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THE AGRICULTURAL AND THE EXTERNAL (NET BARTER) TERMS OF TRADE IN BANGLADESH: TRENDS, MOVEMENTS AND RELATIONSHIPS, 1952-2006

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This paper analyses the trends and movements of, and the relationship between, the agricultural and the external (net barter) terms of trade in Bangladesh for the period 1952-2006. The Pesaran bounds testing results suggest the presence of a cointegral relationship between the agricultural and the external terms of trade in Bangladesh. The forecasting ability of the error-correction model of the agricultural terms of trade is highly satisfactory, irrespective of whether the level or the percentage change in the agricultural terms of trade is being forecasted. The overall results suggest that the agricultural terms of trade in Bangladesh is determined endogenously and does not seem to have been deployed by policy makers to 'squeeze agriculture' within an import-substituting strategy of development that has effectively ended in this country since the mid-1980s.

JEL Classification: *C22, 024, Q11*

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INTRODUCTION

The movements of the agricultural terms of trade[1] play a key role in capital accumulation, intersectoral resource mobility and economic growth and have therefore implications for welfare of the rural people in particular during transformation of an agricultural economy into an industrial one (Timmer, 1988). A growing body of literature indeed exists on the importance (and also the determination) of the agricultural terms of trade in economic growth and transformation (Thirlwall, 1986,2006). Nevertheless, the key issue remains whether the agricultural terms of trade is an exogenous policy instrument or should be considered an endogenous variable which is determined within a general equilibrium framework. Until the late-1980s most economists[2] working on planned or *quasi*-planned economies considered the agricultural terms of trade an exogenous policy instrument in the toolkit of policy makers. Any movements in the agricultural terms of trade were therefore interpreted as if they were the outcome of policy measures that were designed for 'forced industrialisation' as a strategy of development.[3] However, as most agricultural economies of Asia and Africa operated within a mixed-economy environment, the

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agricultural terms of trade in these regions was determined endogenously.[4] The recent literature recognises this phenomenon and considers the agricultural terms of trade an endogenous variable. For example, Thirlwall (1986) has developed a growth model in which the agricultural terms of trade represents an equilibrating mechanism that establishes a complementary relationship between agriculture and industry. In his model the sectoral demands and supplies are balanced and both agriculture and industry grow simultaneously, in the sense suggested earlier by Kaldor (1979). He has shown that a developing economy can grow steadily at the maximum when the agricultural terms of trade remains at its equilibrium level. An implication is that turning the internal terms of trade against agriculture retards rather than promotes economic growth.[5]

Bangladesh[6] remains a predominantly agricultural economy. Throughout the 1950s and 1960s the trends and movements of the agricultural terms of trade became an issue in Pakistan because they were interpreted as an outcome of policies designed for forced industrialisation as a strategy of development. In fact in the late-1960s some prominent economists working on and in Pakistan developed the 'agriculture-squeeze thesis' to explain industrialisation in (West) Pakistan at the expense of Bangladesh's agriculture.[7] This debate has subsided since the independence of Bangladesh, although the validity of the 'agriculture-squeeze thesis' remains an empirical issue given its historical significance. No major study has however been conducted on the agricultural terms of trade in Bangladesh since the 1970s[8] despite its significance in a rapidly transforming economy. Bangladesh's agriculture suffered the most during the early-1970s. It has however made a breakthrough since agricultural reforms started in the mid-1980s. Since then the economy has been growing at a steady pace of about 5 per cent per annum in an increasingly open-economy environment. This has contributed to structural transformation of the economy in favour of the non-tradable goods sector. The trends and movements of the agricultural terms of trade can therefore provide information on economic transformation and its implications for welfare of the rural people in particular (Hossain, 2006, 2007).

Having outlined the importance of the agricultural terms of trade in economic growth and transformation, this paper examines in an historical context the proposition that there exists a long-run relationship between the agricultural and the external terms of trade in Bangladesh[9]. The remainder of the paper is organised as follows. Section 2 establishes a relationship between the agricultural and the external terms of trade for an open economy in which the domestic production structure and the compositions of exports and imports have similar characteristics. The structural transformation of the Bangladesh economy is then briefly reviewed to suggest the possibility of such a relationship in this country. Section 3 applies the Autoregressive Distributed Lag (ARDL) bounds testing cointegration approach to investigate the long-run relationship between the agricultural and the external terms of trade in Bangladesh. Annual data for the period 1952-2006 are used for this investigation. An associated error-correction model is also estimated and used for forecasting of both the level and the percentage change in the agricultural terms of trade. Section 4 draws conclusion and policy implications.

THE RELATIONSHIP BETWEEN THE AGRICULTURAL AND THE EXTERNAL TERMS OF TRADE

For a small open economy, the external (net barter) terms of trade is an exogenous variable as it is determined in the international markets. Assuming that both the export and import prices are denominated in a foreign currency ($), the external barter terms of trade in domestic currency (TOT^e) can be expressed as: $TOT^e = P^x/P^m = E^x \times P^{x\$}/E^m \times P^{m\$}$, where E^x (E^m) is the effective exchange rate of domestic currency per unit of foreign currency for exportables (importables). Under an unbiased free-trade regime $E^x \cong E^m$ and the external terms of trade based on domestic currency approximates the external terms of trade based on foreign currency. By assumption, the external terms of trade (based on foreign currency) is exogenous, in the sense that for a small economy, it remains outside the control of the domestic authorities. In reality, the ratio of the effective exchange rate of domestic currency for imports to the effective exchange rate of domestic currency for exports (E^m/E^x) may not be equal or remain constant. In general, the value of this ratio exceeds one for most developing countries and is used to measure the anti-export bias.[10] The effective barter terms of trade therefore represents the exogenously determined external terms of trade based on a foreign currency times the degree of anti-export bias, which is captured by the term (E^m/E^x).[11]

Assuming that the production structure and the compositions of exports and imports remain stable (but not constant), the agricultural and the external terms of trade are expected to be closely related. For example, given the predominance of agriculture in Argentina, the agricultural terms of trade[12] TOT^a and the external terms of trade TOT^e (P^x/P^m) maintained a close long-term relationship over a long period (Diaz-Alejandro, 1970). This followed the relationship: $P^a/P^i \approx P^x/P^m$ ($= E^x \times P^{x\$}/E^m \times P^{m\$}$). To the extent that the external terms of trade based on a foreign currency ($P^{x\$}/P^{m\$}$) was determined in the international markets and the term E^x/E^m remained stable, the causal relationship ran from the external terms of trade to the agricultural terms of trade.

In order to determine whether the agricultural terms of trade in Argentina was affected by fiscal, commercial and exchange rate policies, Diaz-Alejandro (1970) developed an index in which he expressed the agricultural terms of trade as a ratio of the external of terms of trade. His idea was that any significant rise or fall of this index indicates the net impact of government policies that modify the price signals that a producer may otherwise receive from the world markets. Since the government policy changes with respect to tariffs, subsidies, taxes, trade controls and other financial policies are unlikely to be haphazard, the term E^x/E^m remains predictable. A long-run relationship should therefore exist between the agricultural and the external terms of trade in a developing country undergoing economic transformation. When such a relationship exists, the causality is expected to run from the external terms of trade to the agricultural terms of trade. The absence of a long-run or cointegral relationship between the agricultural and the external terms of trade may then point to the existence of barriers that sever the linkage between them.[13]

The Case of Bangladesh

Bangladesh is a small open economy, which has undergone considerable structural change since the 1980s. The agricultural and industrial prices in Bangladesh are market determined and therefore the agricultural terms of trade can be considered an endogenous variable (Hossain, 2008a). According to the *Purchasing Power Parity* condition[14], the domestic prices of tradables are linked to the international prices and therefore the agricultural terms of trade bears a close relationship with the external terms of trade. However this relationship may change with economic growth because of the change in the composition of output in favour of non-tradables. Similarly, the composition of trade changes with economic growth and the trade structure does not necessarily mimic the composition of domestic output. Therefore it is possible that with economic transformation, the linkage between the agricultural and the external terms of trade in the growing economy of Bangladesh has become weaker since the 1980s.[15]

Table 1 reports data for the ratio of the effective exchange rate for exports (E^x) to the effective exchange rate for imports (E^m) in Bangladesh for the period 1992-2006.[16] This ratio shows a downward but stable trend. This suggests the possibility of a close relationship between the agricultural and the external terms of trade in Bangladesh. The remainder of the paper examines this proposition in an historical context.

Table 1
The Effective Exchange Rates for Imports and Exports in Bangladesh: 1992-2006

Fiscal Year	*Nominal Exchange Rate: Taka/US$*	*Effective Exchange Rate for Imports (EER^a_m)*	*Effective Exchange Rate for Imports for Imports (EER^b_m)*	*Effective Exchange Rate for Imports for Exports (EER_x)*	*EER^a_m/ EERx*	*EER^b_m/ EERx*
1991-92	38.15	66.24	60.94	38.53	1.72	1.58
1992-93	39.14	62.83	58.45	39.76	1.58	1.47
1993-94	40.00	58.36	55.14	40.50	1.44	1.36
1994-95	40.20	55.29	51.64	40.52	1.36	1.27
1995-96	40.84	53.89	51.04	41.24	1.31	1.24
1996-97	42.70	56.20	53.27	43.17	1.30	1.23
1997-98	45.46	60.53	57.37	46.06	1.31	1.25
1998-99	48.06	63.64	60.34	49.10	1.30	1.23
1999-00	50.31	65.09	61.72	51.82	1.26	1.19
2000-01	53.96	69.36	66.56	55.50	1.25	1.20
2001-02	57.43	74.33	71.24	59.19	1.26	1.20
2002-03	57.90	73.20	70.42	59.68	1.23	1.18
2003-04	58.94	76.10	72.88	60.74	1.25	1.20
2004-05	61.39	77.66	74.51	62.81	1.24	1.19
2005-06	67.08	84.84	80.95	68.01	1.25	1.19

Notes: 1. The effective exchange rate for imports refers to the nominal exchange rate adjusted for (protective) import levies and any scarcity premium that exchange controls generate. The effective exchange rate for imports indicates the domestic currency cost of one US$ worth of imports.

2. The effective exchange rate for exports represents the exchange rate after adjusting for existing export promotion schemes (direct export cash subsidies, subsidised export credits, etc.). The effective exchange rate represents the domestic currency equivalent of proceeds from one US$ worth of exports.

3. a/average (unweighted) total protection, based on *Most Favoured Nations* (MFN) rates only. b/average (unweighted) total protection, based on MFN rates adjusted for end-user concessions and exemptions. This also reflects duty-free access to imported inputs provided to readymade-garments exports.

Source: World Bank (2007).

TESTING FOR THE COINTEGRAL RELATIONSHIP BETWEEN THE AGRICULTURAL AND THE EXTERNAL TERMS OF TRADE IN BANGLADESH

The two most commonly used approaches to testing for the long-run relationship between two or more variables in levels are the Engle-Granger two-step residual based procedure (Engle and

Granger, 1987) and the Johansen system-based reduced rank regression approach (Johansen, 1988; Johansen and Juselius, 1990). These approaches are applied to cases where the underlying variables in the relationship are integrated of order one. Since most applied researchers face the problem of not knowing with certainty that the variables in the relationship have a unit root, an increasing number of studies use the Pesaran bounds testing cointegration approach.[17] The main attraction is that this approach does not require testing for a unit root in the series before testing for the long-run relationship. Information gained from testing for a unit root in the series may however become useful for making inference when the estimated F-statistic falls inside the critical value bounds. This paper applies the Pesaran bounds testing approach to determine the relationship between the agricultural and the external terms of trade in Bangladesh.

The ARDL bounds testing approach to cointegration

The error-correction form of the ARDL model in the variables ln TOT^a and ln TOT^e is specified as follows:

$$\Delta \ln TOT_t^a = \alpha_0 + \alpha_1 T + \Sigma\beta_i \Delta \ln TOT_{t-i}^a + \Sigma\phi_i \Delta \ln TOT_{t-i}^e + \delta_1 \ln TOT_{t-1}^e + \delta_2 \ln TOT_{t-1}^a + U_t$$

where the coefficients β_i and ϕ_i represent the short-run dynamics of the underlying variables in the ARDL model and the coefficients δ_s represent the long-run relationship. This specification is based on the maintained hypothesis that the time series properties in the agricultural terms of trade relationship can be approximated by a log-linear VAR(p) model, augmented with deterministic intercepts and (probably) trends (T) (Pesaran, Shin and Smith, 2001). Although in the specification the value of i can be infinity, the model is estimated sequentially with one to the maximum lag four.[18]

Testing for the Hypothesis that $\delta_1 = \delta_2 = 0$

The model is estimated first in a restricted form by excluding the level form lag variables and then tested for the significance of the lagged level variables through a variable addition test (*F*-test). The estimated *F*-statistic for the restriction that $\delta_1 = \delta_2 = 0$ in the specification with (log) of the agricultural terms of trade as dependent variable is denoted by $F(\ln TOT^a \mid \ln TOT^e)$. This process is repeated for the specification with the external terms of trade as dependent variable. The estimated *F*-statistic for the restriction that $\delta_1 = \delta_2 = 0$ in this specification is denoted by $F(\ln TOT^e \mid \ln TOT^a)$. The estimated *F*-statistics are then compared with the critical values to determine whether there exists a long-run relationship between the agricultural and the external terms of trade. In addition, the *F*–statistics provide information on whether one of these variables can be considered a long-run forcing variable in determining the other.[19]

Table 2 reports the *F*-statistics with different lags in the specification and the critical values at the 90 per cent and 95 per cent levels. The asymptotic distribution of the *F*-statistic is non-standard under the null hypothesis that there exists no level relationship irrespective of whether the regressors are $I(0)$ or $I(1)$. Two sets of critical values are provided: one when all the regressors are purely $I(0)$ and the other if they are purely $I(1)$. These two sets of critical values provide a band covering all the possible classifications of regressors into purely $I(0)$, purely $I(1)$ or mutually cointegrated. If the test statistic exceeds the upper critical value, the null hypothesis of no long-run relationship is rejected regardless of whether the underlying orders of integration of the variables are zero or one. Similarly, if the test statistic falls below the lower critical value, the null hypothesis is not rejected. If the test statistic falls between the two critical bounds, the result is inconclusive and further information on the time series properties of variables in the underlying relationship is required. When the order of integration of the variables is known and all the variables are $I(1)$, the decision can be made based on the upper bound. Similarly, if all the variables are $I(0)$, the decision can be made based on the lower bound.[20]

Table 2
Testing for the Long-Run Relationship

Order of lag (i = 1, 2, 3, 4)	*F-Statistic (with constant and trend)*	*F-Statistic (with constant)*
1	$F(\ln TOT^a \mid \ln TOT^e) = 6.50$	$F(\ln TOT^a \mid \ln TOT^e) = 4.63$
2	$F(\ln TOT^a \mid \ln TOT^e) = 9.92$	$F(\ln TOT^a \mid \ln TOT^e) = 9.01$
3	$F(\ln TOT^a \mid \ln TOT^e) = 7.52$	$F(\ln TOT^a \mid \ln TOT^e) = 8.47$
4	$F(\ln TOT^a \mid \ln TOT^e) = 5.61$	$F(\ln TOT^a \mid \ln TOT^e) = 4.25$
1	$F(\ln TOT^e \mid \ln TOT^a) = 5.78$	$F(\ln TOT^e \mid \ln TOT^a) = 3.08$
2	$F(\ln TOT^e \mid \ln TOT^a) = 4.15$	$F(\ln TOT^e \mid \ln TOT^a) = 1.66$
3	$F(\ln TOT^e \mid \ln TOT^a) = 6.29$	$F(\ln TOT^e \mid \ln TOT^a) = 1.63$
4	$F(\ln TOT^e \mid \ln TOT^a) = 3.07$	$F(\ln TOT^e \mid \ln TOT^a) = 0.38$

Note: The critical value bounds of the F-statistic (with constant) are {4.042-4.788} and {4.934-5.764} at the 90 per cent and 95 per cent respectively and those (with constant and trend) are {5.649-6.335} and {6.606-7.423} at the 90 per cent and 95 per cent respectively.

The test results are generated for two cases: with an intercept and trend and with an intercept only. In the specification with only intercept, the critical value band for $k = 1$ is {4.042-4.788} at the 90 per cent level and {4.934-5.764} at the 95 per cent level. Since $F(\ln TOT^a \mid \ln TOT^e) = 9.01$ exceeds the upper bound critical value, the null hypothesis of no long-run relationship between $\ln TOT^a$ and $\ln TOT^e$ is rejected irrespective of the order of integration of the regressor. In the specification of $\ln TOT^e$ the statistic $F(\ln TOT^e \mid \ln TOT^a) = 3.08$, which falls below the lower bound of the band even at the 90 per cent level. Therefore the external terms of trade can be considered a long-run forcing variable in determining the agricultural terms of trade irrespective of whether the time series properties of the variables in the underlying relationship are $I(0)$ or $I(1)$.

In the specification with both intercept and trend, the critical value band for $k = 1$ is {5.649-6.335} and {6.606-7.423} at the 90 per cent and 95 per cent level respectively. Since $F(\ln TOT^a \mid \ln TOT^e) = 9.92$ exceeds the upper limit of the critical band, the null hypothesis of no long-run relationship between $\ln TOT^a$ and $\ln TOT^e$ is rejected again irrespective of the order of integration of the regressor. In the specification of $\ln TOT^e$, the statistic $F(\ln TOT^e \mid \ln TOT^a) = 6.29$, which falls between the lower and upper bounds of the F-statistic at the 90 per cent level. The time series properties of the TOT^a and TOT^e (Appendix A1 and A2) suggest that they are $I(0)$. Therefore the lower bound critical values can be used to draw inference.

The overall results suggest that there exists a long-run relationship between the agricultural and the external terms of trade in Bangladesh. However the issue whether the external terms of trade is a long-run forcing variable in explaining the agricultural terms of trade cannot be resolved because the results are sensitive to the inclusion of trend in the specification.

Estimating the Coefficients of the Long-Run Relationship

The second stage of the ARDL modelling involves estimating the coefficients of the long-run relations and making inference on their values. The estimation procedure is untidy because a number of choices are made with respect to the inclusion of intercept, trend and the lag-length. This makes the procedure experimental. In general, in estimating the long-run coefficients, the ARDL technique estimates $(p + 1)^k$ number of regressions in order to obtain the optimal lag length for each variable, where p is the maximum number of lags and k is the number of variables in the equation. The model is selected using the Akaike Information Criterion (AIC).

Appendix Table A3 reports the ARDL models selected by the AIC for the period 1956-2006. In the estimated model, D7275 is a dummy variable which takes a value one during 1972-1975 and 0 otherwise and it captures the economic crises during 1972-1975. Table 3 reports a summary of the long-run coefficients with four lag terms in the variables. Preliminary estimation of the model with a trend is found superior to one without a trend. The AIC has selected the ARDL (2, 3) specification. All the estimated coefficients are statistically significant and bear their expected signs. The overall results suggest that the agricultural terms of trade has a long-run upward trend and is affected by the external terms of trade. The restriction that the coefficient on the external terms of trade equals one is however rejected.

Table 3
The Estimated Long-Run Coefficients
(Sample: 1956-2006)

Model: ARDL (2,3)

Regressor	*Long-run coefficient*	*t-ratio (prob.)*
Intercept	3.01	8.62 (0.00)
ln TOT^e	0.27	3.67 (0.00)
*D*7275	–0.10	–2.18 (0.04)
T	0.010	11.78 (0.00)

The Wald test for the restriction(s) on long-run coefficient (s)

H_0: Coefficient on ln $TOT^e = 0$	$\chi^2_{(1)} = 13.49$ (prob. 0.00)
H_0: Coefficient on ln $TOT^e = 1$	$\chi^2_{(1)} = 102.24$ (prob. 0.00)
H_0: Coefficient on $T = 0$	$\chi^2_{(1)} = 138.75$ (prob. 0.00)
H_0: Coefficient on dummy, $D7275 = 0$	$\chi^2_{(1)} = 4.74$ (prob. 0.029)
H_0: Coefficients on TOT^e, T and $D7275 = 0$	$\chi^2_{(3)} = 162.30$ (prob. 0.00)

The Error-Correction Representation

Table 4 reports the error-correction model of the agricultural terms of trade corresponding to the long-run estimates. In the estimated model, most of the coefficients are significant. The error-correction coefficient measures the speed of adjustment to the equilibrium. The estimated coefficient value –0.85 suggests a rapid speed of convergence to equilibrium. The presence of a significant error-correction term confirms the existence of a long-run relationship between the agricultural and the external terms of trade.

Table 4
The Error-Correction Model Dependent Variable: Δ ln TOT^a

Regressor	*Short-run coefficient*	*t-ratio (prob.)*
Δ Intercept	2.57	6.98 (0.00)
ecm_{t-1}	–0.85	–7.86 (0.00)
Δ ln TOT^a_{t-1}	0.15	1.52 (0.14)
Δ ln TOT^e_t	0.37	5.42 (0.00)
Δ ln TOT^e_{t-1}	–0.09	–1.16 (0.25)
Δ ln TOT^e_{t-2}	0.17	2.50 (0.02)
Δ *D*7275	–0.08	–2.18 (0.04)
Δ *T*	0.008	5.64 (0.00)
Adjusted R^2	0.66	
Standard error of the regression	0.061	
DW	2.28	
The Wald test for restriction on the coefficient:		
H_0: Coefficient on error-correction term, ecm_{t-1} = 0	$\chi^2_{(1)}$ = 61.75 (prob. 0.00)	

Dynamic Forecasts

In order to examine the forecasting ability of the error-correction model, it was estimated for a shorter period 1956-2000 and the remaining six observations were used for forecasting both ln TOT^a and Δ ln TOT^a. Figures 1 and 2 report the in-sample fitted values and out of sample forecasts of ln TOT^a and Δ ln TOT^a respectively. They show that the error-correction model

Table 5
Dynamic Forecasts for Both ln TOT^a and Δ ln TOT^a

	Dynamic forecasts for ln TOT^a		
Year	*Actual*	*Prediction*	*Error*
2001	4.7475	4.7485	–0.0010860
2002	4.7525	4.7538	0.018757
2003	4.7823	4.7264	0.055948
2004	4.7843	4.7310	0.053304
2005	4.7803	4.7206	0.059701
2006	4.7184	4.7323	-0.013859

	Summary statistic for forecast errors	
	Estimation period: 1956-2000	*Forecast period: 2001-2006*
Root-mean-sum squares	0.057834	0.040989

	Dynamic forecasts for Δ ln TOT^a		
Year	*Actual*	*Prediction*	*Error*
2001	–0.048623	–0.047537	–0.0010860
2002	0.0050697	–0.014773	0.019843
2003	0.029772	–0.0074196	0.037192
2004	0.0019849	0.0046297	–0.0026448
2005	–0.0039543	–0.010351	0.0063972
2006	–0.061907	0.011653	–0.073560

	Summary statistic for forecast errors	
	Estimation period: 1956-2000	*Forecast period: 2001-2006*
Root-mean-sum squares	0.057834	0.034730

tracks the trends and fluctuations of the agricultural terms of trade remarkably well. Table 5 reports the out-of sample forecasting results in a summary form, which suggests that the root-mean-squares of forecasts of 4.1 per cent for ln TOT^a and 3.5 per cent for $\Delta \ln TOT^a$. The forecasting errors are smaller than the value of the same criterion computed over the estimation period 1956-2000.

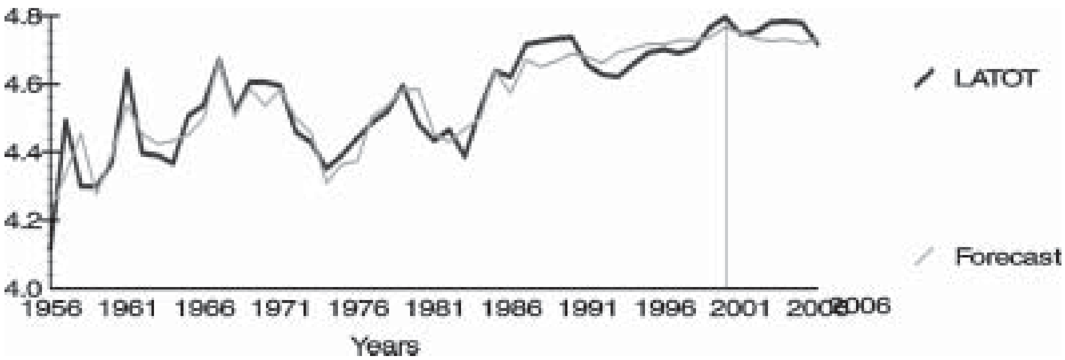

Figure 1: Dynamic Forecasts for ln TOT[a] (LATOT): 1956-2006

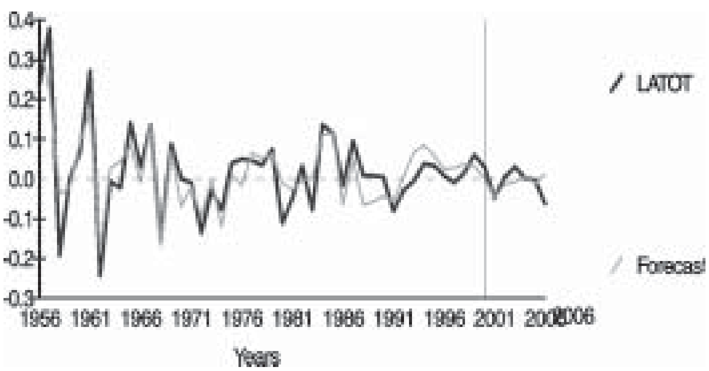

Figure 2: Dynamic Forecasts for the Change in ln TOT[a] (DLATOT): 1956-2006

CONCLUSION AND POLICY IMPLICATIONS

This paper has analysed the trends and movements of, and the relationship between, the agricultural and the external (net barter) terms of trade in Bangladesh for the period 1952-2006. The Pesaran bounds testing results suggest the presence of a cointegral relationship between the agricultural and the external terms of trade in Bangladesh. The forecasting ability of the error-correction model of the agricultural terms of trade is highly satisfactory, irrespective of whether the level or the percentage change in the agricultural terms of trade is being forecasted. The overall results suggest that the agricultural terms of trade in Bangladesh is determined endogenously and does not seem to have been deployed by policy makers to 'squeeze agriculture' within an import-substituting strategy of development that has effectively ended in this country since the mid-1980s.

The empirical results have policy implications. The main finding of the paper is that the domestic terms of trade in Bangladesh has a close relationship with the external terms of trade. However the increasing openness of the economy is likely to cause greater fluctuations of the agricultural terms of trade and affect the intersectoral resource mobility, productivity growth and economic transformation. The movements of the agricultural terms of trade have implications on welfare of different groups in the society, especially the rural people, as they affect sectoral capital accumulation, productivity and resource flows. Lately, this has become an important monetary policy issue in Bangladesh. For example, in addition to the international price shocks that affect the domestic prices, the agricultural prices in Bangladesh remain volatile due to the asymmetric response of the monetary authorities to negative production shocks. Because something has to be done to appease the urban consumers, policymakers tend to put a sharp break on the money supply growth. This lowers agricultural prices abruptly and hurts farmers. In contrast, when agricultural prices decrease, the monetary authorities do not face any effective pressure from farmers for monetary expansion. Such asymmetric responses of monetary policy to production shocks are one of the reasons for excessive volatility of agricultural prices in Bangladesh. While the increasing economic openness is desirable for improvement of macroeconomic performance, the volatility of agricultural prices (and the domestic terms of trade) can be reduced by adopting a steady monetary policy (Hossain, 2008b).

NOTES

1. In this paper the agricultural terms of trade is defined as the ratio of the agricultural wholesale price index to the industrial wholesale price index, expressed in a percentage form.
2. They include Mitra (1977), Preobrazhensky (1965), and Sah and Stiglitz (1984, 1987).
3. This view was apparently based on the development experiences of the former Soviet Union and some countries of East Europe.
4. There were however controls over some commodity prices, especially food grains and cash crops. In most cases, price controls were not comprehensive or effective and therefore the agricultural terms of trade moved in the direction that was otherwise determined by the prevailing demand and supply conditions in the economy. In recent decades some developing countries have joined the WTO and introduced price deregulatory measures. As a result, domestic agricultural prices have established a close relationship with those in international markets. For discussion on different aspects of agricultural price policy in developing countries, see Ahmed and Mellor (1988), Bates (1983) and Timmer, Falcon and Pearson (1983).
5. Following this theme, Rattsϕ and Torvik (2003) have developed a model which shows that the technological advantage of industry (that takes lead in a modern economy) is neutralised when capital imports are squeezed because of any binding foreign-exchange constraint in a stagnant agricultural economy.
6. Throughout the paper Bangladesh represents its former name East Pakistan/East Bengal. Since Bangladesh's independence in 1971, Pakistan represents former West Pakistan.
7. On this issue, see Falcon (1967), Islam (1981), Khan (1972), Lewis (1968, 1970a, 1970b), Lewis and Hussain (1966), Soligo (1967) and Stepanek (1977).
8. A number of studies however were closely related to the agricultural terms of trade, such as Rahman (1976), Hossain (1984) and Chowdhury (1992).
9. Throughout the paper the external net barter terms of trade is defined as the ratio of the export price index to the import price index (both based on domestic currency), expressed in a percentage form.

10. The effective exchange rates for imports and exports depend on trade controls, subsidies, taxes and other financial measures that affect the prices of exports and imports and thereby distort trade flows (Bhagwati, 1978).
11. One referee points out that the external terms of trade and the domestic terms of trade may reflect the common resource transfer policies worldwide and therefore the movements of the domestic and the external terms of trade should be similar. Therefore, Bangladesh's economic policies should not be out of line with such policies worldwide. This is an important but contentious idea. This paper does not explore this theme. It continues with the assumption that the external terms of trade (based on foreign currency) is determined in the international markets and remains outside the influence of economic policies of a developing country like Bangladesh.
12. Defined as the ratio of agricultural prices P^a to industrial prices P^i.
13. This paper does not explore the fiscal, monetary/exchange rate and commercial policies that affect the relationship between the domestic and external terms of trade in a country like Bangladesh. The presence of a long-run relationship between the domestic and the external terms of trade in the presence of economic policies that aim to sever such linkage implies that such policies are not effective or applied rigorously.
14. Following the Purchasing Power Parity proposition, the price of tradables in domestic currency can be expressed as: $\ln PT_t = \ln ER_t + \ln PT_t^f$, where ER is the exchange rate (defined as units of domestic currency for each unit of foreign currency), PT^f is the price of tradables in foreign currency and ln is natural logarithmic operator.
15. One referee points out that the shares of agriculture in domestic output and external trade do not remain unchanged during economic transformation and that the structure of output may not match the compositions of exports and imports. This is a valid point. The share of agriculture in output in Bangladesh has declined from about 70 per cent in the 1950s to about 16 per cent in 2007. During this period the share of agricultural products in exports has declined from 80 per cent to less than 20 per cent. The share of agricultural products in imports has also declined over time. However, as data for the shares of primary and manufactured products in exports and imports and the export and import prices for major commodities are not available, it is not possible to examine any changes in the relationship between the agricultural and the external terms of trade at the disaggregated level. Despite its relevance to the present context, this paper does not examine the stability of the relationship by applying stability tests. Future research may explore this issue.
16. Data for the complete sample period are not available. The reported data indicate the stability of the effective exchange rates and therefore the degree of export-bias appears to have remained stable. Any future study should explore any structural breaks (known or unknown) in the relationship between the domestic and the external terms of trade in Bangladesh.
17. The ARDL cointegration approach has been developed in a series of papers by Pesaran and Shin (1996), Pesaran and Pesaran (1997), Pesaran and Smith (1998) and Pesaran, Shin and Smith (2001), which remains valid irrespective of whether the regressors are purely I(0), purely I(1) or mutually cointegrated.
18. Instead of estimating the model sequentially using one to four lag terms, it is possible to use an information criterion to choose the optimal lag length. This paper follows the sequential approach to find out how sensitive is the results to the lag length. Pesaran and Pesaran (1997) suggest that a lag length of one period can be a reasonable choice in case of annual data.
19. The external terms of trade can be considered a long-run forcing variable if it is not determined in the long run by the agricultural terms of trade, although they may have contemporaneous or short-run interactions.
20. Appendix Tables A1 to A2 report the time series properties of variables.

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APPENDIX

The Unit Root Test Results

The three variables under unit root tests are the agricultural terms of trade (TOT^a), the external terms of trade (TOT^e) and the ratio of the agricultural to the external terms of trade (*DAI*). Annual data for these variables have been compiled from a number of sources, including Alamgir and Berlage (1974), Islam (1981), Lewis (1970a), the *Statistical Yearbook* of *Bangladesh* of the Bangladesh Bureau of Statistics, the *Economic Trends* of the Bangladesh Bank, the *Bangladesh Economic Review* of the Government of Bangladesh and the *International Financial Statistics Yearbook* of the International Monetary Fund. The data series have been transformed into a common base (1970 = 100). Some minor adjustment/interpolation has been made for the data gaps for 1971 and 1972 using the terms of trade data for India as a proxy.

Tables A1 to A2 report the two widely used unit root tests results. They are the augmented Dickey-Fuller (ADF) and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests. The first test treats the series under consideration non-stationary as a null hypothesis while the second test treats the series under consideration stationary as a null hypothesis. It is better when these tests results are confirmatory because most unit root tests have low power, especially when the sample size is small (Maddala, 2001). For testing purposes, all the series have been transformed into a natural logarithmic form. The tests have been conducted for the sample period 1952-2006. The adjusted sample size is however shorter depending on the number of lag terms used in the specification. Since the tests results are sensitive to the lag length, the test statistics have been

Table A1
The ADF Test Statistics

Variables	Constant (C) and Trend (T) in the ADF Testing Equation	*ADF test statistics* — ADF statistics with different lags (Mackinnon one-sided p-values in parentheses)						Optimal lag length	
		l = 0	*l = 1*	*l = 2*	*l = 3*	*l = 4*	*l = 5*		
ln TOT^a	*C* and *T*	–3.43 (0.058)	–3.68 (0.032)	–3.86 (0.021)	–3.83 (0.023)	–4.39 (0.005)	–2.82 (0.199)	l = 4	–4.39 (0.005)
Δ ln TOT^a	*C*	–7.80 (0.000)	–6.45 (0.000)	–7.19 (0.000)	–4.19 (0.002)	–4.03 (0.003)	–3.35 (0.018)	l = 3	–4.19 (0.002)
ln TOT^e	*C* and *T*	–3.23 (0.090)	–3.40 (0.062)	–2.91 (0.169)	–3.07 (0.123)	–2.25 (0.452)	–1.90 (0.643)	l = 0	–3.23 (0.090)
Δ ln TOT^e	*C*	–7.47 (0.000)	–6.50 (0.000)	–4.90 (0.000)	–4.97 (0.000)	–4.76 (0.000)	–2.68 (0.084)	l = 5	–2.68 (0.084)
ln *DAI*	*C* and *T*	–3.90 (0.019)	–3.73 (0.029)	–2.67 (0.253)	–3.44 (0.056)	–2.58 (0.291)	–1.81 (0.686)	l = 0	–3.90 (0.019)
Δ ln *DAI*	*C*	–7.90 (0.000)	–8.19 (0.000)	–4.92 (0.000)	–4.91 (0.000)	–5.47 (0.001)	–3.20 (0.026)	l = 3	–4.91 (0.000)

Notes: 1. Definitions of variables: TOT^a = the agricultural terms of trade, measured as the ratio of the agricultural wholesale price index to the industrial wholesale price index (per cent). TOT^e = the external terms of trade, measured as the ratio of the export price index to the import price index (per cent), *DAI* = the ratio of the agricultural terms of trade to the external terms of trade (per cent); for simplicity, this index is named the Diaz-Alejandro Index (*DAI*).
2. Sample period: 1952-2006.
3. Optimum lag-length is determined by applying the *AIC* given that the maximum lag = 5.
4. The Mackinnon one-sided *p*-values are in parentheses.

generated for up to 5 lags of the first-difference of the variable in the logarithmic form and then the Akaike information criterion (AIC) has been used to select the optimal lag length under the restriction that the maximum lag length is 5. Because of the annual data, the five lag terms have been found more than adequate to make the residuals in the regression a white noise.

Both the ADF and the KPSS tests results suggest that the time series for the agricultural terms of trade, the external terms of trade and the ratio of the agricultural to the external terms of trade do not have a unit root.

Table A2
The KPSS Test Statistics

Variables	*Constant (C) and Trend (T) in the Testing Equation*	*The KPSS test statistics: LM-statistics with different fixed bandwidths (Bartlett kernel) 0*	*1*	*2*	*3*	*4*	*5*	*Newey-West (bandwidth)*
ln TOT^a	*C* and *T*	0.21*	0.13	0.11	0.09	0.09	0.08	0.09 (4)
Δ ln TOT^a	*C*	0.03	0.03	0.03	0.04	0.05	0.05	0.05 (53)
ln TOT^e	*C* and *T*	0.23*	0.14	0.11	0.09	0.08	0.07	0.07 (5)
Δ ln TOT^e	*C*	0.04	0.04	0.05	0.06	0.07	0.08	0.08 (7)
ln DAI	*C* and *T*	0.21*	0.13	0.11	0.09	0.09	0.08	0.09 (4)
Δ ln *DAI*	*C*	0.04	0.04	0.06	0.07	0.08	0.10	0.13 (11)

Notes: 1. The definitions of variables are similar to those reported in Table A1.
2. Sample period: 1952-2006.
3. *indicate that, on the basis of the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (1992) critical values (0.146 when *C* and *T* are included and 0.463 when only *C* is included), the corresponding null hypothesis of stationarity is rejected at the 5 percent significance level.

Table A3
The Autoregressive Distributed Lag Model

ARDL (2, 3) selected based on the Akaike Information Criterion
Dependent variable: ln TOT^a
51 observations used for estimation: 1956-2006

Regressor	*Coefficient*	*t-ratio (prob.)*
ln TOT^a_t	0.30	2.70 (0.01)
ln TOT^a_{t-1}	–0.15	–1.52 (0.14)
ln TOT^e_t	0.37	5.42 (0.00)
ln TOT^e_{t-1}	–0.23	–2.70 (0.10)
ln TOT^e_{t-2}	0.25	2.83 (0.01)
ln TOT^e_{t-3}	–0.17	–2.50 (0.16)
C	2.57	6.98 (0.00)
T	0.008	5.64 (0.00)
D7275	–0.083	–2.18 (0.04)
Adjusted R^2	0.80	
S. E. of regression	0.7	
DW statistic	2.05	
Other test statistics:	LM Version	F-Version
Serial Correlation	$\chi^2_{(1)} = 0.20$ (0.65)	F (1,38) = 0.15 (0.70)
Functional Form	$\chi^2_{(1)} = 0.54$ (0.82)	F (1,38) = 0.04 (0.84)
Normality	$\chi^2_{(2)} = 0.23$ (0.89)	Not applicable
Heteroskedasticity	$\chi^2_{(1)} = 4.63$ (0.03)	F (1,48) = 4.90 (0.03)