.89
Sri Lanka	3	2	4.54	6.36	3.68	2	1	0.48	8.40	4.45
South Korea	1	7	9.49	4.64	2.91	7	1	2.27	9.33	4.75
Thailand	1	7	6.12	4.54	2.91	7	1	2.03	9.33	4.75

Table 4 *Optimal Lags and Results of Granger Causality Test based on S_p Criterion*

Country	m	n	F computed	F-S_p †	q	p	F computed	F-S_p †
Australia	1	7	13.78	6.00	5	3	87.29	4.00
China	3	5	75.84	4.00	5	1	15.18	2.29
India	1	4	6.06	2.56	6	1	3.55	2.40
Indonesia	3	1	1.17	2.18	6	1	0.09	2.40
Japan	6	2	21.92	3.00	6	2	4.50	3.00
Malaysia	4	4	6.39	3.67	5	1	2.55	2.29
Nepal	5	2	5.76	2.60	2	1	2.58	2.15
Pakistan	3	4	7.29	4.00	5	1	0.18	2.29
Philippines	1	2	4.55	2.23	6	2	23.72	3.00
Sri Lanka	3	2	4.55	2.33	1	1	0.08	2.13
South Korea	1	7	9.49	4.67	5	1	2.93	2.29
Thailand	1	4	5.73	2.56	1	1	3.18	2.13

Note: † $F\text{-}S_p = 2 + \frac{k_2 + 1}{n - k - 1}$. The decision rule is to choose the restricted model if $F < F\text{-}S_p$. It must be mentioned that the significance level of $F\text{-}S_p$ is 'much higher' than the conventional 5% level of significance.

Table 5 *Test of Hypotheses*

Country	FPE Criterion				S_p Criterion	
	Test of Hypothesis at 1% level of significance		*Long term multiplier effects of*		*Test of Hypothesis*	
	H_0^1	H_0^2	*Trade on GNP*	*GNP on Trade*	H_0^1	H_0^2
Australia	Accept	Accept	-	-	Reject	Reject
China	Reject	Reject	0.448	1.215	Reject	Reject
India	Reject	Accept	0.573	-	Reject	Reject
Indonesia	Reject	Accept	1.807	-	Accept	Accept
Japan	Reject Reject*	Accept Reject*	-3.261	0.451	Reject	Reject
Malaysia	Reject	Accept	0.861	-	Reject	Reject
Nepal	Accept Reject*	Accept Accept*	0.246	-	Reject	Reject
Pakistan	Reject	Accept	6.846	-	Reject	Accept
Philippines	Accept Reject*	Reject Reject*	0.750	-0.070	Reject	Reject
Sri Lanka	Accept Reject*	Accept Accept*	1.056	-	Reject	Accept
South Korea	Reject	Accept	-5.987	-	Reject	Reject
Thailand	Reject	Accept	1.609	-	Reject	Reject

Note: 1. *Conclusion at 5% level of significance.

2. H_0^1: Trade does not affect GNP.

3. H_0^2: GNP does not affect Trade.

4. Multiplier effects are calculated for the results under FPE criterion at 5% level of significance.

The test of hypotheses based on Hocking's S_p is very interesting. Nearly 75 per cent of the countries sampled exhibit feedback relationship between GNP growth and trade. Two countries, Pakistan and Sri Lanka, show unidirectional causality from trade to GNP growth. Surprisingly, Indonesia shows independence between economic growth and trade under the S_p criterion.

The above results point to the fact that there are causal relationships between economic growth and trade. Hence, there is overwhelming evidence to support Bahmani-Oskooee *et al.* (1991) and to cast doubt on the findings of Afxentiou and Serletis (1991).

Lastly, we tried to investigate Bhagwati's 'immiserizing growth' paradox by calculating long-term multipliers[2]. Surprisingly, no country in the sample, except Japan and South Korea, showed the Bhagwati paradox of immiserizing growth. This result is puzzling and it is difficult to explain such a result for Japan and South Korea.

4. CONCLUSION

The purpose of this study has been to explore the key issue of growth and trade nexus. This study produces substantial evidence in favour of international trade influencing economic growth. This conclusion is substantiated by the Granger causality tests using two different model selection criteria, namely the Finite Prediction Error criterion and Hocking's S_p criterion. Of the twelve countries investigated, we were able to find unambiguous unidirectional causality from trade to growth in at least 75 per cent of the cases under the FPE criterion, and in 75 per cent of the cases we were able to observe a feedback (bi-directional) relationship at work under the S_p model selection criterion. Therefore, the major conclusions which emerge from our investigation are in line with the findings of Bahmani-Oskooee *et al.* (1991), despite the differences in data source and the model selection criterion.

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2 The computation of the long-run multiplier of x on y (LRM_{xy}) is based on the regression equation selected in the second stage of the causality tests by the FPE criterion. For example, if the selected equation is of the form:

$$y_t = \sum_{i=1}^{m} \alpha_i y_{t-i} + \sum_{j=1}^{n} \beta_j x_{t-j} + \text{residuals}$$

then the long-run multiplier of x on y is given by: $LRM_{xy} = \sum_{j=1}^{n} \beta_j \Big/ \left(1 - \sum_{i=1}^{m} \alpha_i\right)$

The long-run multiplier of y on x is computed in an analogous way.

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