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4 authors, including:

M. Kabir Hassan
University of New Orleans

Ihsan Isik
Rowan University

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Neal C. Maroney, Kabir Hassan, Syed A. Basher, Ihsan Isik

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A MACROECONOMETRIC MODEL OF THE BANGLADESH ECONOMY AND ITS POLICY IMPLICATIONS

Neal C. Maroney
University of New Orleans, USA
M. Kabir Hassan
University of New Orleans, USA
Drexel University, USA
Syed A. Basher
York University, Canada
Ihsan Isik
Rowan University, USA.

ABSTRACT

This paper develops a macroeconometric model for the Bangladesh economy using nine key macroeconomic variables employing annual data from 1974 to 2000. The methodology employed in this paper uses unit root and Johansen's cointegration tests followed by vector error correction model and variance decomposition to examine the dynamic relationships among macroeconomic variables. Our results show that within the context of Bangladesh, monetary policy is more important than fiscal policy. As significant amount of development expenditure for Bangladesh comes from foreign donation, it is also argued that this aid must be channeled to productive activities so that it contributes to economic growth. The domestic export base has also to be widened and diversified.

JEL Classifications: C32, E60
Keywords: Conintegration, Vector Error-Correction Model, Macro Model, Developing Countries

INTRODUCTION

This paper applies recent developments in time-series techniques to estimate a macroeconometric model for the Bangladesh economy. A number of authors alluded to the possibility of such a modeling technique in Bangladesh without actually performing such estimation. To our knowledge, this is the first attempt to apply such an approach in the case of Bangladesh.[1] This study will develop and estimate an annual macro-econometric model for the economy of Bangladesh over the period 1974 to 2000. The primary objective of this paper is to analyze the empirical strength of short-run and long-run impact of monetary policies, fiscal policies, external resources, and remittance shocks (or innovations) on Bangladesh's macro-economy. The methodology employed in this paper uses unit root and cointegration tests followed by vector error correction model and variance decomposition to examine the dynamic relationships among macro variables. The results of this paper will help us shed light on the impact of Government policies on macro variables in the context of Bangladesh.

The estimated VECM macro-econometric model in this paper includes nine key macroeconomic variables [i.e., real gross domestic product (GDP), consumer price index (CPI), terms of trade between agriculture and manufacturing sectors (TOT), real investment (INV), real value of remittances (REM), real net exports (NX), real external resources (RES), money stock (M1) and real government expenditure (GCONS)]. The unanticipated policy shocks are analyzed by impulse response functions and variance decompositions (VDCs) obtained from the vector error correction model (VECM). Our contribution lies in applying a vector error correction model to unveil the dynamic relationships in the Bangladesh macro-economy. The assignment involves three steps: first, it examines the time-series properties of the nine macro variables used in this paper; second, it examines the number of cointegration relationships among the nine macroeconomic variables, and uses the error correction terms from the cointegrating vectors in VEC models; finally, it uses variance decomposition to discern short-term relationships among the macro variables.

The rest of the paper is organized as follows. Section 2 reviews the previous macroeconometric models for Bangladesh's economy. Section 3 discusses the econometric methodology used in this paper. Section 4 presents the data, model specification and results. Concluding remarks appear in Section 5.

RELATED LITERATURE

Empirical works on constructing macroeconometric models for Bangladesh economy can be traced back to the sixties when macromodeling as a professional academic activity was still in its infancy (Krishnamurty and Pandit, 1984). Islam (1965) conducted one of the first studies on the macroeconomic model for the Pakistan economy, in which East Pakistan (the present Bangladesh) was treated as a region. The objectives of Islam's study were to formulate an econometric model of Pakistan, undertake statistical estimation, collect, organize, and process both published and unpublished data systematically.

However, no theory for such an exercise (statistical estimation) was presented. The model was highly aggregative and contained limited data.

Later in 1978, a paper prepared by the World Bank attempted to present a model of the Bangladesh economy, but until 1980 virtually any attempt confronted the serious problem of too few observations. Rashid (1981) developed a short-run macroeconometric model for Bangladesh economy; the primary objective of the model was to help the understanding of the workings of the economy. Despite the absence of the rigorous formulation of the model (e.g., no policy simulation was carried out, therefore, no definite conclusions about the policy implications of the model were presented), the author made some tentative conclusions on the basis of the signs and magnitudes of estimated coefficients which was actually the beginning of the attempt to quantify macro model for the Bangladesh economy.

Thereafter, in 1983, Parikh constructed a macroeconometric model of the Bangladesh economy using the Keynesian approach of price rigidity with quantity rationing. The model also explicitly delineated the structure of the economy and interdependence between various sectors of the economy. Another feature of the model distinguished it from the model developed by Islam (1965); Parikh included the weather factor. However, Parikh's model is confined to strict functional forms. It did not test the equations and therefore, no definite policy suggestions were offered.

Chowdhury (1986) first offered a theoretical framework vector autoregression (VAR) technique as an alternative approach to forecast the macroeconomic model in the context of the Bangladesh economy. However, the model was once again restricted into functional form and no estimation of the parameters was carried out. A study carried out by Rahman and Shilpi (1996) developed a dynamic macroeconometric model for the Bangladesh economy with regard to five economic blocks such as expenditure, fiscal, money and finance, trade, and aggregate supply block. The objectives of the model were to estimate and validate followed by a dynamic policy simulation. Chowdhury, Dao and Wahid (1995) analyzed the relationship between money, output, prices and the exchange rate for Bangladesh using a VAR model with quarterly data over 1974-92 period. They found, among other things, monetary policy is significant in explaining output, and monetary policy and inflation jointly determine the exchange rate.

More recently, Basher and Haque (2000) have developed a computerized simulated macroeconometric model for Bangladesh economy. Their model consisted of five important sectors of the Bangladesh economy: demand, fiscal, money and finance, trade and the supply side. It has also included remittance income as an endogenous factor in the model. The model was estimated using annual data from 1974 to 1997. The impact simulation was done from 1998 to 2000 while the simulation is live meaning that the model can include the latest available data to extend both the base simulation and ex *ante* simulation.

METHODOLOGY

The first step requires that the unit root test be conducted in order to determine whether the series are non-stationary in levels and stationary in first differences, that is integrated of degree one. The second step is to use the cointegration test in order to determine whether those six non-stationary series have common long run relationships. Evidence of cointegration rules out the possibility that the estimated relationships are spurious and, thus, as long as the variables in a given VAR have common trends, causality (in the Granger sense but not in the structural sense) must exist in at least one direction. However, although cointegration implies the presence of causality it does not identify the direction of causality between the variables. The dynamic Granger causality can be captured through the vector error correction models (VECM) derived from the long-run cointegrating vectors (Granger 1988).

Moreover, Engel and Granger (1987) show that in the presence of cointegration there always exists a corresponding error - correction model representation.

Unit Rroot and Cointegration

If the individual series has a stochastic trend it means that the variable of this series does not revert to average or long run values after a shock strikes and its distribution does not have a constant mean and variance (Hendry and Juselius, 2000). The primary unit root test employed in this investigation is the augmented Dickey-Fuller test (ADF). The following equation presents a high autoregressive (AR) process (with an intercept and a time trend) of the ADF test:

$$\Delta y_t = \mu + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + e_t \qquad (1)$$

where e_t –IID(0, σ^2), y_t represents a time series, Δ implies the first difference of the natural logarithm of the series, and t is the time trend. This equation corrects for higher order correlation by adding lagged differences of the series y_t to the regressors. The null hypothesis in this test is unit root or non-stationary, while the alternative hypothesis is the series y_t is stationary, requiring γ to be negative and significantly different from zero. That is, $H_0 : \gamma = 0; H_1 : \gamma < 0$. The null hypothesis of a unit root is rejected against the one-sided alternative if the ADF test statistic is less than [illegible] critical value.

A system of two or more time series, which are non-stationary in levels and have individual stochastic trends, can share a common stochastic trend(s). In this case those series are cointegrated. Thus, two or more non-stationary time series are cointegrated if a linear combination of these variables is stationary, that is, converges to equilibrium over time. The stationary linear combination is called the cointegrating equation and is considered a cointegrating vector, and may be interpreted as a long run equilibrium relationship between the variables. The idea behind cointegration is that there are common forces that co-move or bind the variables over time. Thus, a common stochastic trend in a system of nine macroeconomic variables can be interpreted to mean that the stochastic trend in one variable is related to the stochastic trend in some other macro variable.

There are many possible tests for cointegration, the most general of them is the multivariate test based on the autoregressive representation discussed in Johansen (1988, 1991, 1995) and Johansen and Juselius (1990). The Johansen maximum likelihood method provides two different likelihood ratio tests, the trace test and the maximum eigenvalue test, in order to determine the number of cointegrating vectors (Hendry and Juselius, 2001). This paper will use the trace statistics to test for cointegration. The critical values for the test statistics have been generated by Monte Carlo methods and tabulated by Osterwald-Lenum (1992). The finding of the presence of cointegration paves the way for using the error correction model.

Causality and Eerror Correction Models

The Johansen maximum likelihood approach sets up the nine non-stationary time series in level form as a vector autoregressive (VAR):

$$\Delta X_t = C + \sum_{i=1}^{n} \Gamma_t \Delta X_{t-1} + \Pi X_{t-1} + \upsilon_t . \qquad \upsilon_t \text{ --niid } (0, \delta^2) \tag{2}$$

where X_t is an n x 1 vector of variables that are cointegrated of order 1,1 denoted by CI(1,1), Δ represents first difference and C is an n x 1 vector of constants. The information on the coefficient n x n matrix between the levels of the series Π is decomposed as $\Pi = \alpha\beta'$ where α is the n x r matrix of the adjustment coefficients and β is the matrix that includes the cointegrating vectors. The constant term C is included to capture the trending characteristics of the time series under consideration. The term $\beta' X_{t-1}$ implies the r stationary variables, which are called the error correction terms (ECTs) representing deviations from the long run equilibrium relationship. If the term $\beta' X_{t-1} = 0$, then it represents a convergence to the long-run equilibrium in the system. On the other hand, if this term is not equal to zero then the system is out of equilibrium.

Variance Decomposition (VDCs) and Impulse Response Functions (IRFs)

Once VECM is estimated, we can estimate variance decomposition and impulse response functions. Both VDCs and Impulse response provide indicators of dynamic properties of the macro econometric system. VDCs provide out of sample causality tests, by partitioning the variance of the forecast error of a one macro variable into proportions attributable to shocks in each variable including its own. The information contained in the VDCs is equivalently represented by IRFs. IRFs show the dynamic response path of a variable due to a one-period standard deviation shock to another variable.

DATA, MODEL SPECIFICATION, AND RESULTS

Data and Model Specification

The empirical analysis is conducted using nine major annual macroeconomic data that represent fairly the Bangladesh economy. The sample period is from 1974 to 2000. The data series are obtained from the *Yearly Statistical Bulletin*, published by the Bureau of Statistics, Bangladesh; *Bangladesh Economic Review*, published by the Ministry of Finance, Bangladesh; *Economic Trends*, published by the Bangladesh Bank; and *International Financial Statistics data on CD-ROM*, International Monetary Fund. Appendix A explains each time series in detail. All variables except TOT are in natural logarithmic forms.

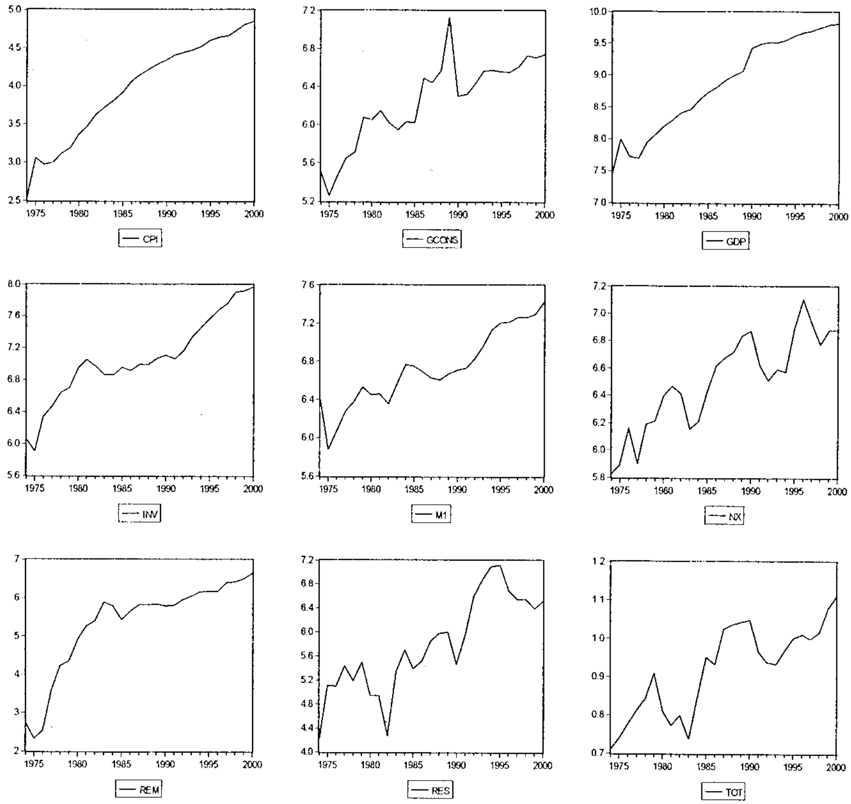
Empirical Results: Unit Root and Cointegration Tests

Figure 1 shows the full-sample time series of all the variables, with logarithmic transformation. The first impression that one can infer from these graphs is that all the time series shown in Figure 1 seem to be "trending" upward, albeit with fluctuations. This suggests that the time series may be I (1) or nonstationary. Univariate autoregressive models can help characterize the order of integration of time series for use in subsequent cointegration analysis.

The ADF test was first conducted in levels on all of the series, and the number of the lagged terms was chosen based on the AIC and SICS information criteria. This test shows that all of the ten variables are non-stationary in levels at the 1% or 5% significance level. This means that the individual macro series has a stochastic trend, and it does not revert to average or long run values after a shock strikes. The test was conducted again in first differences, and the number of lagged first difference terms is also chosen on the basis of the Akaike Information Criteria (AIC) and Schwarz Information Criteria (SIC) criteria. All of the individual series are stationary after first difference, that is, contain a unit root, and thus are integrated of degree one, $I(1)$. Table 2 records the p-value of ADF statistics over the sample 1974-2000 for all the variables of the macro-econometric model.Since all the time series are found nonstationary, we next investigate the long-run equilibrium relationships among these nine macro variables. To do this we use the Johansen (1991, 1995) procedure to test for cointegration (Trace) in a multivariate framework. The cointegration results are presented in Table 3.

It is well known that the cointegration tests are very sensitive to the choice of lag length. Here, the Schwartz Criterion (SC) is used to select the number of lags required in the cointegration test using an unrestricted vector autoregressive framework. The P-value of trace statistics suggests one cointegration vector. Since the time series are nonstationary and are known to be cointegrated, a natural extension is to estimate the Vector Error Correction Model (VECM). The VECM has cointegration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their cointegrating relationships while allowing for short-run adjustment dynamics.

Figure 1: The Full Sample Time Series



Note: Consumer price index (CPI), government consumption expenditure (GCONS), real gross domestic product (GDP), real private investment (INV), real money (M1), real net export (NX), real inflow of remittance (REM), real external balance (RES), and terms of trade (TOT). All variables are in logarithm.

Variance Decomposition And Impulse Response Analysis

Since the estimated coefficients of a VECM are difficult to interpret, impulse response functions (IRFs) and variance decompositions (VDC) usually do the task to draw conclusion about a VECM. An impulse response function traces the response of an endogenous variable to a change in one of the innovations. Variance decomposition measures the percentage of a variable's forecast error variance that occurs as a result of a shock from a variable in the system. We present the VDC results in table 4. Both direct and indirect effects are captured by the VDCs. We consider responses over five year periods to a one standard deviation shock in each variable[2].

Table 2: Unit Root Statistics

Series	P-value of ADF Unit Root Statistics
GDP	0.474
TOT	0.862
CPI	0.116
INV	0.769
REM	0.480
NX	0.331
RES	0.277
M1	0.986
GCONS	0.405
ΔGDP	0.000
ΔTOT	0.010
ΔCPI	0.000
ΔINV	0.000
ΔREM	0.006
ΔNX	0.013
ΔRES	0.000
ΔM1	0.011
ΔGCONS	0.000

Note: Each ADF test uses a constant and no trend. Δ denotes series in first difference. For the ADF test, the lag length has been chosen using the Akaike's infomation criterion. Each P-value of the ADF statistics is reported for the shortest lag length obtained (commencing from 4 lags). P-values are from MacKinnon (1996).

The real gross domestic product is fully exogenous as this variable is fully explained by its own innovation (100%) in the first year. However, by the fifth year, 47% of GDP's variation can be explained by its own innovation. Government expenditure (GCONS), money stock (M1), and net export (NX) explain 18%, 26%, and 7% respectively of GDP variation.

Only 44% of innovation in CPI can be explained by its own shock and gradually declines from second year. By the end of fifth year, only 35% of CPI's variation can be explained by its own innovation. Output (GDP), government expenditure (GCONS), and money stock (M1) explain about 10%, 19%, and 28% of the innovation of CPI respectively. Government expenditure is mostly explained by its own innovation (67%) in the first year, and the rest are explained mostly by output (GDP) alone. The government expenditure shock remains significant through out the period and never dies out even after 5 years.

The innovations in investment (INV) are significantly influenced output (53%) alone and relatively by price (12%) in the first year. However, only 35% of innovation in investment can be explained by its own shock. The response of output to the shock of

Table 3: Johansen (Trace) Cointegration Test

No. of CE Equations	Eigenvalue	Trace Statistics	P-value
H_0: r=0	0.9876	211.27	0.004
H_0: r≤1	0.9305	136.58	0.388
H_0: r≤2	0.7414	91.24	0.800
H_0: r≤3	0.6764	68.24	0.755
H_0: r≤4	0.6067	49.06	0.696
H_0: r≤5	0.5682	33.19	0.587
H_0: r≤6	0.5256	18.91	0.577
H_0: r≤7	0.2823	6.24	0.758
H_0: r≤8	0.0346	0.599	0.742

Notes: The cointegration test uses an intercept but no trend in the cointegration equations. To determine the optimal lag length for Johansen test we first ran an unconstrained VAR for lags 1 to 4. The minimum value of Schwarz criterion suggests the optimum lag is equal to zero for Johansen Cointegration Test. P-values are calculated based on MacKinnon (1996).

investment increases gradually and peaks at the fifth year (62%), whereas its own innovation declines slowly with time and only explain 19% of the variation.

The innovations in M1 are influenced by innovations in M1 (21%), GDP (39%), CPI (32%), INV (5%), and GCONS (4%), respectively. The influences of these variables remain constant and in some cases increase over time. By the end of fifth year M1 is explained by 22% of its own, 40% by GDP, 28% by CPI, and 5% by INV and GCONS respectively. In the first year, the innovations in NX are fully explained by the innovations in NX (44%), M1 (45%), INV (5%), and GDP (3%). By the fifth year, the innovations in NX, can be explained by GDP, GCONS, INV, M1, and NX by 17%, 11%, 4%, 28%, and 39%, respectively.

The innovations in REM are explained by the innovations in REM (55%), M1 (16%), NX (7%), respectively. By the fifth year, REM explains 37%, GDP 23%, GCONS 7%, M1 25%, and NX 9%, respectively. Only 37% of the variation in RES is explained by its own variation and CPI and M1 explain 16% and 36% respectively in the first year. By the fifth year, the variation in RES is explained by RES, CPI, GCONS, and M1 by 34%, 15%, 5%, and 39%, respectively. The innovations in TOT are influenced by innovations in TOT (11%), CPI (8%), INV (17%), M1 (28%), REM (17%), and RES (12%), respectively. By the fifth year, TOT is explained by only 9% of its own variation, 10% by GDP, 5% by CPI, 7% by GCONS, 19% by INV, 11% by M1 and NX, 17% by REM, and 10% by RES, respectively.

Table 4: Summary Results of Variance Decomposition

Relative Variance in	Periiod	S.E.	GDP	CPI	GCONS	INV	M1	NX	REM	RES
GDP	1	0.121478	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2	0.160756	92.37690	0.177398	2.493864	0.207977	3.706960	0.986574	0.028641	0.000826
	3	.194622	77.51113	0.523342	.357136	0.613552	10.93589	2.910486	.084494	.002436
	4	0.231053	0.96544	0.908379	12.76999	1.064959	18.98172	5.051813	0.146658	0.004229
	5	0.271247	46.62806	1.242027	17.46040	1.456118	25.95370	6.907342	0.200526	0.005782
CPI	1	0.081535	56.54784	43.45216	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	2	0.115385	38.48888	48.81898	4.251108	0.354523	6.318985	1.681740	0.048822	0.001408
	3	0.153237	23.03718	45.84660	10.42207	0.869153	15.49170	4.122975	0.119693	0.003451
	4	0.197221	13.90806	40.13704	15.39214	1.283635	22.87938	6.089138	0.176773	0.005097
	5	0.245418	9.271553	34.80502	18.73100	1.562080	27.84236	7.409992	0.215118	0.006203
GCONS	1	0.250824	24.55184	8.109285	67.33888	0.000000	0.000000	0.000000	0.000000	0.000000
	2	0.359162	24.83038	8.040646	67.09930	0.001246	0.022215	0.005912	0.000172	4.95E-06
	3	0.444760	25.06525	7.979087	66.87199	0.003514	0.062641	0.016671	0.000484	1.40E-05
	4	0.518606	25.26464	7.924153	66.66065	0.006323	0.112707	0.029996	0.000871	2.51E-05
	5	0.584863	25.43502	7.875261	66.46665	0.009369	0.166989	0.044443	0.001290	3.72E-05
INV	1	0.118521	52.80885	11.70206	0.036238	35.45285	0.000000	0.000000	0.000000	0.000000
	2	0.176091	57.72315	9.553913	1.075099	30.10432	1.206141	0.321003	0.009319	0.000269
	3	0.227855	60.28110	7.782234	2.514177	25.43632	3.114882	0.828998	0.024066	0.000694
	4	0.277720	61.40919	6.402580	3.971254	21.65286	5.129348	1.365129	0.039631	0.001143
	5	0.326484	61.74107	5.347706	5.291986	18.66892	6.993980	1.861384	0.054038	0.001558
M1	1	0.152454	38.82595	31.71487	3.581062	5.281320	20.59680	0.000000	0.000000	.000000
	2	0.218278	39.06238	30.66908	3.856227	5.275158	21.13005	0.006753	0.000196	5.65E-06
	3	0.270286	39.25217	29.76875	4.101959	5.267746	21.58936	0.019043	0.000553	1.59E-05
	4	0.315159	39.40631	28.99113	4.320487	5.259844	21.98622	0.034265	0.000995	2.87E-05
	5	0.355428	39.53290	28.31707	4.514424	5.251918	22.33034	.050766	0.001474	4.25E-05
NX	1	0.154165	2.471040	2.872691	0.677090	4.714609	44.84219	4.42238	0.000000	0.000000
	2	0.207331	5.368062	2.677639	2.401586	4.511191	40.70762	44.32060	0.007572	0.000218
	3	0.245374	8.979691	2.446472	4.839803	4.226766	36.25792	43.20828	0.023374	0.000674
	4	0.277435	12.91779	2.202183	7.685278	3.896652	31.86268	41.35682	0.044729	0.001290
	5	0.306847	16.85227	1.963473	10.65679	3.553086	27.78593	39.06738	0.068904	0.001987
REM	1	0.302899	16.34696	1.392500	1.594053	0.015785	16.02523	6.511369	58.11410	0.000000
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3	0.587549	20.27127	0.726275	4.226614	0.051117	21.58290	7.984693	45.14756	0.000365
	4	0.712524	21.53763	0.544065	5.361982	0.095819	23.49948	8.454430	40.49066	0.000607
	5	0.831927	22.49934	0.418395	6.335016	0.142675	25.00272	8.808952	36.77088	0.000838
RES	1	0.427251	0.520213	15.88526	3.722037	3.268370	35.66197	0.003467	3.486265	37.45241
	2	0.613686	0.337447	15.70582	4.201246	3.320988	36.71282	0.009428	3.437227	36.27468
	3	0.762325	0.227880	15.53318	4.633455	3.362559	37.58548	0.030555	3.391160	35.23475
	4	0.891595	0.166847	15.37180	5.019461	3.395767	38.31483	0.059917	3.348791	34.32083
	5	1.008378	0.137742	15.22354	5.362340	3.422591	38.92856	0.093154	3.310321	33.51915
TOT	1	0.048309	1.937288	8.099240	0.550072	16.80823	28.02594	5.276909	16.85923	11.50833
	2	0.068237	3.962593	7.375372	1.842534	18.11096	22.23758	6.985111	17.35870	11.47275
	3	0.084387	6.178356	6.627526	3.442442	18.89870	17.51460	8.522984	17.42852	11.19798
	4	0.099023	8.334688	5.924834	5.105253	19.30244	13.83451	9.831227	17.22519	10.79634
	5	0.112875	10.30283	5.298967	6.688285	19.44688	11.04139	10.90896	16.87208	10.34685

Table 5: Data Used in the Paper

Year	CPI	REM	RES	GDP	NX	M1	TOT	GCONS	INV
1974	12.72	196	874	1729.93	-4300	7677	0.71	3100	5405
1975	21.24	219	3508	2957.65	-7700	7579	0.74	4100	7802
1976	19.46	246	3189	2253.67	-9200	8417	0.78	4600	10965
1977	19.97	729	4562	2182.19	-7300	10606	0.81	5700	12827
1978	22.51	1542	4048	2842.72	-11000	13281	0.84	6800	17170
1979	24.29	1888	5940	3211.90	-12100	16642	0.91	10600	19725
1980	28.87	3855	4053	3633.03	-17300	18320	0.81	12300	29976
1981	32.43	6197	4523	4008.59	-20900	20707	0.77	15200	37529
1982	37.78	8397	2698	4516.18	-23100	21748	0.80	15500	40082
1983	41.47	14802	8765	4743.42	-19500	29566	0.74	15900	39450
1984	45.47	14910	13595	5518.93	-22600	39467	0.85	19000	43548
1985	50.44	11465	11068	6170.47	-31100	42909	0.95	20900	52667
1986	58.03	16611	14408	6767.44	-43400	46725	0.93	38100	58446
1987	63.75	21363	22164	7520.22	-50500	48204	1.02	40100	69490
1988	68.48	23039	26963	8090.79	-56600	50827	1.04	48600	74306
1989	72.62	24774	29454	8713.34	-67800	57475	1.04	90500	85191
1990	77.07	24961	18161	12432.47	-74300	63268	1.05	42100	94427
1991	81.97	27256	31501	13251.80	-61500	68742	0.96	45700	95955
1992	84.95	32415	62713	13646.12	-56900	78787	0.94	53200	109851
1993	87.50	36969	84407	13686.68	-63800	92175	0.93	62100	135214
1994	92.15	43548	111289	14208.81	-65800	115159	0.97	66100	158927
1995	100.00	48145	123089	15252.00	-97800	134669	1.00	70600	194651
1996	104.06	49780	84237	15900.57	-126500	140552	1.01	73200	225803
1997	105.86	63054	73921	16382.59	-108900	150972	1.00	78900	247510
1998	113.24	69346	79042	17256.90	-99100	161547	1.01	94700	305569
1999	123.33	81978	73633	18052.59	-120000	181655	1.08	100800	339949
2000	128.16	98070	86513	18393.33	-124400	214658	1.11	108400	370149

Note: All figures are in million.

CONCLUSIONS

The main purpose of this paper is to develop and test a macro-econometric model of Bangladesh. For this purpose, we used unit root, cointegration, vector error correction and variance decomposition tests to examine the dynamic relationships among nine macro variables that comprise the economy of Bangladesh. It has been argued by other studies that VECMs are a more flexible approach to macromodeling particularly when the underlying true structural model is unknown. There is a great debate in monetary economics about the relative importance of monetary policy versus fiscal policy. Our results clearly show that within the context of Bangladesh and within the time-period studied, monetary policy is more important than fiscal policy. This can be seen vector decomposition (VDC) analysis. The result is very much expected as significant amount of development expenditure for Bangladesh comes from foreign donation. As such, fiscal policy is hostage to foreign aid.

However, monetary policy, except the fact that part of foreign monies have to converted into domestic currency is a more effective contributor to domestic economic growth. Our results are very similar in spirit to those of Chowdhury, Dao and Wahid (1995) with regards to monetary policy in Bangladesh. As in all developing countries, since a significant part of the domestic economy is not monetized, an active monetary policy is needed to monetize the rest of the economy. However, in the process of implementing such a policy, we should keep in mind that such money creation does not contribute to excessive inflation. A moderate inflation is likely to result from this monetization effort.

The government should undertake policies to attract overseas remittance into productive investment activities. Currently, most foreign money is being used in speculative and unproductive investment such as real estate and consumption, resulting in an excessive rise in land prices. The government can create investor friendly investment atmosphere and give various tax incentives to channel these overseas remittances to various projects deemed necessary for economic development. While export-processing zones (EPZ) give such incentives to foreign investment, the government should devise alternative mechanisms so that it can put remittances into work.

Finally, the government should focus on export diversification. Currently, we are heavily dependent on garments and leather exports. The government should provide incentives to investors and entrepreneurs in other sectors in which Bangladesh has comparative advantage.

DATA APPENDIX

The definitions of the variables used in the paper are given below. Except the variable *terms of trade* (TOT), all variables used in the analysis are in natural logarithm. All data used are annual, 1974 – 2000, reported in Table 5. All data are in million Taka. The base year for all index variables is 1995. Except GDP and TOT, all variables have been deflated by CPI to get real variables. The sources of the data are explained below.

GDP: Real gross domestic product. We deflated the series with GDP deflator to get *real gross domestic product*. The base year for GDP deflator is 1995. Both GDP and

GDP deflator are from *IFS CD-ROM,* International Monetary Fund, lines **99B** and **99BVP**, respectively.

NX: Real net export has been calculated as export minus import. The data for export and import are from *IFS CD-ROM,* lines **90C** and **98C**, respectively.

GCONS: Real government consumption expenditure is taken from *IFS CD-ROM*, line **91F**.

M1: real M1 money stock is taken from *IFS CD-ROM*, line **34B**.

INV: Real private Investment is taken from *Statistical Yearbook of Bangladesh*, Bureau of Statistics.

REM: Real wage earners' remittance inflow. *Economic Trend*, Bangladesh Bank. The data points for years 1974 and 1975 were not available. To keep the sample size from 1974 to 2000, we extrapolated the missing points for remittance data. We followed the following steps: first, we calculated the growth rate of remittance, g, for each year using $g = \log(REM_t) - \log(REM_{t-1})$. Second, we calculated the average growth rate of remittance, $\bar{g}$, using $\bar{g} = \sum_{1977}^{2000} g$. Finally, to calculate the data point for 1975 we use the following formula, $1975_t = 1976_t(1 - \bar{g})$, where 1975_t and 1976_t are generated and actual data points, respectively. We followed the same procedure for 1974_t.

RES: Real external resources (international reserves). *Bangladesh Economic Review*, Ministry of Finance.

CPI: Consumer price index (1995=100). The whole series is not available from a single source, thus we complied the series from two sources. From year 1974 to 1990, the data is taken from *Statistical Yearbook of Bangladesh* where the base year was 1974. From 1990 to 2000, the data is taken from *IFS CD-ROM*, line **64**, with base year 1995. Using Spliced Index formula we transformed the series in a single base year, 1995=100.

TOT: Terms of trade between the agriculture and manufacturing sector. The series is constructed dividing the wholesale price index of agriculture sector by the wholesale price index of manufacturing sector. The data on the wholesale price indexes are from *Statistical Yearbook of Bangladesh*. The original base year was 1970, which then transformed into 1995=100 using the Spliced Index formula.

ENDNOTES

[1] A similar approach was suggested by Chowdhury (1986) where the author offered a theoretical framework of the vector autoregression model for the Bangladesh economy, however, no such estimation of the parameters was done by the author.

[2] We can show these results by impulse response functions. To conserve space, the impulse response figures are not reported in the paper but are available from authors upon request.

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