

Testing Export-Led Growth in Bangladesh: An ARDL Bounds Test Approach

Biru Paksha Paul

Abstract—Existing literature on export-led growth for developing countries is voluminous but inconclusive. The emerging economy of Bangladesh is registering spectacular growth in both exports and output in recent decades. This scenario has sparked a rise in research on the export-output relationship for the country. The results are nevertheless ambiguous. In a study over the liberalized regime from 1979 to 2010, this study engages a relatively new method of the autoregressive distributive lag (ARDL) bounds test approach, and finds strong evidence on export-led growth for Bangladesh in both the long run and the short run. Imports, however, do not show any significant relationship with output. The trade reform that began in Bangladesh in the late 1970s appears to have benefited the country's economic growth.

Index Terms—ARDL bounds test, Bangladesh economy, export-led growth, level relationship, trade liberalization.

JEL Codes: F41, F43, C32, O53

I. INTRODUCTION

With the advent of trade liberalization in recent decades, the hypothesis of export-led growth has drawn widespread attention to research. Bangladesh, as a vibrant South Asian economy, has recently exhibited spectacular growth performance. The growth rates of its gross domestic product (GDP), imports, and exports remained above 5, 6, and 10 percent, respectively, over the last two decades [1]. This scenario has triggered a number of questions such as: 1) Is a significant part of Bangladesh's GDP growth export-led? 2) What is the import-output relationship? 3) Is export-led growth in Bangladesh, if any, a long-run or short-run phenomenon? This paper attempts to address these questions by examining Bangladesh's trade-output relationship in an autoregressive distributed lag (ARDL) bounds test approach, a relatively new method to cointegration.

The studies on export-led growth in Bangladesh are numerous, but the results are still inconclusive. The positive impact of exports on output in the short run is not surprising as exports enter the aggregate income equation [2]. In the long run, exports may affect growth through availing economies of scale, introducing incentives of improving the quality of the products, reducing inefficiencies, and finally, innovating new technology due to competitive pressure in the world market [3]-[6]. Since the main objective of this study is to examine export-led growth for Bangladesh, I present the most relevant studies on the trade-output

relationship for the country.

While [7] finds evidence of export-led growth in Bangladesh for the 1967-1986 period, [8] finds no significant effect of export growth on GDP growth over the 1971-1990 period. Reference [9] finds that export growth significantly increases economic growth through its positive impact on total factor productivity over the 1962-1992 period. Reference [10] finds no evidence of a long-term relationship between exports and economic growth over the 1962-1992 period. Reference [11] finds the evidence of export-led growth for Bangladesh in both the long and the short run over the 1974-1999 period. Reference [12] finds both long-run and short-term causality from income to exports over the 1972-2000 period.

Reference [13] finds unidirectional causality from exports to growth for the 1976-2003 period. Reference [14] shows that trade liberalization fosters export growth for the 1973-2003 period. Reference [15] works with 44 developing countries over the 1960-2002 period, and finds evidence on export-led growth for Bangladesh in the long run, not in the short-run. Reference [16] finds limited support for export-led growth over the 1976-2005 period. Reference [17] finds long-run evidence on export-led growth for the 1973-2008 period. Reference [18] is the only one that uses the ARDL approach like mine, and examines the contributions of exports, foreign direct investments, and remittances to GDP of South Asian countries. Based on a 1976-2006 sample, this work finds the evidence of cointegration among these variables in Bangladesh. The error correction term, however, is highly insignificant (p -value 0.63), suggesting an unstable long-run equilibrium model.

When most papers in this respect find evidence on export-led growth in Bangladesh, they have three major shortcomings: omitting important variables, selecting inappropriate variables and samples, and indulging methodological deficiencies. Although GDP and exports are of primary importance in testing export-led growth, excluding imports can create omitted variable bias or misspecification error. Many studies overlook this issue. Some studies use the IIP to proxy GDP – an attempt inappropriate for a country like Bangladesh [19].

Of crucial importance is the issue of sample selection. After its independence in 1971, Bangladesh embarked on socialist planning, and the consequential trade controls were massive. After the regime change in 1975, the country slowly began to move towards privatization and the market economy. The exchange rate remained fixed until the late 1970s. In 1979, Bangladesh launched a managed exchange rate to promote exports in particular. In the same year, the ruling government won the parliamentary election and that legitimacy empowered the regime to continue its liberalization policies. Anti-export bias was reversed. The

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export promotion bureau was remodeled in 1979 to explore new areas of trade. Hence, the year of 1979 can be viewed as a beginning of trade liberalization in Bangladesh (see [20], [21] for details). Most studies ignored this point in sample selection. Many studies suffer from methodological deficiencies such as small sample and omitted variable bias, improper conversion of data frequency, conflicting results in the Johansen test, and insignificant error-correction model. My study overcomes these shortcomings, and adopts an efficient approach to measure both the long-run and short-run export-income relationship in Bangladesh.

In a sample over the liberalized regime from 1979 to 2010, this study finds evidence on export-led growth for Bangladesh. The result is robust in that the effect of exports on output is positive and significant in both the long run and the short run. Imports, however, do not show any significant relationship with GDP. The exchange rate reform and export promotion efforts that began in the late 1970s appear to have benefited Bangladesh's growth.

II. DATA AND METHODOLOGY

The 2000-constant U.S. dollar values of GDP, exports, and imports have been collected from [1]. These series commence in 1979, the beginning of the liberalized regime, and end in 2009. Based on [22] and [23], I add observations for 2010. Although discarding the observations of 2010 does not make any difference in findings, I prefer to keep them to increase the degrees of freedom. Thus, the sample begins in 1979 and ends in 2010, as shown in Fig. 1.

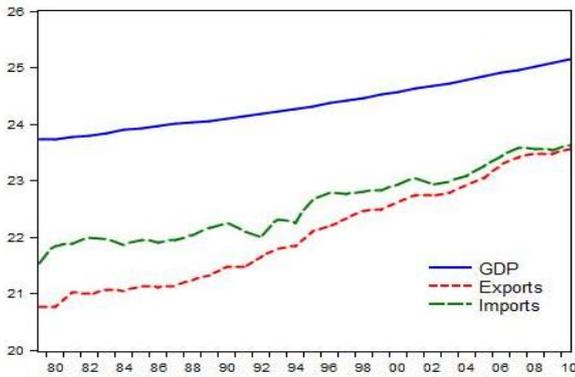


Fig. 1. Bangladesh's output, exports, and imports (in log).
Source: [1], [22], and [23].

The studies that sequentially developed the ARDL bounds test approach include [24], [25], and [26]. There are numerous advantages in the ARDL method, which makes it more useful than others. With a small sample size, as is the case with mine, this method is more efficient than other techniques. In contrast, the Johansen cointegration technique, as in [27], requires larger samples for the results to be valid [28]. The simplicity of this ARDL bounds test method is appealing. As opposed to other multivariate cointegration techniques, it allows the cointegrating relationship to be estimated by the OLS method once the lag order of the model is identified. This asymptotic theory provides a simple univariate framework for testing the existence of a single level relationship between a variable and its regressors when it is not known with certainty whether the regressors are purely integrated of order one,

$I(0)$, purely $I(1)$, or mutually cointegrated. In contrast, the Johansen test can work only with nonstationary $I(1)$ series. Moreover, it is unnecessary that the order of integration of the underlying regressors be ascertained prior to testing the existence of a level relationship. Therefore, unlike typical applications of cointegration analysis, this method is not subject to this particular kind of pretesting problem.

Thus, a long-run relationship can be established with this technique irrespective of the time series properties of the variables in the model. Even when some of the model regressors are endogenous, the bounds testing approach generally provides unbiased long-run estimates and valid t -statistics [29], [30]. Moreover this approach provides a method of simultaneously assessing the short-run and the long-run effects of one variable on the other. At the same time, the ARDL has an appealing separation of short-and long-run effects [31]. The long-run relationship can be estimated in the following forms:

$$y_t = \alpha_1 + \beta_1 x_t + \beta_2 m_t + \varepsilon_{1t} \quad (1)$$

$$x_t = \alpha_2 + \beta_3 y_t + \beta_4 m_t + \varepsilon_{2t} \quad (2)$$

$$m_t = \alpha_3 + \beta_5 y_t + \beta_6 x_t + \varepsilon_{3t} \quad (3)$$

where y denotes income/GDP/output, x stands for exports, m is imports, α_i ($i = 1 \dots 3$) stands for intercept terms, β_i ($i = 1 \dots 6$) signifies coefficients on respective variables, and finally ε_{it} ($i = 1 \dots 3$) denotes error terms. To implement the bounds testing procedure, the following conditional ARDL-error correction models (ECMs) are presented, which correspond to (1) through (3), respectively:

$$\Delta y_t = c_1 + \pi_1 y_{t-1} + \pi_2 x_{t-1} + \pi_3 m_{t-1} + \sum_{i=1}^p \theta_i \Delta y_{t-i} + \sum_{i=1}^p \phi_i \Delta x_{t-i} + \sum_{i=1}^p \delta_i \Delta m_{t-i} + u_{1t} \quad (4)$$

$$\Delta x_t = c_2 + \pi_1 x_{t-1} + \pi_2 y_{t-1} + \pi_3 m_{t-1} + \sum_{i=1}^p \theta_i \Delta y_{t-i} + \sum_{i=1}^p \phi_i \Delta x_{t-i} + \sum_{i=1}^p \delta_i \Delta m_{t-i} + u_{2t} \quad (5)$$

$$\Delta m_t = c_3 + \pi_1 m_{t-1} + \pi_2 y_{t-1} + \pi_3 x_{t-1} + \sum_{i=1}^p \theta_i \Delta y_{t-i} + \sum_{i=1}^p \phi_i \Delta x_{t-i} + \sum_{i=1}^p \delta_i \Delta m_{t-i} + u_{3t} \quad (6)$$

where Δ denotes the first difference operator. c_i ($i = 1 \dots 3$) shows constants, π_i ($i = 1 \dots 3$) signifies coefficients on the lagged levels, θ_i , ϕ_i , and δ_i ($i = 1 \dots p$) denote coefficients on the lagged variables, and finally u_i ($i = 1 \dots 3$) stands for error terms. p signifies the maximum lag length, which is decided by the user. The researcher usually depends on literature and convention to determine the maximum lag length. The selection criteria such as Schwarz Bayesian Criterion (SBC) and Akaike Information Criterion (AIC) are mainly used to determine the order of the ARDL model. Given my sample size, I decide to use the SBC to determine the lag length of the ARDL, because the SBC chooses the most parsimonious model [32], [33].

Here F and W (Wald) statistics are employed to 'bounds test' for the existence of a long-run relationship where the null hypothesis states that the coefficients on the lagged levels are zero: $H_0: \pi_1 = \pi_2 = \pi_3 = 0$. This method provides lower and upper bound critical values where the lower

bound critical values assume all variables are $I(0)$ while the upper bound critical values assume all variables are $I(1)$. If the calculated F or W statistic exceeds the upper bound, the null hypothesis of no cointegration can be rejected. If they fall below the lower bound, the null hypothesis of no long-term relationship cannot be rejected. However, if they fall within their respective bounds, inference would be inconclusive. Now estimating long-run coefficients and the ECM along with the short-run parameters becomes necessary. The sign of the error-correction (EC) coefficient must be negative and significant to ensure convergence of the dynamics to the long-run equilibrium.

III. ARDL AND ERROR CORRECTION ESTIMATIONS

As discussed before, testing the variables for unit roots before the ARDL estimation is unnecessary, because this estimation can accommodate any variables, which are $I(1)$, $I(0)$, or mutually cointegrated. However, one limitation of the ARDL method is that it cannot be estimated with $I(2)$ series. Although the series of GDP, exports, and imports, as shown in Fig. 1, are most likely $I(1)$, I prefer to test them to make sure that none of them are $I(2)$.

TABLE I: PHILLIPS-PERRON UNIT ROOT TESTS WITH BANGLADESH'S OUTPUT, EXPORTS, AND IMPORTS: 1979-2010

Variables:	In levels		In first difference		Integration
	Model A	Model B	Model A	Model B	
Output	7.39 (1.00)	-1.17 (0.90)	-3.91 (0.01)	-7.29 (0.00)	I(1)
Exports	0.60 (0.99)	-2.20 (0.47)	-6.65 (0.00)	-6.80 (0.00)	I(1)
Imports	-0.23 (0.92)	-2.43 (0.36)	-6.62 (0.00)	-7.65 (0.00)	I(1)

Note: Model A includes intercept, and Model B includes both intercept and trend. The null hypothesis states that the variable has a unit root. p -values are shown in the parentheses under each adjusted t -statistic. Source: [1], [22], and [23].

The Augmented Dickey-Fuller (ADF) test is widely used in this regard, as in [34] and [35]. Reference [36] proposed a modification of the Dickey-Fuller (DF) test and has developed a comprehensive theory of unit roots. The Phillips-Perron (PP) test has introduced a t -statistic on the unit-root coefficient in a DF regression, corrected for autocorrelation and heteroskedasticity. Formally, the power of a test is equal to the probability of rejecting a false null hypothesis. Monte Carlo simulations show that the power of the various DF tests can be very low. Reference [37:107] comments that the DF test does not have serious size distortions, but it is less powerful than the PP test. Reference [38] asserts that for low frequency data like mine the PP test appears to be more powerful than the ADF test. Accordingly, I adopt the PP methodology to test unit roots in the variables. Table I presents the results of the Phillips-Perron unit root tests with Bangladesh's GDP, exports and output. All the variables exhibit unit roots, whereas they become stationary in first differences. Thus, none of the series are (2), and they can be used in the ARDL bounds test method. The approach provides us with 95 percent critical

bounds for the F and W (Wald) statistics, as shown in Table II.

TABLE II: ARDL COINTEGRATION TESTS WITH GDP, EXPORTS, AND IMPORTS IN BANGLADESH: 1979-2010.

LHS Variable	Forcing Variable	F -statis	95% Critical Bounds		W -statis	95% Critical Bounds		Co-integration
			I(0)	I(1)		I(0)	I(1)	
ΔGDP_t	exports, imports	12.21	4.29	5.49	36.62	12.87	16.46	Positive
$\Delta exports_t$	GDP, imports	2.36	4.29	5.49	7.08	12.87	16.46	Absent
$\Delta imports_t$	GDP, exports	3.64	4.29	5.49	10.92	12.87	16.46	Absent

Note: The null hypothesis for the F -test W -test is $\pi_1 = \pi_2 = \pi_3 = 0$. π_1, π_2 , and π_3 denote coefficients on lagged levels as per (4) through (6). Statistics are bold when significant at the 5 percent level. Δ denotes the first order difference operator. Source: Same as in Table I.

The critical value bounds are computed by stochastic simulations using 20,000 replications [39]. The long-run level relationship is evident only when GDP is dependent on exports and imports. The F statistic is significant at the 5 percent level, and so is the W statistic in a consistent manner. Both statistics exceed the 95 percent upper bound, signifying cointegration among GDP, exports, and imports. Cointegration disappears when either export growth or import growth is placed in the LHS as per (4) and (5), suggesting no evidence of growth-led export or growth-induced import in the long run. The long-term feedback between exports and imports is also absent. Since both exports and imports act as forcing variables in the explanation of GDP, we are not sure at this point whether this implies export-led growth or import-led growth or a combination of both until we get the long run estimates.

TABLE III: LONGRUN COEFFICIENTS AND ERROR CORRECTION ESTIMATES FOR ARDL(1, 0, 0) MODEL

Panel A: Long run coefficients with GDP(t) as dependent variable:				
	Regressors			
	Constant	exports(t)	imports(t)	
Coefficient	12.983***	0.881***	-0.319	
Standard error	2.633	0.274	0.317	
Panel B: Error correction model (ECM) estimations with $\Delta GDP(t)$ as dependent variable:				
	Regressors			Adj. R ²
	$\Delta exports$ (t)	$\Delta imports$ (t)	ECM (t-1)	
Coefficient	0.045**	-0.016	-0.052*	0.63
Standard error	0.018	0.016	0.028	
$ECM(t) = GDP(t) - 0.88074 \times exports(t) + 0.31940 \times imports(t) - 12.9828 \times intercept$				
Panel C: Diagnostic tests:				
	LM-Version		F-Version	
	Statistics	p -value	Statistics	p -value
A: Serial Correlation	$\chi^2(1)=0.39$	0.53	F(1,25)=0.33	0.57
B: Functional Form	$\chi^2(1)=0.80$	0.37	F(1,25)=0.68	0.42
C: Normality	$\chi^2(2)=4.02$	0.13	N/A	-
D: Heteroskedasticity	$\chi^2(1)=3.34$	0.07	F(1,28)=3.51	0.07

Note: Δ denotes the first order difference operator. *, **, and *** indicate that the coefficients are significant at the 10 %, 5%, and 1% levels, respectively. In Panel C, the nulls are: (A) no serial correlation, (B) no functional-form misspecification, (C) no non-normal errors, and (D) no heteroskedasticity. Source: Same as in Table I.

Table II guides us to select (4) only for the ARDL. The

SBC selects an ARDL (1, 0, 0) model, whose results are presented in Table III. Panel A of Table III gives the long-run coefficients of the ARDL estimations. The coefficient on exports is 0.88, and is highly significant, suggesting that GDP rises by the 88 percent of the increase in exports in the long run. In contrast, the long-run impact of imports on GDP is negative but highly insignificant. While export-led growth for Bangladesh is quite evident, imports have no significant effect on output in the long run. The results of the error-correction model, as presented in Panel B of the same table, are quite consistent with that of Panel A. The short-run impact of exports on GDP is also positive and significant at the 5 percent level. Thus, exports foster GDP growth in Bangladesh both in the short run and long run. The role of imports in the error-correction model remains as insignificant as before. The error-correction term is negative as expected, but it is significant at the 10 percent level, instead of the conventional 5 percent level.

The negative sign before the error-correction term, -0.052, suggests that the long-run equilibrium relation comes back to the steady state if the system is ever shocked. The value of the coefficient, however, is very low, suggesting that it will take a long time to restore the steady-state relation if the system is disturbed.

The estimated model reflects a fairly high level of goodness of fit, as shown in the adjusted R-squared value, 0.63. Panel C of the same table presents the diagnostic tests for the estimation. Given the results of the diagnostic tests in both *LM* and *F* versions, this estimated model is free of serial correlations, functional-form misspecification, non-normal errors, and heteroskedasticity at the 5 percent level.

IV. CONCLUSION

The recent growth performance of Bangladesh in both output and exports has sparked some questions such as: 1) Is a significant part of Bangladesh's GDP growth export-led? 2) Is export-led growth in Bangladesh, if any, a long-run or short-term phenomenon? 3) Is there any feedback between GDP and imports? My paper addresses these questions in an ARDL bounds test approach. The results of the studies in this respect are still inconclusive. This paper fills that gap by overcoming the shortcomings of sample selection and methodology that persisted in most previous papers.

In a study over the liberalized regime from 1979 to 2010, this work finds evidence on export-led growth for Bangladesh. The result is valid in both the long run and the short run. Imports, however, do not have any significant relationship with GDP. The trade reform and export promotion agenda that commenced in the late 1970s appear to have benefited Bangladesh's growth. This finding of export-led growth for Bangladesh has policy implications for other developing nations that aspire to grow fast but confront dilemmas with trade liberalization and economic openness.

This paper raises some additional questions: 1) Why is not the feedback between GDP and import significant? 2) How do we estimate the import demand function for Bangladesh? 3) Is export-led growth also evident in other South Asian countries? These questions are left for future research.

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