

# **ON EXPORT-LED GROWTH: IS MANUFACTURING EXPORTS A NEW ENGINE OF GROWTH FOR BANGLADESH?**

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## **Abstract:**

The study attempts to empirically verify the export-led growth hypothesis for Bangladesh. In this context, we examine whether manufacturing exports has become a new engine of export-led growth replacing total exports, as claimed by the so-called *de novo* hypothesis. The empirical analysis, based on the vector error correction modelling (VECM), suggests that both total exports and manufacturing exports have both long run and contemporaneous effects on the growth of GDP as well as manufacturing output. According to the non-nested tests, total exports emerges as the engine of export-led growth (i.e., GDP). For manufacturing output, however, both total exports and manufacturing exports emerge as engines of growth. Therefore, manufacturing exports is not the sole determinant of the export-led growth for Bangladesh.

Key Words: *De novo* hypothesis. Encompassing principle. Export-led growth. 'general to specific' modelling. Innovation accounting. Non-nested tests. Vector error correction modelling.

JEL Classification: C32, F13, F14.

## 1. INTRODUCTION

The debate on the relative efficacy of alternative trade policies is an old one. The early years of the post-war period saw an extensive use of restrictive trade policies, better known as the import substituting industrialisation (ISS) strategy, by the developing countries in particular. During the 1970s, the bias has shifted towards the export promotion strategy (EPS) often used synonymously with trade liberalisation or outward-orientation. The bulk of the recent literature on alternative trade policies finds trade liberalisation or EPS a better option than protection or ISI [see, for example, Krueger, 1998; Krugman, 1986; Bhagwati, 1988; Dornbusch, 1992]. These studies refer to the success stories of the High Performance Asian Economies (HPAEs), notably South Korea, Taiwan and Hong Kong, who experienced massive increases in exports especially manufacturing exports following their drive towards outward orientation. Consequently, these countries enjoyed higher growth rates of gross domestic product (GDP) over the last two decades or so. This has prompted many to view manufacturing exports as a new engine of export-led growth replacing the total exports-engine [Thomas and Nash, 1991; Reidel, 1993; Joshi and Little, 1996; Krueger, 1997]. The country concerned here, Bangladesh, is also viewed as a beneficiary of a liberal trade regime in that manufacturing exports grew *de novo* in response to the new incentives created by liberalising measures of the 1980s and the early 1990s [Helleiner, 1994 and 1995; Athukorala, 1998]. This claim is supported by a recent empirical study (Hossain and Karunaratne, 2001), that shows both total exports and manufacturing exports to have responded to the anti-export bias reduction and openness, and that manufacturing exports grew faster than the overall exports during the period 1974 -1999.

In view of the above considerations, the present study aims at the following research questions: *First*, does the export-led growth hypothesis hold for Bangladesh? We look for an answer to this by separately examining the contribution of total exports and manufacturing exports to the growth of GDP. *Secondly*, if the first holds, has manufacturing exports become a new engine of export-led growth replacing total export-engine? In the process, we also explore how exports contributed to the growth of *manufacturing output* and see whether manufacturing exports acted as a *prime mover* of the manufacturing output.

Empirical studies to date by and large support the export-led hypothesis. While the case for an export-led growth is well established, studies also argue for the potential for growth-led exports. This is a case when growth-induced supply and demand do not give rise to anti-trade bias (Bhagwati, 1988) and when economic growth leads to enhancement of skills and technology that creates comparative advantage for the country facilitating exports (Krugman, 1984). There is also the prospect for a feedback causation between exports and growth [Helpman and Krugman, 1985; Bhagwati, 1988]. Finally, there is the potential for no causal relationship between exports and economic growth since other variables in the economic system may determine the growth paths of the time series [Yaghmainan, 1994].

***The Bangladesh Perspective:*** After a decade of restrictive trade policy practices, Bangladesh started the move towards outward-orientation in 1982 by initiating the structural adjustment programmes in different sectors of the economy. The 1982 measures were followed by further comprehensive changes in 1985-86 and 1991. As to the empirical evidence on Bangladesh, there are a few studies linking total exports and growth (Islam and Ifthekharuzzaman, 1996; Islam, 1998), but no substantial study regarding manufacturing exports and growth of GDP as well as exports in general and manufacturing output. In an ordinary least squares framework based on

annual data (1971:1990), Islam and Ifthekharuzzaman (1996) find no significant relationship between total exports and growth. However, the reliability of the results may be undermined by the fact that the time series used in the study are non-stationary. Islam (1998), on the other hand, conducts Granger causality tests along with cointegration tests (using Johansen and Juselius (1990) technique) and error correction modelling (in the Engle-Granger proper) to examine the nature and direction of causation between export expansion and growth. On the basis of annual data (1969:1991), the study shows that *total* exports Granger causes economic growth positively and significantly but not *vice versa*, in both the bivariate and the error correction models. However, the multivariate Granger test shows no causality between the two. While the present study takes these results as a benchmark, it revisits the total exports-GDP relationship on the following grounds: First, Islam's results are based on annual data; and hence cannot fully capture the short run dynamics. Secondly, since the period 1982 through 1991 can be described as the transition process towards outward orientation, Islam's results may not reflect true assessment of trade liberalisation. The present study addresses the problems by using higher frequency (quarterly) data and a larger and extended sample (1974Q1:1999Q4). Thirdly, the use of Engle-Granger procedure may not be an appropriate method for analysing long run relationship since it produces different error correction terms depending on the variable chosen for normalisation. Also the procedure has poor small sample properties. The present study, therefore, supplements the Engle-Granger method by the Johansen-Juselius (Johansen, 1988; Johansen and Juselius, 1990) Maximum Likelihood in a Fully Specified Error Correction Modelling (MLECM), which has better small sample properties than the Engle-Granger procedure and which produces identical cointegrating vector(s) for either variable in the model.<sup>1</sup> On the whole, the above modifications are necessary for the consistency of the overall analysis of the present study as

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<sup>1</sup> The use of multiple techniques is justified by the fact that the true data generating process (DGP) is unknown to a researcher. The sample evidence available in practice may not discover the true DGP. This inevitably renders

outlined in the beginning. After deriving the error correction models as per the Engle-Granger and the Johansen-Juselius procedures, we incorporate the 'general-to-specific' modelling *a la* Hendry (1995) to arrive at parsimonious and economically interpretable models. Further, the technique of innovation accounting has been applied in order to check the conformity of the results to the theory. Finally, the study applies the techniques of the encompassing principle and the non-nested tests in order to distinguish between total exports and manufacturing exports as cogent explanation of growth. The rest of the paper is organised as follows. Section 2 sets out the framework for the analysis of causality, cointegration and error correction. It also identifies and defines the variables considered. Section 3 discusses the time series properties of the variables. Section 4 reports and interprets the empirical results based the causality tests. Section 5 presents the innovation accounting. Section 6 reports the results based on the encompassing principle and the non-nested tests. Finally, Section 7 presents the summary and conclusion.

## **2. THE ANALYTICAL FRAMEWORK**

We begin with the Granger causality tests. The main theme of the Granger causality is that X causes Y if Y can be explained better by the present and past (lagged) values of X than by the past values of Y alone assuming that both X and Y are stationary variables. Let  $X_t$  and  $Y_t$  be stationary in their first differences meaning that they are integrated of order 1 or I(1). In other words,  $\Delta X_t$  and  $\Delta Y_t$  are stationary or I(0). Then, according to Granger and Weiss (1983), the variables are cointegrated and can therefore be expressed in an error correction model. Alternatively, an error correction representation implies cointegration [Engle and Granger, 1987]. The notions of cointegration and error correction provide the basis for examining long

run equilibrium relationship between non-stationary variables and the short run adjustment mechanism that lead to the long run equilibrium.

Although most widely applied in empirical research for its simplicity, as mentioned earlier, the Engle-Granger method has several shortcomings such as the size distortion, non-unique sample properties depending on the variable used for normalization and its inability to identify multiple cointegrating vectors [Banerjee et al., 1993; Ng and Perron; 1997]. Johansen-Juselius MLECM overcomes the above shortcomings, and is considered a better technique as it satisfies the key elements in a cointegrated system [Gonzalo, 1994]. Since both the Engle-Granger procedure and the Johansen-Juselius techniques are extensively described elsewhere [see, for example, Enders, 1995; Maddala and Kim, 1998], we do not attempt an elaboration here.

With the above empirical framework in mind, we now define and explain the variables of the present study. The empirical approaches to the export-led growth hypothesis have used a wide variety of definitions of the 'export' and the 'growth' variables. In most cases the variables used are the real total- or manufacturing exports and real GDP or the growth rates of these variables [see, for example, Bahmani-Oskooee et al., 1991; Karunaratne, 1994; Doyle, 1998]. One issue arising from this body of work is that some of the results may prove 'spurious' since exports are a part of GDP. This "accounting identity" effect leads some researchers to use GDP net of exports as a measure of the growth variable (Heller and Porter, 1978; Islam, 1998) and exports-GDP ratio as the measure of the export variable (Michaely, 1977 and Islam, 1998). Alternative measures of growth include per capita GDP and labour productivity (Marin, 1992). The present study follows Heller and Porter (1978) and Islam (1998) in defining the growth variable(s) but uses the traditional definitions for the export variable(s). Thus the growth variables we consider in this study are: real non-export GDP (TY) and real manufacturing output net of manufacturing

exports (MY); and the export variables are: real total exports (TX) and real manufacturing exports (MX). While a substantial proportion of empirical studies to date carried out Granger causality test and/or cointegration in a bivariate framework, it is also important not to exclude other candidate variables that might be related to growth in order to avoid possible misspecification bias. Investment, imports of capital goods, and government expenditure are some of the factors that can be considered individually or collectively for the purpose. This study uses investment (INV) as proxied by the incremental fixed capital formation as a third factor. The rationale for the inclusion of investment as an argument is that it can shed light on the linkage between exports and efficiency. Technically, if the export variable is correlated with improved efficiency, its coefficient should be significant in the presence of the investment variable in the regression equation. Similarly, if the export variable works through an increase in capital formation, then it should affect the movements of investment [Ghirmay, et al., 2001]. It may be reckoned that both imported capital goods and government expenditure eventually contribute to the formation of capital or the production capacity of the economy. Combining the growth and trade variables as well as the investment variable, and letting the lower case letters to denote the logarithm of the variables, we identify the following multivariate models:

Model 1:  $U_1(ty_t, tx_t, inv_t)$

Model 2:  $U_2(ty_t, mx_t, inv_t)$

Model 3:  $U_3(my_t, tx_t, inv_t)$

Model 4:  $U_4(my_t, mx_t, inv_t)$

Normalising on  $ty_t$ , the long run equilibrium relationship for Model 1, following Engle and Granger, can be written as



$$ty_t = \alpha_0 + \alpha_1 tx_t + \alpha_2 inv_t + \varepsilon_t \quad (1)$$

Assuming the variables to be I(1) or integrated in the first differences and that there exists only one cointegrating vector, the Vector Error Correction (VEC) representation is given by

$$\Delta ty_t = \delta_0 + \sum_{i=1}^n \delta_{1i} \Delta ty_{t-i} + \sum_{i=0}^n \delta_{2i} \Delta tx_{t-i} + \sum_{i=0}^n \delta_{3i} \Delta inv_{t-i} + \delta_4 ec_{t-1} + \varepsilon_t \quad (2)$$

where  $ec_t$  is the residual of the regression of  $ty_t$  on  $tx_t$  and  $inv_t$ . Similar specifications hold for the other models.

### 3. DATA AND THEIR TIME SERIES PROPERTIES

As mentioned earlier, the study covers the sample period 1974Q1 to 1999Q4. Quarterly data on total exports, manufacturing exports and manufacturing output are obtained from various monthly issues of the *International Financial Statistics*. Data on GDP and capital formation are taken from various issues of the *International Financial Statistics Yearbook*. Annual figures are then converted into quarterly series by using the Lisman-Sandee method. Real GDP, real gross capital formation and real manufacturing output series are constructed by deflating the nominal series by the domestic consumer price index (CPI) while exports series are deflated by the unit price index of exports of Bangladesh. All the variables are expressed in domestic currency.

### 3.1 *The Order of Integration of the Variables*

Since we are dealing with time series macro-variables, it is necessary to test for the 'stationarity' status or order of integration of the time series, which is conventionally done by unit root testing. However, conventional unit root testing may not be appropriate if a break or jump exists in the time series [Perron 1989, Zivot and Andrews 1992; Gregory and Hansen, 1996]. To check for the presence of a break, we estimate the following equation for each of the variables:

$$y_t = y_{t-1} + \epsilon_t + DP_1 + DP_2 + DP_3$$

where,  $DP_1$ ,  $DP_2$ , and  $DP_3$  are pulse dummies representing three phases of structural adjustment programmes in Bangladesh in 1982, 1986 and 1991 respectively. On the basis of the 't' values of the  $DP_j$  coefficients, we cannot reject the null hypothesis of no break or jump in either of the series. Therefore, the standard unit root tests can be applied to each series under consideration.

Both the Augmented Dickey-Fuller (ADF) and the Phillip-Perron (PP) tests indicate that the variables are non-stationary in their levels. The test statistics are presented in Table 1. A non-stationary series can be made stationary by detrending or differencing depending on whether the series contains a trend stationary process (TSP) or a difference stationary process (DSP). To see if the variables are TSP or DSP, following Nelson and Plosser (1982) and Bhargava (1986), we carry out a nested hypothesis testing as follows:

$$\text{TSP: } y_t = \alpha + \delta t + u_t$$

$$\text{DSP: } y_t = \alpha + \rho y_{t-1} + u_t$$

where  $u_t$  is stationary. The nested model can be written as:

$$y_t = \alpha + \delta t + \rho y_{t-1} + e_t$$

**Table 1:** *The ADF and the PP Tests for Unit Roots in the Levels of the Variables*

Series	Test Category	t-Values (with constant)	t-Values (with constant & trend)	Comment
ty <sub>t</sub>	ADF	-1.40 (4) <sup>sbc</sup>	-2.41 (4) <sup>sbc</sup>	Not I(0)
		-1.30 (6) <sup>aic</sup>	-2.80 (5) <sup>aic</sup>	Not I(0)
my <sub>t</sub>	ADF	<b>-1.11</b>	<b>-1.36</b>	<b>Not I(0)</b>
		-2.03 (4) <sup>sbc</sup>	-2.18 (4) <sup>sbc</sup>	Not I(0)
tx <sub>t</sub>	ADF	-1.84 (5) <sup>aic</sup>	-2.31 (5) <sup>aic</sup>	Not I(0)
		<b>-2.24</b>	<b>-2.70</b>	<b>Not I(0)</b>
mx <sub>t</sub>	ADF	-0.47 (4) <sup>aic, sbc</sup>	-1.20 (4) <sup>sbc</sup>	Not I(0)
		<b>-1.20</b>	<b>-2.69</b>	<b>Not I(0)</b>
inv <sub>t</sub>	ADF	-0.17 (5) <sup>aic, sbc</sup>	-2.61 (4) <sup>aic, sbc</sup>	Not I(0)
		<b>-1.21</b>	<b>-2.00</b>	<b>Not I(0)</b>
inv <sub>t</sub>	ADF	-1.42 (3) <sup>sbc</sup>	-2.43 (3) <sup>sbc</sup>	Not I(0)
		-1.30 (4) <sup>aic</sup>	-2.78 (4) <sup>aic</sup>	Not I(0)
	<b>PP</b>	<b>-0.27</b>	<b>-1.62</b>	<b>Not I(0)</b>

Legend: <sup>aic</sup> = Akaike's Information Criterion; <sup>sbc</sup> = Schwartz Bayesian Criterion

Notes: (a) Numbers in parentheses corresponding to ADF t-statistics are the optimal lags as specified AIC or SBC  
 (b) t-values corresponding to Phillips-Perron (PP) tests are based on 4 truncation lags. similar results are obtained for different lags upto 12, the maximum examined; and  
 (c) Critical values for t-statistics with constant and with constant and trend at 5% significance levels are -2.89 and -3.45 respectively.

**Table 2:** *The ADF and the PP Tests for Unit Roots in the First-Differences of the Variables*

Series	Test Category	t-Values (with constant)	t-Values (with constant & trend)	Comment
Δty <sub>t</sub>	ADF	-8.11 (4) <sup>sbc</sup>	-7.93 (4) <sup>sbc</sup>	I(1)
		-5.32 (5) <sup>aic</sup>	-6.42 (5) <sup>aic</sup>	I(1)
Δmy <sub>t</sub>	ADF	<b>-6.92</b>	<b>-7.36</b>	<b>I(1)</b>
		-11.96 (3) <sup>sbc</sup>	-9.12 (4) <sup>sbc, sbc</sup>	I(1)
Δtx <sub>t</sub>	ADF	-6.38 (4) <sup>aic</sup>	-7.24	I(1)
		<b>-7.23</b>	<b>-13.47 (3)<sup>sbc</sup></b>	<b>I(1)</b>
Δmx <sub>t</sub>	ADF	-13.47 (3) <sup>sbc</sup>	-13.47 (3) <sup>sbc</sup>	I(1)
		-9.54 (4) <sup>aic</sup>	-9.59 (4) <sup>aic</sup>	I(1)
Δinv <sub>t</sub>	ADF	<b>-16.36</b>	<b>-17.21</b>	<b>I(1)</b>
		-4.09 (3) <sup>sbc</sup>	-4.10 (3) <sup>sbc</sup>	I(1)
Δinv <sub>t</sub>	ADF	-4.42 (4) <sup>aic</sup>	-4.48 (4) <sup>aic</sup>	I(1)
		<b>-3.66</b>	<b>-3.72</b>	<b>I(1)</b>
Δinv <sub>t</sub>	ADF	-4.86 (2) <sup>sbc</sup>	-4.82 (3) <sup>sbc</sup>	I(1)
		-4.32 (3) <sup>aic</sup>	-4.29 (4) <sup>aic</sup>	I(1)
	<b>PP</b>	<b>-3.35</b>	<b>-3.79</b>	<b>I(1)</b>

Legend: <sup>aic</sup> = Akaike's Information Criterion; <sup>sbc</sup> = Schwartz Bayesian Criterion

Notes: (a) Numbers in parentheses corresponding to ADF t-statistics are the optimal lags as specified AIC or SBC  
 (b) t-values corresponding to Phillips-Perron (PP) tests are based on 4 truncation lags. similar results are obtained for different lags upto 12, the maximum examined; and  
 (c) Critical values for t-statistics with constant and with constant and trend at 5% significance levels are -2.89 and -3.45 respectively.

We test the null hypothesis  $H_0: \rho = 1$  and  $\delta = 0$ , the rejection of which will confirm that the series is TSP or else, it is DSP. Applying the procedure we find that all of the variables of the present study fall into the DSP category. The results are summarised in Table 3.1.

**Table 3.1:** *Summary Results of the Nested Hypothesis*

Series	Sample Size	$t_{\rho^{\wedge}}$
$ty_t$	103	-1.77
$my_t$	103	-1.47
$txt$	103	-3.40
$mx_t$	103	-2.13
$inv_t$	103	-1.88

*Note:* the one-tail critical value of t for a sample size of 100 at 5% significance level is -3.45 (source: Nelson and Plosser, 1982, p.151).

Applying the ADF and the PP tests, we find the first differences of the variables to be  $I(0)$  implying that the level variables are  $I(1)$ . The results are shown in Table 2.

### ***3.2 The Test for Cointegration***

As specified in models 1 through 4, the variable vectors we are interested in are  $(ty_t, mx_t, inv_t)'$ ,  $(ty_t, mx_t, inv_t)'$ ,  $(my_t, txt, inv_t)'$  and  $(my_t, mx_t, inv_t)'$ . For the first vector, the AIC and the SBC suggest an order of the VAR of 4 and 3 respectively. Both the orders are supported by the Adjusted Likelihood Ratio (LR) test. Besides, there is no problem of residual serial correlation

**Table-3.2:** *Johansen-Juselius Tests for Cointegration: ( $z_t$ :  $ty_t$ ,  $tx_t$ ,  $inv_t$ )*

$\lambda_{\max}$ statistic				$\lambda_{\text{trace}}$ statistic			
Null	Alternative	Statistic	95% Critical t	Null	Alternative	Statistic	95% Critical t
$r = 0$	$r = 1$	<b>17.68</b>	<b>13.65</b>	$r = 0$	$r \geq 1$	<b>39.33</b>	<b>36.38</b>
$r \leq 1$	$r = 2$	2.77*	11.03	$r \leq 1$	$r \geq 2$	21.75*	23.83
$r \leq 2$	$r = 3$	1.16	4.16	$r \leq 2$	$r \geq 3$	8.04	11.54

**Table-3.3:** *Johansen-Juselius Tests for Cointegration: ( $z_t$ :  $ty_t$ ,  $mx_t$ ,  $inv_t$ )*

$\lambda_{\max}$ statistic				$\lambda_{\text{trace}}$ statistic			
Null	Alternative	Statistic	95% Critical t	Null	Alternative	Statistic	95% Critical t
$r = 0$	$r = 1$	<b>22.59</b>	<b>22.04</b>	$r = 0$	$r \geq 1$	<b>35.83</b>	<b>34.87</b>
$r \leq 1$	$r = 2$	8.92*	15.87	$r \leq 1$	$r \geq 2$	13.23*	20.18
$r \leq 2$	$r = 3$	4.31	9.16	$r \leq 2$	$r \geq 3$	4.16	9.16

**Table-3.4:** *Johansen-Juselius Tests for Cointegration ( $z_t$ :  $my_t$ ,  $tx_t$ ,  $inv_t$ )*

$\lambda_{\max}$ statistic				$\lambda_{\text{trace}}$ statistic			
Null	Alternative	Statistic	95% Critical t	Null	Alternative	Statistic	95% Critical t
$r = 0$	$r = 1$	<b>30.85</b>	<b>21.12</b>	$r = 0$	$r \geq 1$	<b>39.41</b>	<b>31.54</b>
$r \leq 1$	$r = 2$	8.41*	14.88	$r \leq 1$	$r \geq 2$	8.56*	17.86
$r \leq 2$	$r = 3$	0.15	8.07	$r \leq 2$	$r \geq 3$	0.15	8.07

**Table-3.5:** *Johansen-Juselius Tests for Cointegration ( $Z_t$ :  $my_t$ ,  $mx_t$ ,  $inv_t$ )*

$\lambda_{\max}$ statistic				$\lambda_{\text{trace}}$ statistic			
Null	Alternative	Statistic	95% Critical t	Null	Alternative	Statistic	95% Critical t
$r = 0$	$r = 1$	<b>24.21</b>	<b>21.12</b>	$r = 0$	$r \geq 1$	<b>33.80</b>	<b>31.54</b>
$r \leq 1$	$r = 2$	8.32*	14.88	$r \leq 1$	$r \geq 2$	8.93*	17.86
$r \leq 2$	$r = 3$	0.61	8.07	$r \leq 2$	$r \geq 3$	0.61	8.07

Note:  $r$  is the number of cointegrating vectors.

or normality associated with the individual equations in the unrestricted VAR. Noting that the SBC has superior large sample properties while the AIC tends to favour an overparameterised model, we select an order of 3 for the first vector. For the second vector, both AIC and SBC suggest an order of 2 which is consistent with the diagnostic checks. For both the third and fourth vectors, the AIC suggests an order of 3 while the SBC suggests an order of 2, neither of which can be rejected on the basis of the adjusted LR test. However, an order of 3 results in residual

serial correlation for the respective equations in the unrestricted VAR, while an order of 2 does not. We, therefore, select an order of 2 for both the vectors. To examine the number of cointegrating vectors in each model, we compute the maximum eigen values ( $\lambda_{\max}$ ) and the trace statistics ( $\lambda_{\text{trace}}$ ) by applying the Johansen-Juselius procedure. The results are presented in Tables 3.2 to 3.5. The  $\lambda_{\max}$  and the  $\lambda_{\text{trace}}$  statistics reject the null hypothesis of no cointegration ( $r = 0$ ) against  $r=1$  or  $r \geq 1$  respectively in each of the models at 5 % significance level. However, neither of the criteria can reject the null hypothesis of  $r = 1$  against the alternative hypothesis of  $r = 2$  or  $r \geq 2$  at 5 % significance level. We, therefore, conclude that there exists only one cointegrating relationship among the [I(1)] variables in each model.

## 4. ESTIMATED RESULTS

### 4.1 *The Bivariate and Multivariate Granger Causality*

The Granger causality tests are performed using the (optimal) lag lengths for the variables as determined by Akaike's final prediction errors. For the five variables-- $ty_t$ ,  $my_t$ ,  $tx_t$ ,  $mx_t$ , and  $inv_t$ -- the optimal lag lengths are respectively 11, 10, 11, 10, and 12 quarters. As shown in Table 4.1, both the bivariate and the trivariate frameworks suggest positive and significant two-way causation between total exports and GDP growth (Model 1 and Model 5). This is in contrast with Islam's (Islam, 1998) findings where the causation is unidirectional, from total exports to GDP. The bivariate models also indicate bi-directional causality between manufacturing exports and GDP, total exports and manufacturing output as well as manufacturing exports and manufacturing output. However, the multivariate models confirm only unidirectional causality from manufacturing exports to GDP and from manufacturing exports to manufacturing output.

**Table 4.1:** *Test results of Causality between Expansion of Exports and Growth*

	Model	Direction of causation	F-Statistic
1.	(tyt, txt)	txt $\rightarrow$ tyt (+ 0.02) ty <sub>t</sub> $\rightarrow$ tx <sub>t</sub> (+ 0.32)	79.50* 65.45*
2.	(tyt , mxt )	mxt $\rightarrow$ tyt (+ 0.02) ty <sub>t</sub> $\rightarrow$ mx <sub>t</sub> (+ 0.01)	81.37* 16.80*
3.	(myt , txt )	txt $\rightarrow$ myt (+ 0.06) my <sub>t</sub> $\rightarrow$ tx <sub>t</sub> (+ 0.03)	15.16* 67.51*
4.	(myt , mxt )	mxt $\rightarrow$ my (+ 0.02) my $\rightarrow$ my <sub>t</sub> (+ 0.03)	17.03* 22.31*
5.	(ty <sub>t</sub> , tx <sub>t</sub> , inv <sub>t</sub> )	tx <sub>t</sub> $\rightarrow$ ty <sub>t</sub> (+ 0.03) ty <sub>t</sub> $\rightarrow$ tx <sub>t</sub> (+ 0.22)	73.02* 57.58*
6.	(ty <sub>t</sub> , mx <sub>t</sub> , inv <sub>t</sub> )	mx <sub>t</sub> $\rightarrow$ ty <sub>t</sub> (+ 0.02) ty <sub>t</sub> $\rightarrow$ mx <sub>t</sub>	75.66* 1.42
7.	(myt , txt , invt )	txt $\rightarrow$ myt my <sub>t</sub> $\rightarrow$ tx <sub>t</sub>	1.67 1.60
8.	(my <sub>t</sub> , mx <sub>t</sub> , inv <sub>t</sub> )	mx <sub>t</sub> $\rightarrow$ my <sub>t</sub> my <sub>t</sub> $\rightarrow$ mx <sub>t</sub>	10.93* 1.51

*Legend:*

$\rightarrow$  indicates that the left hand side variable Granger causes the right hand side variable.

\* the F-statistic is significant at 5% level of significance.

*Note:* figures in brackets show sum total of the coefficients of the lagged terms of the independent variable.

Total exports neither causes nor is caused by manufacturing output. The existence of Granger causality from total exports to GDP and from manufacturing exports to GDP and manufacturing output in the presence of the investment variable is indicative of an improvement in efficiency

#### **4.2 Error Correction in the Engle-Granger Framework**

Since the primary objective of the study is to ascertain whether export variables caused the growth variables, we skip the analysis of reverse causality from this point onwards. While we continue with the three-variable framework, we introduce three dummy variables to represent

shifts in the trade policy regime. Accordingly,  $D_{1982} = 0$  for quarters 1974Q1 through 1981Q4 and 1 otherwise,  $D_{1986} = 0$  for quarters 1974Q1 through 1986Q4 and 1 otherwise, and  $D_{1991} = 0$  for quarters 1974Q1 through 1991Q4 and 1 otherwise. The error correction term,  $EC_t$ , in each model, is derived by normalising on the growth variable in the respective vector. We then apply the principle of 'general-to-specific modelling' (Hendry, 1995) to arrive at 'parsimonious' and economically interpretable models. The results are shown in Table 4.2. A comparison between equations (1) and (2) shows that both total exports and manufacturing exports have positive and statistically significant impact on the growth of GDP although the coefficients are rather small in magnitude, 0.06 and 0.03 respectively. In both the cases, investment and the past values of GDP appear as more important sources of growth. The negative and statistically significant coefficients of the error correction terms suggest that there is a short run adjustment process working behind the long run equilibrium relationship between total exports and growth, and between manufacturing exports and growth. In both cases, the period of adjustment is roughly 6 quarters. With statistically significant error correction terms and lagged values of exports appearing as explanatory variables, we can also conclude that both total exports and manufacturing exports have contemporaneous effects on growth. Total exports appear not to (Granger) cause manufacturing output (equation (3)) though the variables are cointegrated as indicated by the negative and statistically significant coefficient of the error correction term. Manufacturing exports, on the other hand, emerges as a very important determinant of the growth of manufacturing output, the coefficient being 0.60. Higher values of the coefficients of the error correction terms in equations (3) and (4) imply shorter period of adjustment in the exports-manufacturing output growth relationship. Of the dummy variables, only  $D_{1986}$  has been found significant in a lone case that indicates a (small) shift in the long run relationship between the growth of manufacturing-output and manufacturing exports.



**Table 4.2:** *Estimated Regression Results Based on Engle-Granger Error Correction Procedure***(1) GDP and Total Exports**

$\Delta ty_t$	= -0.01	+ 0.22 $\Delta ty_{t-4}$	+ 0.06 $\Delta tx_{t-2}$	+ 0.21 $\Delta inv_t$	+ 0.15 $\Delta inv_{t-1}$	- 0.16 $ec_{t-1}$
	(-1.37)	(3.19)*	(2.74)*	(2.70)*	(1.86)***	(-3.35)*
$R^2$	= 0.39	LMS = 6.74 [.150]				
Adjusted $R^2$	= 0.35	RESET = 2.93 [.147]				
F(6, 94)	= 9.89*	NORM = 0.57 [.757]				
DW	= 1.97	HET = 2.02 [.182]				

**(2) GDP and Manufacturing Exports**

$\Delta ty_t$	= 0.01	+ 0.21 $\Delta ty_{t-4}$	+ 0.03 $\Delta mx_{t-2}$	+ 0.21 $\Delta inv_t$	+ 0.16 $\Delta inv_{t-1}$	- 0.16 $ec_{t-1}$
	(0.58)	(2.85)*	(3.33)*	(2.66)*	(1.94)***	(-3.16)*
$R^2$	= 0.34	LMS = 3.85 [.427]				
Adjusted $R^2$	= 0.30	RESET = 1.14 [.285]				
F(6, 94)	= 8.17*	NORM = 1.30 [.523]				
DW	= 1.94	HET = 0.74 [.389]				

**(3) Manufacturing Output and Total Exports**

$\Delta my_t$	= -0.03	+ 0.19 $\Delta my_{t-4}$	+ 0.10 $\Delta tx_{t-2}$	+ 0.33 $\Delta inv_t$	- 0.34 $ec_{t-1}$	+ 0.04 $D_{1986}$
	(-1.42)	(2.10)**	(1.30)	(1.28)	(-4.65)*	(1.39)
$R^2$	= 0.28	LMS = 3.41 [.491]				
Adjusted $R^2$	= 0.24	RESET = 0.01 [.952]				
F(6, 94)	= 6.92*	NORM = 0.71 [.703]				
DW	= 1.94	HET = 1.06 [.304]				

**(4) Manufacturing Output and Manufacturing Exports**

$\Delta my_t$	= -0.03	+ 0.29 $\Delta my_{t-4}$	+ 0.60 $\Delta mx_{t-4}$	+ 0.57 $\Delta inv_t$	- 0.36 $ec_{t-1}$	+ 0.05 $D_{1986}$
	(-1.30)	(3.09)*	(1.96)***	(1.96)***	(-4.75)*	(1.80)**
$R^2$	= 0.40	LMS = 6.99 [.136]				
Adjusted $R^2$	= 0.30	RESET = 0.53 [.466]				
F(6, 94)	= 4.23*	NORM = 1.91 [.384]				
DW	= 1.94	HET = 1.26 [.261]				

Legend:

\*significant at 1% level; \*\*significant at 5% level; \*\*\*significant at 10% level.

*Note:* figures in parentheses denote the rejection level of significance.**Diagnostic Tests:**

LMS: Lagrange multiplier test for residual serial correlation.

RESET: Ramsey RESET test for functional form mis-specification.

NORM: Jarques-Bera test for normality of residuals.

HET: Test for heteroscedasticity based on squared residuals.

### ***4.3 Error Correction in the Johansen Proper***

The results of this section are based on essentially the same procedure as in the previous section except that the error correction terms are now derived from the imposition of general restrictions on the cointegrating vectors as determined by the likelihood ratio test. As pointed out earlier, the Johansen procedure treats all the variables as endogenous. Therefore, normalising on any of the variables produces identical cointegrating vector(s), unlike the Engle-Granger procedure. The regression results based on the Johansen procedure are presented in Table 4.3. In most of the cases, the results support the findings based on the Engle-Granger procedure. First, both total exports and manufacturing exports are found to have significantly contributed to the growth of GDP. However, the elasticity coefficients differ considerably. The two lagged values of total exports in equation (1) have a combined elasticity coefficient of 0.12 (against 0.06 in the Engle-Granger case). The difference is even more apparent in the case of the manufacturing exports that have a coefficient of 0.14 instead of 0.03. Similar is the case with manufacturing output and manufacturing exports. Secondly, in all the above three cases, the error correction terms are statistically significant. Coupled with the existence of the lagged terms in the estimated equations, this suggests Granger causality from total exports to GDP, from manufacturing exports to GDP as well as from manufacturing exports to manufacturing output. However, the speed of adjustment coefficients are much lower in the cases of total exports-GDP, and manufacturing exports-manufacturing output relationships implying longer 'short run' adjustment processes towards the long run equilibrium. Thirdly, as before, structural change is indicated only in the relationship between manufacturing exports and manufacturing output.

The most contrasting results are evidenced in the case of manufacturing output and total exports relationship. While the Engle-Granger technique suggests no link between total exports and

**Table 4.3:** *Estimated Regression Results Based on Johansen Error Correction Procedure***(1) GDP and Total Exports**

$\Delta y_t$	= 0.36	+ 0.21 $\Delta y_{t-1}$	+ 0.05 $\Delta x_{t-1}$	+ 0.07 $\Delta x_{t-2}$	+ 0.24 $\Delta inv_t$	+ 0.15 $\Delta inv_{t-4}$	- 0.11 $ec_{t-1}$
	(2.44)**	(2.49)**	(2.12)**	(3.04)*	(3.09)*	(-2.52)**	(-2.47)
$R^2$	= 0.39	LMS = 4.98 [.290]					
Adjusted $R^2$	= 0.35	RESET = 0.39 [.535]					
F(7, 93)	= 8.46*	NORM = 1.42 [.491]					
DW	= 2.10	HET = 0.01 [.934]					

**(2) GDP and Manufacturing Exports**

$\Delta y_t$	= 0.36	+ 0.23 $\Delta y_{t-1}$	+ 0.14 $\Delta mx_{t-4}$	+ 0.27 $\Delta inv_t$	- 0.13 $ec_{t-1}$
	(2.64)*	(2.61)*	(1.80)***	(3.26)*	(-2.70)*
$R^2$	= 0.31	LMS = 5.86 [.214]			
Adjusted $R^2$	= 0.28	RESET = 1.19 [.276]			
F(5, 95)	= 8.56*	NORM = 2.65 [.352]			
DW	= 2.09	HET = 1.54 [.214]			

**(3) Manufacturing Output and Total Exports**

$\Delta my_t$	= 0.68	+ 0.14 $\Delta my_{t-4}$	+ 0.15 $\Delta x_{t-1}$	+ 0.32 $\Delta inv_t$	- 0.31 $ec_{t-1}$
	(5.09)*	(2.12)**	(1.95)***	(1.25)	(-5.22)*
$R^2$	= 0.29	LMS = 8.07 [.097]			
Adjusted $R^2$	= 0.25	RESET = 0.80 [.372]			
F(5, 95)	= 7.48*	NORM = 0.15 [.926]			
DW	= 1.97	HET = 0.08 [.773]			

**(4) Manufacturing Output and Manufacturing Exports**

$\Delta my_t$	= 0.41	+ 0.15 $\Delta my_{t-4}$	+ 0.79 $\Delta mx_{t-4}$	+ 0.57 $\Delta inv_t$	- 0.11 $ec_{t-1}$	+ 0.10 $D_{1986}$
	(2.11)**	(1.60)	(2.91)*	(2.01)**	(-2.27)*	(1.85)**
$R^2$	= 0.25	LMS = 4.29 [.287]				
Adjusted $R^2$	= 0.24	RESET = 2.40 [.121]				
F(6, 94)	= 3.71*	NORM = 2.43 [.297]				
DW	= 1.84	HET = 0.42 [.516]				

Legend:

\*significant at 1% level; \*\*significant at 5% level; \*\*\*significant at 10% level.

*Note:* figures in parentheses denote the rejection level of significance.**Diagnostic Tests:**

LMS: Lagrange multiplier test for residual serial correlation.

RESET: Ramsey RESET test for functional form mis-specification.

NORM: Jarques-Bera test for normality of residuals.

HET: Test for heteroscedasticity based on squared residuals.

manufacturing output and hence no Granger causality from total exports, the Johansen procedure indicates a significant impact of total exports on manufacturing output *vis-a-vis* the Granger causality, in that order. All the models confirm an improvement in efficiency.

## 5. THE INNOVATION ACCOUNTING

The innovation accounting is a way to ascertaining the dynamic responses of the variables in a VAR. The *impulse response function* measures the time profile of a variable as a result of a unitary exogenous shock in another variable, or a system-wide unitary shocks, at time  $t$ . The shock(s) to be chosen is an alteration in the error term(s) by one standard error of the respective equation(s) in a VAR, which is equivalent to a one unit change in the variable to shock. The alternative impulse response functions include the *orthogonalised impulse response function* *a'la* Sims (1980, 1981) and the *generalised impulse response function* proposed by Koop *et al.* (1996). The orthogonalised impulse responses, derived from the Choleski decomposition of the variance-covariance matrix of the VAR, are not in general unique since they depend on the particular orderings of the variables in the VAR. They are unique only if the variance-covariance matrix is diagonal. The generalised impulse responses overcome the non-uniqueness problem of the orthogonalised impulse responses. The *forecast error variance decomposition* measures the proportion of the movements in a sequence explained by its own shocks as well as the movements due to other variable(s). Depending on the relative contribution of the "own" shocks in the sequence of a variable, one can judge if the sequence is exogenous or endogenous. The impulse responses, in the context of a traditional VAR, are an efficient tool to determining the stability of the estimated equations, the stability being indicated by the convergence or lack of it of the impulse response coefficients to zero. In a cointegrating VAR model, however, the effects of the shocks on individual variables do not converge to zero. Lee and Pesaran (1993) suggest an alternative approach that considers the variable-specific shocks on the cointegrating relations rather than on the individual variables in the models whereby the effects of the shocks necessarily die out. Pesaran and Shin (1996), on the other hand, consider the effect of system-

wide shocks or the *persistence profiles* for the cointegrating relations, which gives the speed of convergence of the model to its long run equilibrium. The authenticity of a cointegrating vector is measured by the tendency of the profile to zero as the horizon extends to infinity.

We find the impulse responses of both GDP and manufacturing output to shocks in all the variables in the alternative models to die out after a certain period (not shown here). This verifies the stability of all the estimated models. The impulse responses of the cointegrating vectors are also found to be converging to zero, thus verifying the stability of the long run equilibrium relationship of the variables in each model. The effects of the system-wide shocks disappear over time in all the cointegrating relations, which confirms the authenticity of the cointegrating relations. The speeds of convergence are approximately 10, 28, 5 and 15 quarters for models  $(ty_t, tx_t, inv_t)$ ,  $(ty_t, mx_t, inv_t)$ ,  $(my_t, tx_t, inv_t)$  and  $(my_t, mx_t, inv_t)$  respectively.

The forecast error variance decompositions of the sequences  $\{ty_t\}$  and  $\{my_t\}$ , due to "own" shocks are found to be decaying through time. The proportions of movements due to "own" shocks are found to be higher at shorter horizon (almost cent percent) and lower at longer horizons. The proportions of movements in  $\{ty_t\}$  and  $\{my_t\}$  due to shocks from total exports show a rising tendency over time with a very small (near zero) initial value. Similar is the case with the shocks from manufacturing exports. All this suggests that the GDP and the manufacturing output sequences do not evolve independently of total exports or manufacturing exports, which implies that the sequences are not exogenous. The patterns also suggest that shocks from total exports and manufacturing exports have little or no contemporaneous effects on GDP and manufacturing exports. They affect the two sequences with lags.

## **6. EMPIRICAL RESULTS BASED ON ENCOMPASSING PRINCIPLE AND THE NON-NESTED TESTS**

The empirical results presented in Section 4 provide evidence for the 'export-led' growth hypothesis for Bangladesh. Both total- and manufacturing exports appear to have contributed to the growth of GDP as well as manufacturing output. This section attempts to verify the hypothesis that manufacturing exports has emerged as a new engine of export-led growth. We also explore if manufacturing output growth is the result of the expansion of manufacturing exports or total exports.

The principle of encompassing has been extensively used as a formal basis for evaluating competing models. The theoretical underpinnings are described in Cox (1961 and 1962), Davidson and MacKinnon (1981), Dastoor (1983), Godfrey and Pesaran (1983), and MacKinnon (1983). Examples of empirical applications include Godfrey and McAleer (1983), Fan and Li (1995), Davidson and McKinnon (1993). Technically, Model 1 is a cogent explanation of the true data generation process (DGP) if it can explain or encompass the information contained in Model 2 while the converse is not true. Similar argument holds for Model 2. Non-nested tests are examples of encompassing tests. Two models are said to be 'non-nested' or 'separate' if one of them cannot be obtained from the other by imposing a restriction. Tests for non-nested hypotheses are a means for testing the specification of the model under the null hypothesis by working on the rival model which is hypothesised as 'false'. The roles of the two hypotheses are reversed while testing for the specification of the rival model. The earlier non-nested tests aimed at discriminating between models in which case one of the models would be chosen. In recent years, the emphasis has shifted to 'testing' rather than discrimination and the latter is treated as a special case of the former. Non-nested F-, J- and JA-tests fall into this category. F-test is a

'mean' encompassing test while J-and JA-tests are 'variance' encompassing tests. Though very convenient to use, the non-nested F-test may not provide accurate results if the regressors in the artificially nested model are highly correlated. The J- and the JA-test are designed to amend the collinearity problems. The J-test, proposed by Davidson and MacKinnon (1981), is considered as the most convenient one to apply. It also compares well with other tests [Davidson and MacKinnon 1982]. The JA-test is considered to be an exact and robust test when the two sets of regressors are near orthogonal and when the hypotheses are linear [Michelis 1993] and it produces tests of correct size even in small samples [Doran 1993]. The J-test, on the contrary, is not exact and suffers from size distortions. It tends to over-reject a true hypothesis in small samples. However, the J-test is a more powerful procedure than the JA-test. Because of this, it is recommended that both the tests be applied simultaneously. Fan and Li (1995) provide a solution to the size distortions of the J- and the JA-test by suggesting a bootstrap method which, they contend, would overcome the size distortion due to near orthogonality and improve on the normal approximation based on asymptotic theory in small samples.

In order to see if the total exports-GDP relationship can encompass the manufacturing exports-GDP relationship or *vice versa* we choose to apply both the J- and the JA-tests. As the regressors in the rival models of growth of GDP as well as growth of manufacturing output are not found to be highly multicollinear, we also attempt the encompassing F-test. Since the sample size used in the study is not very large, it warrants the use of the bootstrap J- and the JA-tests. However, orthogonality seems not to be serious problem since only in a couple of instances the correlation coefficient is less than or equal to the threshold level of 0.10. We, therefore, do not attempt the bootstrap J- or JA- test.

We consider two rival models each for the growth of GDP and the growth of manufacturing output. The first model,  $M_1$ , postulates that growth of GDP is driven by total exports, and the second model,  $M_2$ , says that manufacturing exports cause growth of GDP. For the manufacturing output, we denote the two rival models as  $M_3$  and  $M_4$  respectively. The variables in each model are chosen from the list of the explanatory variables suggested by the Johansen-Juselius MLECM in Section 4 which are reproduced in summary form in Table 6.1 above.

**Table 6.1:** *Total Exports-Growth and Manufacturing Exports-Growth Models*

$M_1$ : Total Exports-GDP Growth. <i>Dependent Variable:</i> $dy_t$	$M_2$ : Manufacturing Exports-GDP Growth. <i>Dependent Variable:</i> $dy_t$	$M_3$ : Total Exports-Manufacturing Output Growth. <i>Dependent Variable:</i> $dmy_t$	$M_4$ : Manufacturing Exports-Manufacturing Output Growth. <i>Dependent Variable:</i> $dmy_t$
Constant	Constant	Constant	Constant
$dy_{t-1}$	$dy_{t-1}$	$dmy_{t-4}$	$dmy_{t-4}$
$dx_{t-1}$	$dmx_{t-4}$	$dx_{t-1}$	$dmx_{t-4}$
$dx_{t-2}$	$dinv_t$	$dinv_t^*$	$dinv_t$
$dinv_t$	$ec2_{t-1}$	$ec3_{t-1}$	$ec4_{t-1}$
$dinv_{t-4}$			$D_{1986}$
$ec1_{t-1}$			

*Note:* an\* indicates that the coefficient of the variable is not significant at a 10% level of significance or less.

In order for the rival models to qualify as non-nested, each model must contain at least one explanatory variable that is not contained in the second model [Davidson and MacKinnon, 1993: p.381]. Looking at the sets of variables in  $M_1$  and  $M_2$ , and  $M_3$  and  $M_4$  in Table 6.1 we see that both the pairs of models qualify as non-nested. Orthogonality is a problem only in the cases of  $(dmy_{t-4}, dinv_t)$  and  $(dx_{t-1}, dinv_t)$ . We, therefore, assume that orthogonality may not affect the estimated results. Moreover, since the J-test does not suffer from power problem and the JA test is robust to near orthogonality, the joint application of both the tests might lead to a meaningful conclusion. Multicollinearity is not a problem for the pair of models  $M_3$  and  $M_4$ . Thus the F test



can be applied straightaway to these models. However, one can also tentatively apply the F test to  $M_1$  and  $M_2$  since the problem of multicollinearity seems to exist only in the single case of  $(ec1_{t-1}, ec2_{t-1})$ . Alternatively, we can drop the collinear variables from the list of the regressors. The rival models still contain variables representing respectively total exports and manufacturing exports. Similarly, by dropping the orthogonal variables we can still verify that both the pairs of models qualify as non-nested.

***The Estimated Test Statistics:*** We first present the estimated test statistics for various non-nested models without taking into consideration the problems of orthogonality and/or multicollinearity. This is done by dropping  $div_t$  from  $M_3$ , since the coefficient of the variable is not statistically significant at even a 10% level of significance. The results are then compared with those found after dropping the orthogonal and/or the collinear variables. Table 6.2 presents the non-nested tests for  $M_1$  and  $M_2$  and Table 6.3 reports the test results for  $M_3$  and  $M_4$ . Referring to Table 6.1, the small sample N-test cannot reject the null hypothesis of total export-led growth of GDP ( $M_1$ ) against the alternative of manufacturing export-led growth of GDP ( $M_2$ ). It, however, rejects the null of  $M_2$  against  $M_1$  at even 1% significance level. Thus, the N-test favours the total-export led growth hypothesis. The same conclusion can be drawn from the NT-test, the W-test and the J-test. The JA-test also favours  $M_1$  against  $M_2$  at a 5% level of significance. At a 10% significance level, however, the JA-test cannot reject either model. The encompassing F-test suggests that the explanation provided by the total-export model of GDP cannot be improved by incorporating information from the rival model. In other words,  $M_1$  can encompass the explanation of the growth of GDP contained in  $M_2$ . Thus,  $M_1$  provides a plausible explanation of the growth of GDP when compared with  $M_2$ . The encompassing F-test for  $M_2$  vs.  $M_1$  indicates that manufacturing export model of GDP growth can be improved by bringing in information from the rival model. It thus rejects  $M_2$  as a plausible explanation of

**Table 6.2:** *Non-Nested Tests of Total Exports and Manufacturing Exports Models of GDP Growth*

Test Category	t-value: $M_1$ vs. $M_2$		t-value: $M_2$ vs. $M_1$	
N-Test	-1.47		-7.41*	
NT-Test	-0.94		-3.88*	
W-Test	-0.93		-3.63*	
J-Test	1.12		3.68*	
JA- Test	1.05		1.67**	
Encompassing	F (4, 92) 0.62	F (2, 92)	3.34*	
Model $M_1$ :	DW = 2.10	Adjusted $R^2 = 0.35$	LL = 194.55	
Model $M_2$ :	DW = 2.09	Adjusted $R^2 = 0.28$	LL = 188.38	
Model $M_1 + M_2$ :	DW = 2.11	Adjusted $R^2 = 0.34$	LL = 188.38	
Aikaike's Information Criterion:	$M_1$ vs $M_2 = 4.17$		Favours $M_1$	
Schwarz's Bayesian Criterion:	$M_1$ vs $M_2 = 1.55$		Favours $M_1$	

legend: \* significant at 5% level; \*\*significant at 10% level.

**Table 6.3:** *Non-Nested Tests of Total Exports and Manufacturing Exports Models of Manufacturing Output Growth*

Test Category	t-value: $M_1$ vs. $M_2$		t-value: $M_2$ vs. $M_1$	
N-Test	-2.15*		-2.12*	
NT-Test	-1.47		-1.68**	
W-Test	-1.42		-1.61	
J-Test	1.96*		1.87**	
JA- Test	1.53		1.64	
Encompassing	F(3, 90)	1.36	F(2, 90) 1.80	
Model $M_1$ :	DW = 1.79	Adjusted $R^2 = 0.25$	LL = 71.29	
Model $M_2$ :	DW = 1.71	Adjusted $R^2 = 0.24$	LL = 71.53	
Model $M_1 + M_2$ :	DW = 1.78	Adjusted $R^2 = 0.25$	LL = 73.44	
Aikaike's Information Criterion:	$M_1$ vs $M_2 = 0.75$		Favours $M_1$	
Schwarz's Bayesian Criterion:	$M_1$ vs $M_2 = 2.04$		Favours $M_1$	

Legend: \* significant at 5% level; \*\*significant at 10% level.

GDP growth. Last of all, the model selection criteria, AIC and SBC, both favour  $M_1$ . However, the AIC and the SBC are primarily concerned with judging the performance of a model on the basis of estimated residuals. They may not be justifiably applicable to non-nested tests where a choice is to be made between competing models [McAleer, 1987]. Overall, the non-nested tests and the encompassing F-test tend to accept the total-export explanation of the growth of GDP. The conclusion also holds even if the orthogonal variables in the two models are dropped, except for the JA-test, which now supports both  $M_1$  and  $M_2$  as plausible explanations of the growth of

GDP.<sup>2</sup> The encompassing F-test still lends support to  $M_1$ .<sup>3</sup> With respect to the manufacturing output growth, the N-test rejects both the total exports-manufacturing output model ( $M_3$ ) and manufacturing exports-manufacturing output model ( $M_4$ ) at 5% significance level (Table 6.3). The NT-test, the W-test and the JA-test all cannot reject either model at a 5% significance level while the J-test favours  $M_4$  very marginally. However, at a 10% significance level, the NT- and the J-test favour both models. The encompassing F-test indicates that each model can be improved upon plugging in information from the rival model. The AIC and the SBC, however, favour  $M_3$ . Dropping the orthogonal regressors from each model does not seem to affect the results considerably<sup>4</sup>. The N-test now favours  $M_3$  while the NT-test and the J-test cannot reject either model at a 5 percent significance level. Thus, we may conclude that both total exports and manufacturing export models provide plausible explanations for the growth of manufacturing output in Bangladesh.

## 7. CONCLUDING REMARKS

The study has attempted to provide empirical evidence concerning the relationship between expansion of exports and economic growth using Bangladesh as a case study. The findings of the study can be summarized as follows: The bivariate Granger causality tests suggest significant and positive bi-directional causality between total exports and GDP, manufacturing exports and GDP, total exports and manufacturing output, and manufacturing exports and manufacturing output. The trivariate Granger causality tests indicate only unidirectional causality between total

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<sup>2</sup> The t-values of N-test, NT-test, W-test, J-test and JA-test for  $M_1$  Vs  $M_2$  are respectively -1.41, -0.86, -0.85, 1.30 and 0.80. The t-values of the tests corresponding to  $M_2$  Vs  $M_1$  are respectively -8.70, -5.03, -4.60, 4.55 and 0.63.

<sup>3</sup> The encompassing F-values for  $M_1$  Vs  $M_2$  and  $M_2$  Vs  $M_1$  are respectively  $F(1, 94) = 2.20$  and  $F(3, 94) = 5.17$ .

<sup>4</sup>The t-values of N-test, NT-test, W-test, J-test and JA-test for  $M_1$  vs.  $M_2$  are respectively -1.30, -0.89, -0.87, 1.28 and 0.93. The corresponding t-values for  $M_2$  Vs  $M_1$  are respectively -2.02, -1.51, -1.47, 1.80 and 1.51.

exports and GDP, manufacturing exports and GDP, and manufacturing exports and manufacturing output in that order. Total exports do not Granger cause manufacturing output in the multivariate model and *vice versa*. The Engle-Granger error correction method confirms causality from total exports to GDP, from manufacturing exports to GDP as well as from manufacturing exports to manufacturing output. Once again, total exports appear not to cause manufacturing output. The Johansen procedure implicates Granger causality from the export to growth in all the four models considered. Thus, unlike the Engle-Granger method, the Johansen method indicates positive and significant Granger causality from total exports to manufacturing output. The two methods also differ with respect to the magnitudes of the coefficients of the explanatory variables in the other three cases. The two techniques universally support the existence of a cointegrating relation or long run equilibrium relationship among the variables in each model. Again, they differ with respect to the duration of the short run adjustment process. All the models indicate an improvement in efficiency due to an increase in exports. The possibility of a regime shift is evidenced only in the relationship between manufacturing exports and manufacturing output. The impulse responses and the persistence profiles indicate that the estimated equations as well as the cointegrating relations are stable and that the cointegrating relations are authentic. The forecast error variance decompositions verify that both the GDP and the manufacturing output sequences are endogenous to the models specified. On the whole, the study contends that there exists a long run and, stable relationship between expansion of exports and economic growth in Bangladesh. As to the relative importance of total exports and manufacturing exports in enhancing the growth of GDP vis-à-vis the manufacturing output, the empirical results do not to lend support to the claim that manufacturing exports has become a new engine of export-led growth. The whole range of the non-nested and the encompassing tests suggest that total exports, as opposed to manufacturing exports, is the main engine of growth in terms of GDP. As to the *manufacturing output*, both total exports and manufacturing exports

emerge as engines of growth. This implies that manufacturing exports cannot be claimed to be the sole determinant of growth of Bangladesh as claimed by the proponents of the *de novo* hypothesis.

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