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Trade, Growth and Wage Inequality in Bangladesh[1]

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Keywords: Trade liberalisation; Wage inequality; Out-of sample predictive ability; Mean squared forecast errors

JEL Classification: O1; F1

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I. INTRODUCTION

The development paradigm that many developing countries have embraced in recent years has raised concerns and questions regarding the potential effects of trade liberalisation - which has been one of the mainstays of this paradigm - on growth and income distribution in those countries. While its advocates aggressively argue that trade openness enhances growth, they are less vocal about how it affects income or wage distribution. Bangladesh, in its quest for growth, has joined this group of countries by switching from an import-substituting inward-oriented policy regime towards a more liberalised trade and market oriented regime. In over three decades of its independence, Bangladesh has witnessed growth in per capita real GDP, in volume and value of trade, and also an increase in income inequality.[1] It is not clear if these three are interrelated and, if so, what is the exact nature of their causal relations. In the literature, there are theoretical arguments that encompass almost all possible causal relationships between these variables. However, trade, growth and income/wage distribution in a country may be dynamically so intertwined that it requires scrupulous empirical analysis to disentangle their mutual causal relations. This paper is an attempt in that direction with special reference to Bangladesh.

Bangladesh, immediately after its independence in 1971, adopted import-substitution based inward-oriented economic policies. With a leading role accorded to the public sector, these policies entailed extensive government controls through investment

[1] Between 1971 and 2000, real GDP grew almost 3 times which translates into a growth rate of per capita real GDP of slightly over 30 percent. During the same period, the volume of trade (measured by exports plus imports at constant prices) grew almost 23 times. For a detailed account on the growth of GDP and trade, see Ahmed and Sattar (2004). The evidence on income distribution is controversial. While the Deininger and Square inequality data set indicates a decline in inequality, the data set compiled by the University of Texas Inequality Project (UTIP) indicates a rise in income inequality. Some recent studies (for example, Khan and Sen (2001) and Wodon (2000)) have shown that income inequality has risen in the 1990s.

sanctioning, import licensing and exchange controls, arbitrary exemptions, ad hoc concessions and subsidised loans, and allocation of activities to private and public enterprises. The failure of such policies was reflected in dismal growth performance of the first decade of independence. Also, among other developing nations which experimented with similar inward-oriented policies during the 1950s through the 1970s there were signs of disillusionment and, simultaneously, some enthusiasm for trade liberalisation - reinforced by the success of the Asian Tigers with trade-oriented growth strategies. These developments made a case for policy shift in Bangladesh as in many other developing countries. The statements of Industrial and Trade Policy in the 1980s recognised the need for greater efficiency and international competitiveness, faster growth of export-oriented industries, reduction of regulation and control along with tariff rationalisation, a liberalised market-based competitive structure, disinvestment of public sector enterprises and coordination of industrial and export policies.[2] The actual shift to a more liberal trade policy regime in Bangladesh has however been gradual.

From a theoretical point of view, trade liberalisation is likely to allocate resources to those areas where Bangladesh has comparative advantage, which in turn will promote specialisation and growth. It will also accelerate investment by allowing access to bigger markets, permitting scale economies, and encouraging imports of cheaper capital goods and intermediate inputs. Trade openness rewards a country's relatively abundant factor of production – unskilled labour in Bangladesh – by augmenting real wages. This will most

[2] The New Industrial Policy (NIP) announced by the government in 1982 outlined reform measures that were aimed at promoting private sector-led industrialisation. The Revised Industrial Policy (RIP) of 1986 re-emphasised the role of private sector by further strengthening the incentives for private acquisition of public enterprises. Special incentives to attract foreign direct investment (FDI) and significant liberalisation of import licensing were other measures that were intended to help the reform measures. The Industrial Policy of 1991 and trade policies of mid-1990s placed further emphasis on trade liberalisation.

likely improve the income distribution in Bangladesh. However, this prediction should be taken with a pint of salt. If trade involves all unskilled labour intensive industries, only then the wage gap between skilled and unskilled workers is likely to be reduced. But if only one or two industries – which is the case in Bangladesh - benefit from trade then the wage gap between traded and non-traded industries may worsen.

While there have been a few studies that assess the impact of trade liberalisation on economic growth in Bangladesh, to the best of our knowledge there has been no study that examines the relationship between trade and income/wage distribution. Among the macro studies, Begum and Shamsuddin (1998), Siddiki (2002), Ahmed (2003), Hossain and Karunaratne (2004), and Mamun and Nath (2005) find evidence of positive impact of trade on economic growth. Love and Chandra (2005), on the contrary, find evidence of causality running from growth to exports in short run as well as in long run. Using micro data, Salim (2003) finds little evidence of a positive impact of trade and other economic liberalisation measures on productivity growth among manufacturing industries in Bangladesh.

Ahmed and Sattar (2004), however, attribute growth and poverty reduction in recent decades largely to trade liberalisation in Bangladesh. They examine both aggregate and disaggregate data to find that the faster pace of trade liberalisation in the 1990s has much larger impact on growth while reduction in poverty has slowed down during that period. They ascribe this trend in poverty reduction to slowing down of employment and real wage growth. Accelerating growth in output and slowing down in poverty reduction also indicate that the income distribution has worsened. This accords well with the findings of

other empirical research on poverty and inequality in Bangladesh (for example, Khan and Sen (2001)).

There are a few empirical studies that examine poverty and inequality in Bangladesh. Muqtada (1986) examines demographic pressure, land ownership, and impact of High Yielding Variety (HYV) technology as some of the probable determinants of increasing poverty and income inequality. Khan (1990) observes high inequality in agriculture which he attributes to interaction among institutional, technological and demographic factors. He argues that such inequality is a hindrance to poverty alleviation and sustained economic growth. In a study that explores the connections between environmental damages, inequality and poverty in Bangladesh, Khan (1997) argues that a policy that encompasses environmental quality control may help enhance the poverty reducing effects of growth. None of these studies, however, examines the relationship between trade liberalisation and income inequality. One limitation for such an endeavor to be undertaken could be the lack of reliable data on inequality in Bangladesh. A cursory look at widely-used World Bank data on income inequality (Deininger and Square inequality data set) in Bangladesh makes one suspicious about the quality of the data. We, however, use a measure of inequality of wages across four major sectors of the economy: agriculture, fishery, construction and manufacturing. Since trade liberalisation has evidently benefited only a few industries (for example, fishery and readymade garments) in Bangladesh it is expected to have some favorable impact on manufacturing and fishery wages, widening the sectoral wage gaps.

Thus this paper is an attempt to examine the causal relations among trade, growth and wage inequality in Bangladesh using time series data.[3] Both theoretical and empirical literature suggest causal links between these variables though the directions of causality are often an issue of contention and a matter of pure empirical validity. This paper makes two contributions to the literature. *First*, it examines the nexus between trade, growth and wage inequality in Bangladesh. *Second*, instead of using conventional Granger causality tests, we use predictive ability criterion of model selection to test for causal relations between trade, growth and inequality. The use of a Vector Autoregression (VAR) model framework also allows investigation of interrelations among these variables without a priori commitment to any established theorem. The results indicate that there is some evidence of bi-directional causality between growth and inequality and between trade and growth. That growth causes trade and that trade causes inequality are two robust results of our analysis.

The rest of the paper is organised as follows. Section 2 discusses data and describes the variables. We discuss the empirical methodology in Section 3. The results of our empirical analysis are presented in the fourth section. We also present the results of our sensitivity analysis that includes three different experiments. The last section summarizes and concludes.

II. DATA

The data used in this paper have been obtained from various sources. The National Income Accounts data are available from the *Statistical Database* of the United Nations. In particular, we obtain annual data on real GDP per capita, gross fixed capital formation,

[3] We use the term 'causal relation' in the sense of 'Granger causality' as defined in Granger (1969, 1980).

exports and imports of goods and services, and government final consumption expenditures from this source. Data on wages and prices are obtained from various issues of the *Statistical Yearbook of Bangladesh*. Additionally, International Monetary Funds' (IMF) *International Financial Statistics* provides data on nominal exchange rate. The sample period for our data set is 1971 to 2000. The choice of the sample period is dictated by the availability of some of the data series. Except for the indices all variables are in constant Bangladeshi *taka*.

We use first log differences of per capita real GDP (*multiplied by* 100) as measures of *growth*. Real exports *plus* imports as a share of real GDP (in percentage) is used to define the variable – *trade*. We calculate the coefficient of variation across four different wage indices: manufacturing wage, construction wage, agricultural wage and fishery wage, and use this wage inequality measure to define the variable - *inequality*. Note that we deflate the first two wages by a consumer price index (CPI) for working class and the last two wages by a consumer price index for rural families before calculating the coefficient of variation.[4]

Furthermore, we consider a set of additional variables which may be relevant for *growth*, *trade* and/or *inequality*. Real gross fixed capital formation as a percentage of GDP is used as the *investment* variable. The percentage growth rate of CPI is used as the *inflation* variable, and the ratio of wholesale price index for agricultural products to that for industrial products is used to define the variable - *terms of trade*. The real government consumption expenditure as a percentage of real GDP is used as the fiscal policy variable - *fiscal*. We use U.S. CPI data obtained from the Bureau of Labor Statistics (BLS), U.S.

[4] The implicit assumption is that CPI for working class reflects costs of living for workers engaged in manufacturing and construction, and CPI for rural families reflects the costs of living for workers engaged in agriculture and fishery which are predominantly rural industries.

Department of Labor, to calculate *real exchange rate* - another variable that may be relevant – as follows:

$$e_t = EX_t \times \frac{CPI_t^{US}}{CPI_t^{BD}}$$

where EX_t is the nominal exchange rate in period *t*, and CPI_t^{US} and CPI_t^{BD} are the CPI s in the US and Bangladesh respectively.

Table 1 presents summary statistics of the data series. We include descriptive statistics of the variables in Panel A. Real GDP per capita increased at an annual average growth rate of 0.68 percent with a median growth rate of 1.87 percent during 1971 - 2000. On an average, trade accounts for 20 percent of GDP whereas gross fixed investment accounts for 16 percent. Bangladesh has experienced an average inflation rate of 9.91 percent during this period. The terms of trade between agriculture and industry has varied between 77.63 percent and 121 percent turning more against agriculture in recent years. Government consumption expenditure accounts for, on an average, about 4 percent of GDP and the average real exchange rate has been about 8 *taka* per U.S. dollar.[5]

In panel B of Table 1, we break down the sample period into 3 sub-periods and present averages of the variables for these periods. As suggested by Hossain and Alauddin (2005), the time until 1982 can be called the pre-liberalisation period; the post liberalisation period can be further subdivided into two phases: the transition phase that extends from 1983 to 1991 – during which liberalisation policies were gradually introduced; and the second phase since 1991 when further liberalisation – particularly in trade policies - was rigorously introduced and implemented. Average growth rate, trade

[5] This is to say that, on an average, during the sample period the real value of a US dollar is equivalent to the real value of 8 Bangladeshi *taka*: what a dollar can buy in the U.S. is equivalent to what 8 taka can buy in Bangladesh. In other words, $1 can buy 8 times higher than what TK1 can buy.

ratio and investment are much higher in this phase. Average inequality in the 1990s did not change much from the second sub-period though it was higher than average in the pre-liberalisation period. Inflation came down substantially in the 1990s. On an average, agricultural products were relatively more expensive in the post-liberalisation period and the terms of trade is continuously deteriorating against agriculture. The real exchange rate has been continuously rising.

Figure 1 plots *growth*, *trade* and *inequality*. All three series were more volatile during the 1970s and part of the 1980s. Bangladesh frequently experienced negative growth rates of real GDP per capita during the 1970s. Since 1981, the growth rate has been positive and has, in fact, been steady in the 1990s. We observe substantial increase in trade during the last decade. Wage inequality steadily decrease during the later half of the 1970s, fluctuates during the 1980s and has been slowly but steadily rising during the decade of 1990s. This pattern is consistent with the findings of some of the previous studies (for example, Wodon (1999, 2000) and Khan and Sen (2001)) that have shown that inequality has risen in Bangladesh in recent times.

III. EMPIRICAL METHODOLOGY

There has been repeated emphasis on the use of out-of-sample forecasting performance of models for testing for Granger causality.[6] Since our objective is to investigate the causal links between *growth*, *trade* and *inequality* in Bangladesh, we resort to predictive ability criterion of model selection, and use the results to determine the directions of causality.[7] The use of the Vector Autoregression (VAR) framework also allows us not to subscribe

[6] See Granger (1980), Ashley et al (1980) for early advocates; and Chao, Corradi and Swanson (2001) and the references therein for more recent advocates.
[7] Our approach is very similar to Krishna et al (2003)

to any particular theory on potential links between these variables, and thus to accommodate a wide range of theoretical possibilities. Furthermore, because potential misspecification of model is always an important issue in empirical studies, we start with a very general specification of the VAR model including all potential variables (actually those for which data are available) and consider all possible and relevant model combinations of those variables. We then use out-of-sample predictive ability criterion to select the best model. Thus, we adopt a 'general-to-specific' approach to empirical model building.[8]

The first step in any empirical investigation involving time series is to examine the stochastic trending properties of the variables under consideration, and it entails conducting unit root and cointegration tests. We carry out Augmented Dickey-Fuller (ADF) test to find out the order of integration for each relevant series. Thus, for each series we start with the most flexible specification of the test equation that includes an intercept and a trend:

$$\Delta z_t = \alpha_o + \alpha_1 t + \gamma z_{t-1} + \sum_{j=1}^{p} \beta_j \Delta z_{t-j} + \varepsilon_t \qquad (1)$$

where z is the variable under consideration, α_0 represents the intercept term, t is the time trend, Δz s are the augmented terms, p is the appropriate lag length of the augmented terms and ε is the white noise error term. The ADF test is essentially the test of significance of the coefficient γ in the above equation. In order to select the lag length p, we start with a maximum lag of 3 and pare it down to the appropriate lag by examining

[8] For a discussion on usefulness of 'general-to-specific' approach, see Hendry (1995).

the Schwartz Information Criterion (SIC).[9] If we do not find the intercept and the trend – both or one of them – to be statistically significant at 10% significance level, we drop the insignificant term(s) and re-estimate the test statistics.

If we find that two or more of our three variables of interest, namely, *growth*, *trade* and *inequality*, are of same order of integration - the order being 1 or above – we also conduct cointegration tests by estimating "vector error correction" (VEC) models of the following form:

$$\Delta y_t = \delta_o + \lambda t + B(L) y_{t-1} + \sum_{i=1}^{r} \delta_i x_{i,t-1} + \nu_t \qquad (2)$$

where y is an $n \times 1$ vector of variables – z being a typical variable of this vector; δ_0 is an $n \times 1$ vector of constants; λ is an $n \times 1$ vector of coefficients of time t; $B(L)$ is a matrix polynomial in the lag operator L and v_t is a vector of innovations in period t. [10] Furthermore, $x_{i,t-1} = \hat{\alpha}' y_{t-1}$, $i=1, \ldots, r$, is an $n \times 1$ vector of "error-correction" terms defined as in Engle and Granger (1987). r is the rank of the cointegrating space, and is estimated using standard maximum likelihood procedures. The lag length is selected using the SIC.

In order to examine the causal relationship between *growth*, *trade* and *inequality* we form real-time predictions for each of these variables using models that contain variables

[9] There is no general rule as to how one chooses the maximum lag length to start with. Enders (2004) suggests that one should 'start with a relatively long lag length…' (pp.192). Some researchers use the following rule of thumb: start with a maximum lag length equal to the cube root of the number of observation which is 3. ($\cong \sqrt[3]{30}$) in our case. We also use other information criteria such as Akaike Information Criterion (AIC) or Hannan-Quinn Criterion (HQC). Most times these criteria choose the same lag length. Even for cases with different lag lengths selected by different criteria the ADF test results are qualitatively similar.

[10] In this form we are assuming that each element of y is an $I(1)$ process and thus Δy is a vector of $I(0)$ variables. In application, after determining the order of integration of each of *growth, trade, inequality, investment, inflation, fiscal, terms of trade* and *real exchange rate*, we will include the stationary forms of the respective variables in the vactor Δy.

from the set described above. We then assess the relative predictive ability of alternative model specifications. We begin with the most general specification that includes all 8 variables discussed above, and pare it down to models with at least any two of the three variables of interest: *growth*, *trade* and *inequality*. In particular, we estimate models of the form represented by equation (2) with appropriate lag length and cointegrating rank. However, if the variables are $I(1)$ processes but not cointegrated, or are $I(0)$, then the VEC model (2) simply reduces to an unrestricted VAR with variables in their stationary forms. Thus, if the series have unit roots, they will be differenced before estimating the VAR. If, however, they are $I(0)$ then the variables will be included in levels.

The sample is split into two periods with length S and P respectively such that $T = S + P$ where T is the size of the full sample. We first estimate the model with first S observations. A one-step ahead forecast of Δy (or of y if y is $I(0)$) for period $S+1$ is then constructed. Note that we calculate the forecasts only for *growth*, *trade* and *inequality* though the VAR system will include equations for other variables as well. We then augment our sample with one new observation, re-estimate the model, and form a second real-time one-step ahead forecast for each of the three variables for period $S+2$. This process is continued until the entire sample of T observations is exhausted, and we are left with a sequence of P one-step ahead forecasts. We then construct a sequence of real-time forecast errors as follows

$$FE_t = Actual_t - Forecast_t \tag{3}$$

where $Actual_t$ is the actual value of the variable in period t and $Forecast_t$ is the one-step ahead forecast of the variable in period t. These forecast errors are used to construct the Mean Squared Forecast Error (*MSFE*) as follows:

$$MSFE = \frac{\sum_{t=S+1}^{T} FE_t^2}{P} \quad (4)$$

A comparison of *MSFE*s across model specifications for each of the variables (that is, for each of *growth*, *trade*, *inequality*) will allow us to choose the best model: the model with the lowest *MSFE* will be the best model for a variable of interest. Once we choose the best models for each of *growth*, *trade* and *inequality*, we can determine the directions of causality between them by looking at the variables included in the best models.

IV. EMPIRICAL RESULTS

Stochastic Trending Properties of the Variables

We conduct the Augmented Dickey Fuller (*ADF*) Test for unit root on each of the eight variables. The test statistics along with MacKinnon's p-values, lag length and some other relevant information about the specification of the test equations are reported in Table 2. As we see from the table, except for the *investment* and *terms of trade* we reject the null hypothesis of a unit root for each of *growth, trade, inequality, inflation, fiscal* and *real exchange rate*. We find *investment* and *terms of trade* to be *I* (1) processes and, therefore, these two variables need to be differenced in order to include in our regression models. Since all other variables – the three variables of interest, in particular - are (unit root) stationary we do not conduct the cointegration test. Also, model (2) simply reduces to an unrestricted VAR with all but two (*investment* and *terms of trade*) variables in levels.

Model Selection and Direction of Causality Based on Out-of-Sample Predictive Ability

In this section, we present the results of our empirical analysis on how we select the best models to explain *growth*, *trade* and *inequality* respectively. We also use these results to determine the directions of causality between these variables.

We present the Mean Squared Forecast Errors (*MSFE*) for each of the three variables of interest: *growth*, *trade* and *inequality*, calculated from a sequence of one-step ahead forecasts constructed by using VAR models in Table 3. Column (2) through (4) present the *MSFE*s based on a 10-year forecast horizon between 1991 and 2000. In particular, we estimate 128 VAR models that include *at least* two and *at most* eight potentially relevant variables (from the list of variables discussed in Section II) using data from 1971 to 1990, use the equations for *growth*, *trade* and *inequality* to predict their respective values for 1991 and calculate the forecast errors.[11,12] Then we re-estimate the models using data from 1971 to 1991, and predict the values of *growth*, *trade* and *inequality* for 1992. We then calculate the forecast errors for 1992. We continue this process until we exhaust all periods in the forecast horizon. These forecast errors are then used to calculate the *MSFE*s according to the formula in equation (4). The results indicate that the best model for *growth* in Bangladesh includes lags of *growth*, and lags of *inequality*, *inflation*, *terms of trade* (in difference) and *real exchange rate* (**Model 63**). For *trade*, the preferred model includes lags of *trade*, *growth*, *investment* (in difference), *inflation*, *terms of trade*

[11] We further restrict the model specifications by requiring inclusion of at least two of the three variables of interests. Thus when we estimate the models with only 2 variables there are only 3 choices.

[12] We choose 1 lag for the estimation of our VAR models. Ideally, we would like to choose the appropriate lag length using information criteria (for example, Schwartz Information Criterion (SIC) or Akaike Information Criterion (AIC)). But given the length of our sample period and the no. of variables that are included in some of our model specifications, we do not have enough degrees of freedom. Therefore, for parsimony we use 1 lag across all model specifications.

(in difference) and *real exchange rate* (**Model 22**).[13] *Inequality* is best explained by lags of *growth*, *trade*, *inequality*, and *real exchange rate* (**Model 79**).[14]

Thus, our results indicate that *growth* 'causes' (in temporal sense) both *trade* and *inequality* in Bangladesh whereas *inequality* causes *growth*, and *trade* causes *inequality*. Thus, we find evidence of bi-directional causality between *growth* and *inequality*. It is difficult to speculate on one particular explanation for such relationship. Growth may have affected inequality through trade. However, it is not clear how wage inequality may have affected growth in one direction or the other. A glance over the data reveals that there are substantial fluctuations in growth of per capita real GDP during the first few years of our sample period. Our results may have picked some of those noises, thus making it hard to interpret.

The results further demonstrate that *inflation* and *terms of trade* between agricultural products and manufacturing products are important determinants of *growth* and *trade*. Given that inflation was quite high during the 1970s and the 1980s, it is not surprising that they affected *growth* and *trade*. It may be noted that though agriculture has been the largest contributor of GDP, the relative importance of manufacturing has increased over the years. Furthermore, as we have seen before, agricultural products have been relatively more expensive since the mid-1980s. These trends may have indicated the structural

[13] As we can see from the table, the *MSFE* for Model 23 is the same. However, this is because of rounding of the value to the two decimal places. At 5 decimal places, MSFE for Model 22 is 12.15921 and MSFE for Model 23 is 12.15928.

[14] We also compare these best models with simple *AR*(1) models for *growth*, *trade* and *inequality* using Diebold-Mariano (see Diebold and Mariano 1995) type test. We use forecast errors from both models to construct the test statistics as follows (see Amato and Swanson 2001; and MacCracken 1999):

$$dm = \frac{\sum_{t=1}^{P}\left(FE_{AR,t}^{2} - FE_{Best,t}^{2}\right)}{\sqrt{P} \times SE\left(FE_{AR,t}^{2} - FE_{Best,t}^{2}\right)}$$

Following suggestion from Amato and Swanson (2001), we use unity as the 5% critical value. We find that the best models outperform the simple *AR* model in all three cases.

change that has taken place in Bangladesh over the years. However, an investigation of how *growth* and *trade* may have been affected by these changes warrants much closer and detailed look at demand and supply conditions in these two broad sectors as well as in their component industries, and any general conclusion based on our results will be far fetched. *Investment* growth appears to be important for *trade*. Trade policies aimed at promoting exports and reducing import barriers may have encouraged increased investment, which in turn has contributed to increased volume of trade. Since trade is concentrated in only a few items in Bangladesh, it requires more disaggregate level studies to explore the relationship between investment and trade.[15] Interestingly, *real exchange rate* appears to be an important explanatory variable for all three variables of interest.

Sensitivity Analysis

In this section, we conduct three different experiments to examine the robustness of our results. The first experiment involves using a shorter forecast horizon of 5 years to estimate the *MSFE*s. *Second*, we use export-ratio (exports as a share of GDP) and import-ratio (imports as a share of GDP) separately instead of trade ratio. *Finally*, we estimate VAR models using all observations in our sample, and conduct conventional Granger causality tests to examine pairwise causal relationships between the variables of interest.

A. Model selection and direction of causality based on out-of-sample predictive ability using 5-year forecast horizon

During the decade of the 1990s – particularly after the announcement of the Industrial Policy of 1991 – Bangladesh has achieved growth rates persistently higher than ever. By

[15] For a study using disaggregate level data, see Salim (2003)

excluding observations from that period in our estimation of forecast errors, at least for the initial years of our forecast horizon, we may have underestimated the importance of each of the variables of interest in determining the movements in others. In this experiment, therefore, we would like to accord somewhat higher emphasis on what may have been first evidence of a persistent growth pattern that may have significant causal relations with either *trade* or *inequality* or both. We do this by extending the sample of observations from 1971 to 1995 to estimate our first model to generate forecast for 1996 – the first year of our new forecast horizon. Thus, this experiment simply involves taking out forecast errors between 1991 and 1995 – which may have not captured the real importance of trade and inequality for growth or vice versa - and re-estimating the *MSFE*s by using the remaining five forecast errors. Our objective is to see if some of the above results are robust to the selection of our forecast horizon.

The results from this experiment are summarized in Table 4. The best model for explaining growth selected by the lowest *MSFE* is the one that includes lags of *growth*, *trade*, *investment* (in difference) and *terms of trade* (in difference). For *trade*, in addition to *growth, investment* (in difference) and *terms of trade* (in difference) as we found before, *fiscal* variable and *real exchange rates* are also important determinants. *Growth* is no longer important for *inequality*, but *trade* and *investment* (in difference) are. The important findings of these experiments are: *first*, there is now evidence of bi-directional causality between *growth* and *trade*. That there were evidence of *growth* causing *trade* even before, new evidence of causality running in opposite direction as well may be a reflection of the fact that the volume of trade grew substantially to have a significant effect on growth only in the 1990s. In fact, the trade ratio jumped from less than 20

percent in 1991 to more than 30 percent in 1995. *Second*, *trade* is still important for *inequality*. *Third, investment* growth and *real exchange rate* are still important for *trade*. Furthermore, *terms of trade* between agricultural products and manufacturing products is still an important determinant of *growth* and *trade*.

B. Export and Import separately

Bangladesh is a net importer. Although the share of imports is larger than the share of exports, the export share has grown over the years. Since one of the mainstays of trade policies in Bangladesh has been to promote exports and special measures have been adopted for providing incentives, most previous studies (for example, Begum and Shamsuddin 1998, Mamun and Nath 2005, Love and Chandra 2005) focus on the relationship between exports and growth. As we discussed in the beginning, the results have been mixed. There are several channels through which exports may interact with growth. By facilitating production of those items - in which the country has comparative advantage, for a bigger market it not only enhances efficiency but also facilitates imports of state-of-the-art capital goods and intermediate inputs by removing the foreign exchange constraint. Specialisation and trade may also affect the income/wage distribution in the country.

In order to examine how increased exports in Bangladesh have interacted not only with *growth* and *inequality* but also with *imports*, we now replace the variable: *trade* with *export* and *import* and, thus, the set of potentially relevant variables is now expanded to include 9 variables in total.[16] With these variables we can have a maximum of 320 possible models that include *at least* 2 and *at most* 9 variables. We estimate the VAR

[16] The variable '*export*' is defined as the percentage share of real exports in real GDP. Similarly, '*import*' is defined as the percentage share of real imports in real GDP. We find that *export* is an $I(1)$ process and *import* is an $I(0)$ process.

models, and calculate the *MSFE*s for *growth*, *export*, *import* and *inequality* using 10 years of forecast errors. The summary results that show the best models for each of these four variables based on minimum *MSFE*s are reported in Table 5. As we can see, the main findings of this experiment are as follows. *First*, bi-directional causality between *growth* and *inequality* still holds. *Second*, there is bi-directional causality between *growth* and *exports* (in difference) as well. This is interesting because most previous studies find uni-directional causality either from *exports* to *growth* or from *growth* to *exports*. However, the sample period, the data frequency and the empirical methods of those studies are different from ours. Furthermore, *exports* and *imports* cause each other. This may be interpreted as evidence in support of the foreign exchange constraint argument for export promotion. *Third*, *inflation* is important not only for *growth* and two components of trade (i.e. *export* and *import*) but also for *inequality*. *Finally*, while real exchange rate appears to be an important determinant of *growth* and *imports*, *investment* (in difference) is important only for *imports*. Also, interestingly, *imports* and the *fiscal* variable seem to play a role in determining *inequality*.

C. Conventional Granger Causality Test Results

We also conduct more conventional Granger causality tests based on in-sample estimation of relevant VAR models to further investigate the relationships among *growth, trade* and *inequality* and to see if they confirm some of our findings in the previous sections. The multivariate generalisation of the conventional Granger Causality Test is also called 'block causality' test.[17] A likelihood ratio test is used to test the cross equation restrictions on the lags of the variables of interest. Without using any other model selection criterion, we estimate each of the 128 possible VAR models, choosing the appropriate lag length based on Schwartz Information Criterion (SIC), and then conducting pairwise Granger causality tests. Note that each of the three variables of interest appears in 96 out of 128 models. In turn, with each variable in these 96

[17] For a discussion, see Enders (2004) pp. 283-4

models each of the other two variables appears only 64 times. We report the summary results for how many times out of 64 a variable of interest 'Granger causes' the other. Among all possible cases, we find the strongest evidence in favor of '*trade* Granger causes *growth*' (more than half of the time), followed by '*inequality* Granger causes *growth*' (almost half of the time). There is some evidence to support '*growth* Granger causes *trade*' and '*trade* Granger causes *inequality*' (one sixth of the time in each case). However, there is little evidence of *inequality* causing *trade*.

V. CONCLUDING REMARKS

Using model selection technique based on out-of-sample predictive ability criterion in Vector Autoregression (VAR) framework to identify the 'best' model for each of *growth*, *trade* and *wage inequality* this paper examines the directions of causality between these variables in Bangladesh between 1971 and 2000. There is some evidence of bi-directional causality between *growth* and *inequality*, and between *trade* and *growth*. That *growth* causes *trade* and that *trade* causes *inequality* are two more robust results. Evidence also suggest that *investment* growth is an important determinant of *trade,* and the *terms of trade* between agricultural products and manufacturing products is an important causal determinant of both growth and trade.

From the policy perspective, the results seem to suggest that while trade liberalisation is going to affect growth, the policymakers should pay attention to its effect on income/wage distribution. Furthermore, the policymakers should also recognise the link between investment growth and trade and between the structural change and growth and trade. However, to derive more concrete and precise policy implications we need to focus on more specific nature of the relationship between *trade* and *growth,* and between *trade* and income distribution. This study does not tell us how exactly one variable affects the

other. Furthermore, investigation of disaggregate level industries will also help us come up with more specific policy suggestion. Our future research would like to address those issues.

TABLE 1

SUMMARY STATISTICS OF THE DATA SERIES

	Growth	*Trade*	*Inequality*	*Investment*	*Inflation*	*Terms of trade*	*Fiscal*	*Real exchange rate*
	1	2	3	4	5	6	7	8
Panel A: Descriptive Statistics								
Mean	0.68	20.02	12.34	16.09	9.92	100.15	3.94	7.87
Median	1.86	18.43	12.65	16.43	6.74	102.30	4.30	8.21
Maximum	6.64	36.12	18.32	23.29	58.18	121.04	5.07	12.03
Minimum	-17.58	4.45	3.53	4.81	-16.66	77.63	0.96	2.53
Std. Dev.	4.50	7.41	3.48	4.27	14.26	12.93	1.10	2.25
Observations	30	30	30	30	30	29	30	30
Panel B: Average over three Sub-periods								
1971-82	-1.32	14.55	11.44	12.95	16.10	86.10	3.35	5.70
1983-91	1.47	18.12	12.99	16.98	8.31	106.37	4.23	8.34
1992-2000	2.56	29.21	12.89	19.38	3.28	111.11	4.43	10.29

TABLE 2

AUGMENTED DICKEY FULLER TEST RESULTS

Variables	Intercept in the test equation	Trend in the test equation	Lag length	ADF test statistic	MacKinnon's p-value
	1	2	3	4	5
Growth	yes	yes	0	-6.32	0.00
Trade	yes	yes	0	-3.82	0.03
Inequality	yes	no	1	-5.63	0.00
Investment	yes	yes	0	-2.57	0.30
Inflation	yes	yes	3	-14.12	0.00
Terms of trade	yes	yes	0	-2.40	0.37
Fiscal	yes	no	1	-3.79	0.01
Real exchange rate	yes	yes	1	-4.61	0.01
First difference of *investment*	yes	no	0	-7.76	0.00
First difference of *terms of trade*	no	no	0	4.77	0.00

Notes: The appropriate lag length for augmented terms in the test equation is determined by using a step-down method. We start with a maximum lag length of 3 $\left(\cong 3.1 = \sqrt[3]{30}\right)$ and pare it down using Schwartz Information Criterion (SIC). Whether an intercept term and both intercept and time trend are included in the test equation is determined by looking at the t statistics of these terms in the estimated test equation.

TABLE 3

MODEL SELECTION AND DIRECTION OF CAUSALITY RESULTS BASED ON A PREDICTIVE ABILITY APPROACH: 10-YEAR FORECASTING HORIZON

Model No.	Models	Mean Squared Forecast Errors		
		Growth	*Trade*	*Inequality*
	1	2	3	4
1	*Growth, Trade, Inequality, ΔInvestment, Inflation, Fiscal, ΔTerms of Trade, Real Exchange Rate*	1.26	13.86	5.69
2	*Growth, Trade, Inequality, ΔInvestment, Inflation, Fiscal, ΔTerms of Trade*	1.37	14.26	3.59
3	*Growth, Trade, Inequality, ΔInvestment, Inflation, Fiscal, Real Exchange Rate*	3.95	18.52	1.79
4	*Growth, Trade, Inequality, ΔInvestment, Inflation, ΔTerms of Trade, Real Exchange Rate*	0.50	13.32	6.31
5	*Growth, Trade, Inequality, ΔInvestment, Fiscal, ΔTerms of Trade, Real Exchange Rate*	0.76	13.28	5.42
6	*Growth, Trade, Inequality, Inflation, Fiscal, ΔTerms of Trade, Real Exchange Rate*	0.82	14.40	3.75
7	*Growth, Trade, ΔInvestment, Inflation, Fiscal, ΔTerms of Trade, Real Exchange Rate*	1.15	12.67	
8	*Growth, Inequality, ΔInvestment, Inflation, Fiscal, ΔTerms of Trade, Real Exchange Rate*	1.20		2.52
9	*Trade, Inequality, ΔInvestment, Inflation, Fiscal, ΔTerms of Trade, Real Exchange Rate*		14.43	5.55
10	*Growth, Trade, Inequality, ΔInvestment, Inflation, Fiscal*	4.14	26.46	1.86
11	*Growth, Trade, Inequality, ΔInvestment, Inflation, ΔTerms of Trade*	0.41	13.39	5.07
12	*Growth, Trade, Inequality, ΔInvestment, Inflation, Real Exchange Rate*	19.45	23.02	1.82
13	*Growth, Trade, Inequality, ΔInvestment, Fiscal, ΔTerms of Trade*	0.71	13.67	3.56
14	*Growth, Trade, Inequality, ΔInvestment, Fiscal, Real Exchange Rate*	7.59	19.42	2.05
15	*Growth, Trade, Inequality, ΔInvestment, ΔTerms of Trade, Real Exchange Rate*	0.49	14.35	6.83
16	*Growth, Trade, Inequality, Inflation, Fiscal, ΔTerms of Trade*	1.06	14.45	2.22
17	*Growth, Trade, Inequality, Inflation, Fiscal, Real Exchange Rate*	3.55	18.27	1.78
18	*Growth, Trade, Inequality, Inflation, ΔTerms of Trade, Real Exchange Rate*	0.43	13.89	2.96
19	*Growth, Trade, Inequality, Fiscal, ΔTerms of Trade, Real Exchange Rate*	0.54	14.25	3.11
20	*Growth, Trade, ΔInvestment, Inflation, Fiscal, ΔTerms of Trade*	0.89	13.50	
21	*Growth, Trade, ΔInvestment, Inflation, Fiscal, Real Exchange Rate*	1.65	16.33	
22	*Growth, Trade, ΔInvestment, Inflation, ΔTerms of Trade, Real Exchange Rate*	0.88	**12.16**	
23	*Growth, Trade, ΔInvestment, Fiscal, ΔTerms of Trade, Real Exchange Rate*	1.17	12.16	
24	*Growth, Trade, Inflation, Fiscal, ΔTerms of Trade, Real Exchange Rate*	1.13	12.93	
25	*Growth, Inequality, ΔInvestment, Inflation, Fiscal, ΔTerms of Trade*	2.90		2.71
26	*Growth, Inequality, ΔInvestment, Inflation, Fiscal, Real Exchange Rate*	3.63		2.31
27	*Growth, Inequality, ΔInvestment, Inflation, ΔTerms of Trade, Real Exchange Rate*	0.33		3.87
28	*Growth, Inequality, ΔInvestment, Fiscal, ΔTerms of Trade, Real Exchange Rate*	0.66		2.63
29	*Growth, Inequality, Inflation, Fiscal, ΔTerms of Trade, Real Exchange*	0.79		2.04

	Rate			
30	*Trade, Inequality, ΔInvestment, Inflation, Fiscal, ΔTerms of Trade*		14.58	3.24
31	*Trade, Inequality, ΔInvestment, Inflation, Fiscal, Real Exchange Rate*		18.32	1.82
32	*Trade, Inequality, ΔInvestment, Inflation, ΔTerms of Trade, Real Exchange Rate*		13.38	5.68
33	*Trade, Inequality, ΔInvestment, Fiscal, ΔTerms of Trade, Real Exchange Rate*		14.19	5.10
34	*Trade, Inequality, Inflation, Fiscal, ΔTerms of Trade, Real Exchange Rate*		13.22	3.51
35	*Growth, Trade, Inequality, ΔInvestment, Inflation*	19.68	30.39	1.83
36	*Growth, Trade, Inequality, ΔInvestment, Fiscal*	12.25	37.36	2.95
37	*Growth, Trade, Inequality, ΔInvestment, ΔTerms of Trade*	1.02	13.42	7.17
38	*Growth, Trade, Inequality, ΔInvestment, Real Exchange Rate*	19.50	22.93	1.54
39	*Growth, Trade, Inequality, Inflation, Fiscal*	3.65	24.94	1.84
40	*Growth, Trade, Inequality, Inflation, ΔTerms of Trade*	0.40	14.03	2.65
41	*Growth, Trade, Inequality, Inflation, Real Exchange Rate*	17.64	22.83	1.69
42	*Growth, Trade, Inequality, Fiscal, ΔTerms of Trade*	0.61	14.31	2.01
43	*Growth, Trade, Inequality, Fiscal, Real Exchange Rate*	6.68	19.15	2.07
44	*Growth, Trade, Inequality, ΔTerms of Trade, Real Exchange Rate*	0.42	15.02	3.29
45	*Growth, Trade, ΔInvestment, Inflation, Fiscal*	1.74	22.71	
46	*Growth, Trade, ΔInvestment, Inflation, ΔTerms of Trade*	0.45	12.57	
47	*Growth, Trade, ΔInvestment, Inflation, Real Exchange Rate*	11.00	21.22	
48	*Growth, Trade, ΔInvestment, Fiscal, ΔTerms of Trade*	0.88	12.98	
49	*Growth, Trade, ΔInvestment, Fiscal, Real Exchange Rate*	3.03	17.28	
50	*Growth, Trade, ΔInvestment, ΔTerms of Trade, Real Exchange Rate*	0.73	12.97	
51	*Growth, Trade, Inflation, Fiscal, ΔTerms of Trade*	0.89	13.51	
52	*Growth, Trade, Inflation, Fiscal, Real Exchange Rate*	1.63	16.41	
53	*Growth, Trade, Inflation, ΔTerms of Trade, Real Exchange Rate*	0.94	12.53	
54	*Growth, Trade, Fiscal, ΔTerms of Trade, Real Exchange Rate*	1.13	12.62	
55	*Growth, Inequality, ΔInvestment, Inflation, Fiscal*	4.36		2.43
56	*Growth, Inequality, ΔInvestment, Inflation, ΔTerms of Trade*	2.52		3.63
57	*Growth, Inequality, ΔInvestment, Inflation, Real Exchange Rate*	3.90		2.44
58	*Growth, Inequality, ΔInvestment, Fiscal, ΔTerms of Trade*	2.33		2.77
59	*Growth, Inequality, ΔInvestment, Fiscal, Real Exchange Rate*	6.43		2.89
60	*Growth, Inequality, ΔInvestment, ΔTerms of Trade, Real Exchange Rate*	0.37		3.93
61	*Growth, Inequality, Inflation, Fiscal, ΔTerms of Trade*	2.54		2.18
62	*Growth, Inequality, Inflation, Fiscal, Real Exchange Rate*	3.57		2.11
63	*Growth, Inequality, Inflation, ΔTerms of Trade, Real Exchange Rate*	**0.32**		2.52
64	*Growth, Inequality, Fiscal, ΔTerms of Trade, Real Exchange Rate*	0.54		2.03
65	*Trade, Inequality, ΔInvestment, Inflation, Fiscal*		26.12	1.88
66	*Trade, Inequality, ΔInvestment, Inflation, ΔTerms of Trade*		13.29	4.46
67	*Trade, Inequality, ΔInvestment, Inflation, Real Exchange Rate*		23.03	1.62
68	*Trade, Inequality, ΔInvestment, Fiscal, ΔTerms of Trade*		14.05	2.99
69	*Trade, Inequality, ΔInvestment, Fiscal, Real Exchange Rate*		19.30	2.06
70	*Trade, Inequality, ΔInvestment, ΔTerms of Trade, Real Exchange Rate*		15.00	6.35
71	*Trade, Inequality, Inflation, Fiscal, ΔTerms of Trade*		13.87	2.27
72	*Trade, Inequality, Inflation, Fiscal, Real Exchange Rate*		18.33	1.78
73	*Trade, Inequality, Inflation, ΔTerms of Trade, Real Exchange Rate*		12.31	3.39
74	*Trade, Inequality, Fiscal, ΔTerms of Trade, Real Exchange Rate*		12.78	3.22

75	*Growth, Trade, Inequality, ΔInvestment*	20.85	34.54	1.76
76	*Growth, Trade, Inequality, Inflation*	17.85	29.16	1.72
77	*Growth, Trade, Inequality, Fiscal*	10.58	35.28	2.90
78	*Growth, Trade, Inequality, ΔTerms of Trade*	0.90	14.04	3.96
79	*Growth, Trade, Inequality, Real Exchange Rate*	17.68	22.74	**1.42**
80	*Growth, Trade, ΔInvestment, Inflation*	11.77	28.05	
81	*Growth, Trade, ΔInvestment, Fiscal*	6.91	33.44	
82	*Growth, Trade, ΔInvestment, ΔTerms of Trade*	0.57	12.64	
83	*Growth, Trade, ΔInvestment, Real Exchange Rate*	11.11	21.14	
84	*Growth, Trade, Inflation, Fiscal*	1.66	21.81	
85	*Growth, Trade, Inflation, ΔTerms of Trade*	0.48	12.73	
86	*Growth, Trade, Inflation, Real Exchange Rate*	10.24	21.23	
87	*Growth, Trade, Fiscal, ΔTerms of Trade*	0.88	13.14	
88	*Growth, Trade, Fiscal, Real Exchange Rate*	2.86	17.31	
89	*Growth, Trade, ΔTerms of Trade, Real Exchange Rate*	0.81	13.30	
90	*Growth, Inequality, ΔInvestment, Inflation*	8.22		2.43
91	*Growth, Inequality, ΔInvestment, Fiscal*	2.70		1.95
92	*Growth, Inequality, ΔInvestment, ΔTerms of Trade*	3.62		3.47
93	*Growth, Inequality, ΔInvestment, Real Exchange Rate*	4.37		3.78
94	*Growth, Inequality, Inflation, Fiscal*	4.38		2.34
95	*Growth, Inequality, Inflation, ΔTerms of Trade*	2.51		2.42
96	*Growth, Inequality, Inflation, Real Exchange Rate*	3.86		2.24
97	*Growth, Inequality, Fiscal, ΔTerms of Trade*	2.26		2.14
98	*Growth, Inequality, Fiscal, Real Exchange Rate*	6.22		2.59
99	*Growth, Inequality, ΔTerms of Trade, Real Exchange Rate*	0.34		2.79
100	*Trade, Inequality, ΔInvestment, Inflation*		30.06	1.65
101	*Trade, Inequality, ΔInvestment, Fiscal*		38.43	2.85
102	*Trade, Inequality, ΔInvestment, ΔTerms of Trade*		13.79	6.35
103	*Trade, Inequality, ΔInvestment, Real Exchange Rate*		22.90	1.52
104	*Trade, Inequality, Inflation, Fiscal*		24.96	1.84
105	*Trade, Inequality, Inflation, ΔTerms of Trade*		12.91	2.97
106	*Trade, Inequality, Inflation, Real Exchange Rate*		22.82	1.62
107	*Trade, Inequality, Fiscal, ΔTerms of Trade*		13.20	2.12
108	*Trade, Inequality, Fiscal, Real Exchange Rate*		19.51	1.97
109	*Trade, Inequality, ΔTerms of Trade, Real Exchange Rate*		13.47	3.49
110	*Growth, Trade, Inequality*	18.77	32.69	1.75
111	*Growth, Trade, ΔInvestment*	13.31	32.29	
112	*Growth, Trade, Inflation*	10.64	27.08	
113	*Growth, Trade, Fiscal*	5.90	31.81	
114	*Growth, Trade, ΔTerms of Trade*	0.44	12.83	
115	*Growth, Trade, Real Exchange Rate*	10.34	21.16	
116	*Growth, Inequality, ΔInvestment*	6.85		1.89
117	*Growth, Inequality, Inflation*	8.34		2.34
118	*Growth, Inequality, Fiscal*	2.68		1.89
119	*Growth, Inequality, ΔTerms of Trade*	3.65		2.34
120	*Growth, Inequality, Real Exchange Rate*	4.28		3.42
121	*Trade, Inequality, ΔInvestment*		33.13	1.97
122	*Trade, Inequality, Inflation*		29.17	1.66

123	*Trade, Inequality, Fiscal*		37.11	2.68
124	*Trade, Inequality, ΔTerms of Trade*		13.12	4.01
125	*Trade, Inequality, Real Exchange Rate*		22.72	1.43
126	*Growth, Trade*	11.93	30.75	
127	*Growth, Inequality*	6.98		1.85
128	*Trade, Inequality*		32.89	1.97

Note: The Mean Squared Forecast Errors (MSFE) based on per capita GDP growth equations, trade equations and inequality equations from VAR models as specified in the first column are reported in column (2) through (4). These MSFEs are calculated from a sequence of one-step ahead forecasts constructed from the relevant VAR models for last 10 years of the sample period, that is, from 1971 to 2000. In each column, the bold entry denotes the model which has the lowest MSFE among the candidate models, and hence indicates the model with the "best" predictive ability.

TABLE 4

MODEL SELECTION AND DIRECTION OF CAUSALITY RESULTS BASED ON A PREDICTIVE ABILITY APPROACH: 5-YEAR FORECASTING HORIZON

Dependent variable	Best models	Mean Squared Forecast Errors
	1	2
Growth	*Growth, Trade, ΔInvestment, ΔTerms of Trade*	0.12
Trade	*Growth, Trade, ΔInvestment, Fiscal, ΔTerms of Trade, Real Exchange Rate*	5.11
Inequality	*Trade, Inequality, ΔInvestment*	1.91

Note: The mean squared forecast errors (MSFE) reported in col. 2 are the ones associated with the models in col.1. Each represents the lowest value MSFEs among those calculated from 96 possible models for each of *growth*, *trade*, and *inequality*.

TABLE 5

MODEL SELECTION AND DIRECTION OF CAUSALITY RESULTS BASED ON A PREDICTIVE ABILITY APPROACH: 10-YEAR FORECASTING HORIZON

Dependent variable	Best models	Mean Squared Forecast Errors
	1	2
Growth	*Growth, ΔExport, Inequality, Inflation, Real Exchange Rate*	0.24
Export	*Growth, ΔExport, Import, Inflation, ΔTerms of Trade*	0.82
Import	*Growth, ΔExport, Import, Inequality, ΔInvestment, Inflation, Real Exchange Rate*	6.14
Inequality	*Growth, Import, Inequality, Inflation, Fiscal*	1.53

Note: The mean squared forecast errors (MSFE) reported in col. 2 are the ones associated with the models in col.1. Each represents the lowest value MSFEs among those calculated from 224 possible models for each of *growth*, *export*, *import* and *inequality*.

TABLE 6

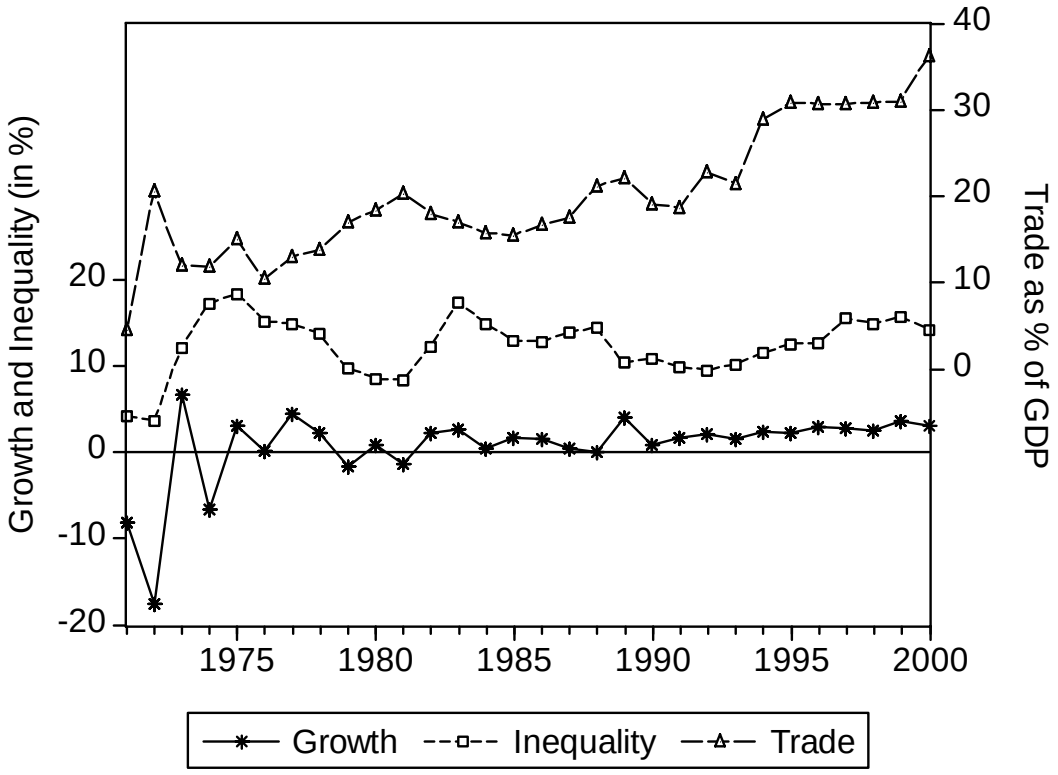
SUMMARY RESULTS OF PAIRWISE GRANGER CAUSALITY TESTS

Number of models in which	*Growth* equation	*Trade* equation	*Inequality* equation
	1	2	3
Lagged '*growth*' is included as explanatory variable	96	64	64
Lagged '*trade*' is included as explanatory variable	64	96	64
Lagged '*inequality*' is included as explanatory variable	64	64	96
Growth Granger causes	-	11 (17.19%)	9 (14.06%)
Trade Granger causes	36 (56.25%)	-	11 (17.19%)
Inequality Granger causes	31 (48.44%)	1 (1.56%)	-

Note: In last three rows, the numbers in parentheses represent percentage of total no. of models in which the relevant variable on the left column 'Granger causes' the variable in the top row. Thus, for example, in the fourth row '17.19%' implies that in 17.19 percent of 64 models in which lags of growth appear as explanatory variables of trade, there is evidence that growth Granger causes trade.

FIGURE 1

GROWTH, TRADE AND WAGE INEQUALITY IN BANGLADESH: 1971 -2000



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