Bangladesh Development Studies
Vol. XXXV, June 2012, No. 2

Determinants of Trade Balance of Bangladesh: A Dynamic Panel Data Analysis

M. ZAKIR SAADULLAH KHAN *
M. ISMAIL HOSSAIN **

Under the new perspective of the world economy, the relationship between the determinants and the overall trade balance of a country in conventional models may not necessarily be the same as with bilateral trade balance. This paper develops a new approach to trade balance modeling that captures the effects of the factors suggested by the conventional model and explores the dynamic relationship between variables of the new model. Using recently developed dynamic panel data analysis techniques, the approach is empirically tested for Bangladesh's trade with its 50 major trading partners for over 26 years and finds the existence of cointegration, that is, stable long-run relationship between variables of the new trade balance model. Short-run dynamics also show convergence, using Unrestricted Error Correction Mechanism (UECM) and Generalized Method of Moments (GMM) estimator.

Keywords: Trade balance, Dynamic panel data
JEL Classification: C23, F49

I. INTRODUCTION

Since there is heterogeneity among economies the relationship between overall trade balance of a country and the underlying determinants may not necessarily be the same as with the bilateral trade balances. While a country's overall trade may be balanced, a country may have bilateral deficits (or surplus) with its heterogeneous trading partners. A recent paper (Khan and Hossain 2010) formulates a trade balance model making an extension of the conventional model which rests on elasticity approach, absorption approach, monetary approach and the gravity model. The model was empirically tested using bilateral trade flows of Bangladesh using static panel data analysis. One important limitation of static analysis is that it does not address the issue of deviation of trade balance from equilibrium and its convergence to equilibrium. An attempt is made here to fill this gap in research through dynamic panel data analysis of the extended model of trade

*Associate Professor, Department of Economics, Comilla Univeristy, Bangladesh.
**Professor, Department of Economics, Jahangirnagar University, Dhaka, Bangladesh.

balance that better explains trade balance of the small countries. Using panel data of Bangladesh trade with its major partners, this study checks whether there is stable long-run relationship between explanatory variables of the model and trade balance of Bangladesh. Further, the short-run dynamic responses of the variables pertaining to Bangladesh's bilateral trade balance have been examined. That is, the study focuses on the joint dynamic behaviour of several variables of the model.

The authors are indebted to an anonymous referee for helpful comments on an earlier version of the paper. They, however, remain responsible for any remaining errors.

The paper is organised as follows. Section II briefly presents the extended trade balance model and its empirical specification. Section III presents the methodology and the data. Section IV describes the dynamic panel data analysis of Bangladesh's trade balance and finally Section V derives the conclusions.

II. THE METHODOLOGY AND THE DATA

2.1 The Model

The extended model of Khan and Hossain (2010) expresses the bilateral trade balance of country-*i* with partner country-*j* (TB_{ij}) as the ratio of exports over imports (X_{ij}/M_{ij}), which according to Bahmani-Oskooee (1991), is unit free and can be interpreted as nominal or real trade balance and it allows focusing on the specific causes of trade imbalance between a country and its major trading partners. The extended model is presented as follows:[1]

$$TB_{ij} = TB_{ij}(RGDP_{ji}, RPGNI_{ji}, RER_{ij}, MWD_{ij}) \quad (1)$$

where, $RGDP_{ji}$ = relative GDP = $Y_j/Y_i = GDP_j/GDP_i$ and

$RPGNI_{ji}$ = relative per capita GDP = y_j/y_i,

RER_{ij} = Real exchange rate between country-*i* and country-*j*, and

MWD_{ij} = Import-weighted distance between country-*i* and country-*j*

The study investigates the dynamic nature of the trade balance of Bangladesh (country-*i*) in bilateral trade with its trading partners (country-*j*), with the model of equation (1). It checks whether there is a stable long-run relationship between explanatory variables and the trade balance of Bangladesh. Besides, the short-run

[1]For detail, see Appendix A1.

dynamic responses of the variables pertaining to Bangladesh's bilateral trade balance with its trading partners have been examined. That is, the study has focused on the joint dynamic behaviour of several economic variables. In this case, the set of explanatory variables includes lagged values of the endogenous variable. The dynamic panel model takes the following form:

$$ln(TB_{ij})_t = \alpha_0 + \delta ln(TB_{ij})_{t-1} + \beta_1 ln(RGDP_{ji})_t + \beta_2 ln(RPGDP_{ji})_t + \beta_3 ln(RER_{ij})_t + \beta_4 ln(MWD_{ij})_t + u_{it} \quad (2)$$

The lagged dependent variable, $(TB_{ij})_{t-1,}$ in the dynamic model complicates estimation very much, because it is correlated with the error term(s). In addition, this type of model suffers from the problems of serial correlation, heteroscedasticity and endogeneity of some explanatory variables. To solve these econometric problems, recent literature on panel data econometrics has formulated different procedures to deal with the dynamic panel model. In analysing the dynamics of trade balance of Bangladesh, these procedures have been used.

2.2 Dynamic Panel Data Analysis Techniques

The dynamic panel data analysis starts with the test of stationarity of variables of the model (2), using panel unit root test procedures. Traditional methods of estimation can be used to estimate a model when all the variables in the model are stationary. If at least one of the series turns out to be non-stationary, then to infer the long-run relationships among variables, some form of cointegration test is required. If the existence of cointegration is confirmed, then dynamic model with panel data estimation techniques is applied.

2.2.1 Panel Unit Root Tests

Panel unit root tests are similar, but not identical, to unit root tests carried out on a single time series. While the tests proposed are commonly termed "panel unit root" tests, they are simply multiple-series unit root tests that have been applied to panel data structures where the presence of cross-sections generates "multiple series" out of a single series.

As a considerable longer time span of 26 years (1980-2005) in the panel data has been used for the study, the variables under consideration might be non-stationary, and thus a simple OLS estimation may end up with spurious results (Kao and Chiang 1999). Therefore, to test the stationarity of variables of the model, panel-based unit root tests has been suggested by the recent econometric literature, which has higher power than unit root tests based on individual time series. Popularly used such panel unit root tests are: Levin, Lin and Chu (2002), Breitung (2000), Im, Pesaran and Shin (2003), and Fisher-type tests using ADF and PP tests are Maddala and Wu (1999) and Choi (2001).

A brief overview of the above mentioned tests is presented here to provide a background of the empirical analyses of the tests. Let us consider the following *AR(1)* process for panel data:

$$y_{it} = \rho_i y_{it-1} + X_{it}\delta_i + \varepsilon_{it} \quad (3)$$

Where $i = 1, 2, \ldots, N$ cross-section units or series, that are observed over periods $t = 1, 2, \ldots, T$.

The X_{it} represent the exogenous variables in the model, including any fixed effects or individual trends, ρ_i are the autoregressive coefficients, and the errors ε_{it} are assumed to be mutually independent idiosyncratic disturbance. If $|\rho_i| < 1$, y_i is said to be weakly (trend-) stationary. On the other hand, if $|\rho_i| = 1$, then y_i contains a unit root.

For purposes of testing, there are two natural assumptions that can be made about the ρ_i. First, It can be assumed that the persistence parameters are common across cross-sections so that $\rho_i = \rho$ for all *i*. The Levin, Lin and Chu (LLC) and Breitung (2000) tests employ this assumption. This class of unit root tests are called "Common root," which indicates that the tests is estimated assuming a common AR structure for all of the series. Alternatively, ρ_i can be allowed to vary freely across cross-sections. The Im, Pesaran and Shin (IPS), and Fisher-ADF and Fisher-PP tests are of this form. This second class of test is called "Individual root," which is used for tests that allow for different AR coefficients in each series.

Most of the proposed panel unit root tests are derived under the hypothesis that the error terms are non-contemporaneous correlated. When this hypothesis is rejected, the asymptotic distributions of these tests are no longer consistent.

2.2.2 Panel Cointegration Tests of the Model

As all the variables in the model are found non-stationary, traditional methods cannot be used to estimate the model. In this case, to infer the long-run relationships among the variables, some form of co-integration analysis is required.

There are different methods for testing co-integration in panels. The first type takes the null hypothesis of no co-integration and uses residuals derived from the panel regression of Engle and Granger (1987) method. Pedroni (1999, 2004) and Kao and Chiang (1999) panel co-integration tests are in this class of test. The works of Maddala and Wu (1999), Groen and Kleibergen (1999) and Larsson and

Lyhagen (1999) have allowed rank tests of cointegration in multivariate framework, by extending the Johansen and Juselius (1990) tests of co-integration in the case of panel data. Maddala and Wu (1999) have formulated Fisher-type test using an underlying Johansen methodology which is of the second type. This study takes Pedroni test, Kao test and combined Johansen Fisher-type tests of panel cointergration.

2.2.3 Estimation of Dynamic Panel Data

There are several ways of estimating dynamic panel data models. Different estimation methods possess both merits and demerits. Given the purpose of this study, it initially uses the "Unrestricted Error Correction Model" (UECM) because of its advantage of separating the short-run and long-run effects (Raihan 2007). In order to check the potential endogeneity problem (explanatory variables correlate with the error term) of the model, the Generalized Method of Moments (GMM) estimation is applied, because GMM is considered as the best method of estimating dynamic panel data.

In the UECM, with the existence of cointegration among the variables, the model is re-parameterised as an error correction model (ECM) to estimate the model for improving forecasting. The cointegrating equations are generally interpreted as the long run equilibrium relationships characterising the data, with the error correction equations representing the short-run adjustment towards such equilibria. The error correction model alone can also make direct inference both about the long-run and the short-run relationships. As there is cointegration in equation, the Vector Autoregressive (VAR) needs to include error correction term involving levels of the series, and this term appears on the right-hand side of each of the VAR equations, which, otherwise, be in first differences.

Cosar (2002), Haddad (2005), Reilly and Witt (1996) applied the unrestricted error correction model (UECM) in the context of panel regression. With the existence of cointegration relationship between the variables, the Engle and Granger two-step method can be used to estimate the model using UECM. According to Engle and Granger (1987), if the variables are cointegrated, the stable long-run relationship can be estimated in the first step by standard least-squares techniques. For panel regression, panel econometric techniques, like fixed effect estimator, would be applied. In the second step, stationarity of the residuals of the estimated equations can be tested by the panel unit root tests.

2.2.4 Tackling the Endogeneity Problem and Alternative Estimation

The estimates obtained from UECM could suffer from the potential endogeneity problem of the variables, and inclusion of fixed effects may bias the coefficient on the lagged dependent variable (Hsiao 1986). Therefore, before estimation it is required to check whether the results are free from endogeneity bias. This can be done by the GMM estimation framework. One way of tackling the endogeneity problem and the fixed effect bias is by using instrumental variables developed by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998, 2000). They developed both the first-differenced GMM (One Step GMM) estimator and the GMM system (Two Step GMM) estimator. The GMM-system estimator is a system containing both first-differenced and levels equations. In addition to using instruments in levels for equations in first differences, it uses instruments in first differences for equations in levels (Arellano and Bover 1995). The GMM-system estimator is an alternative to the standard first-differenced GMM estimator.

In dynamic panel data models, the GMM estimator eliminates the unobserved individual (bilateral specific) effects through the equations in first differences. The GMM estimator also controls for the endogeneity of the explanatory variables. As mentioned above, the GMM estimation procedures contain both first-differenced and levels equations. The GMM procedures exploit additional moment restrictions and thus gain efficiency. They use all available lagged values of the dependent variables plus lagged values of the exogenous regressors as instruments.

2.3 The Data

The empirical study has been done using data on bilateral trade between Bangladesh and its major 50 trading partners covering 75–82 per cent of Bangladesh's trade in both directions, export and import, over the period 1980-2005. The panel data of bilateral trade of major 50 trading partners of Bangladesh–20 industrialised countries and 30 developing partner countries, over the study period have been collected from *Direction of Trade Statistics (DOTS)* database from the International Monetary Fund (IMF) website. The countries are chosen on the basis of their importance as trading partners of Bangladesh and availability of required data. The GDP and per-capita GNI data have been collected from *World Development Indicator (WDI)* database of the World Bank and nominal exchange rate and consumer price indices to calculate *RER*s are collected from *International Financial Statistics (IFS)* database of the IMF. In measuring import-weighted distance (MWD_{ij}), the geographical distance between Dhaka (the capital city of Bangladesh) and the capital cities of respective partner countries are obtained from World Bank website (www.econ.worldbank.org) and have been weighted by the ratio of bilateral import volume from respective partners to total import volume of Bangladesh (W_{ij}) in respective years. All observations are annual and processed following required procedure.

III. TRADE BALANCE DYNAMICS OF BANGLADESH

3.1 Results of Panel Unit Root Tests

In this study, several unit root tests have been applied to reach a more conclusive result regarding the stationarity of the variables. There are strengths and weaknesses of different unit root tests; unit root test results can, in many cases, be inconclusive. Thus one single unit root test may not be enough to draw any firm conclusion regarding the stationarity of variables. Appendix A2 reports the summary statistics of the unit root tests, mentioned above, for all the variables of the model. The null of non-stationarity or no unit root is tested at lag order of 4–the average lag order suggested by the Modified Akaike Information Criteria (MAIC).

In the case of trade balance variable (*lnTB*), among five tests, the Levin, Lin and Chu (LLC) test and ADF-Fisher Chi-square test show existence of unit roots, both with intercept and with intercept and trend. Though Im-Pesaran-Shin (ISP) and Breitung tests do not reject the hypothesis of no unit root at 10 per cent level of significance, these hardly reject at 5 per cent level. In the case of relative GDP (*ln_RGDP*), relative per capita GNI (*ln_RPGNI*) and real exchange rate (*ln_RER*), all the tests show unit roots. In the case of import-weighted distance (*ln_MWD*), all the tests, except PP-Fisher chi-square test, show unit roots. Therefore, it can be concluded that most of the tests provide evidence in favour of the presence of unit roots in all the variables under consideration. That is, all the variables are non-stationary at level.

To check the order of integration of these non-stationary variables, the unit root tests of all the variables in first difference need to be performed. It is important because if variables are of different order of integration then special care is needed to find out valid relationship among those variables (Raihan 2007). Appendix A3 reports the results of the unit root tests of all five non-stationary variables in their first differences. It shows mixed results with different unit root tests. Im-Pesaran-Shin (ISP), ADF–Fisher Chi-square and PP–Fisher Chi-square tests reject the null hypotheses of unit roots of the variables in their first differences, except $\Delta \text{ln\_}RER_{ij}$ with individual intercept and trend. But Levin, Lin and Chu (LLC) and Breitung do not reject the null unit root hypotheses for most of the variables. It is generally considered that the IPS tests and ADF-Fisher tests are more powerful in detecting unit roots in panel data set than the Levin-Lin-Chu (LLC) (Raihan 2007). Therefore, using IPS and ADF-Fisher tests it can be used to confirm that all the variables are stationary in their first differences and are integrated at order one, *I(1)*. That is, they are non-stationary in their levels but stationary in their first differences.

3.2 Result of Co-integration Tests

As in the case of panel unit root tests, several panel cointegration tests have been applied because different panel cointegration tests may produce conflicting outcomes, and therefore, the results in many cases can be inconclusive. This indicates that one single panel cointegration testing may not be enough to draw firm conclusion regarding the cointegration among variables in the models under consideration (Raihan 2007). Appendix A4 and Appendix A5 report various panel cointegration results. The lag length section is used to determine the number of lags to be included in the second stage regression. The optimum lag is automatically determined using the Schwarz information criterion.

Appendix A4 presents summary statistics of four types of Pedroni cointegration tests of the model, for within-dimension and between-dimension. It also reports Kao cointegration test without individual trend. It is evident that six of the eleven Pedroni test statistics do not reject the null hypothesis of no cointegration of the model for all the cases. Kao test also suggests the existence of cointegration among variables of the model.

It is known that the cointegrating vectors are not unique in general. However, Pedroni does not address the issue of normalisation, how to establish the number of cointegrating relationships or how many cointegrating relationships exist among a certain set of variables. The combined Johansen Fisher panel cointegration test does it, whose results are summarised in Appendix A5. It is evident from the combined Johansen Fisher cointegration tests that the null hypothesis of no cointegration relationship between variables of the model is rejected in all the cases and also traces the numbers of cointegrating equations. From different panel cointegration tests performed, the existence of cointegration is evident, except few cases of the Pedroni tests. Therefore, it can be concluded that the model is cointegrated.

3.3 Result of the Unrestricted Error Correction Model (UECM)

As there is cointegration relationship between the variables, the Engle and Granger two-step method can be used to estimate the model using UECM. Following Engle and Granger (1987) first step, the fixed effect estimator gives the panel regression equation a follows:

$$lnTB_{ij,t} = \alpha_{0i} + \beta_1 lnRGDP_{ij,t} + \beta_2\, lnRPGNI_{ij,t} + \beta_3\, lnRER_{ij,t} + \beta_4 lnMWD_{ij,t} + u_{it}$$

$$lnTB_{ij,t} = -2.093 - 2.326 lnRGDP_{ij,t} + 2.314\, lnRPGNI_{ij,t} - 0.047 lnRER_{ij,t} - 0.839 lnMWD_{ij,t} \quad (4)$$

$$(-2.839)\ (-6.052)\qquad (7.072)\qquad (-6.134)\qquad (-19.53)$$

In the second step, stationarity of the residuals of the estimated equations are tested by the panel unit root test. Applying five panel unit root tests used earlier, the test results of the residual of the estimated equation (4), presented in Appendix A7, show that the residual of the model is stationary.

With the existence of cointegration relationship between variables of the model and based on Engle-Granger two-step results above, the error correction model estimated in panel framework is:

$$\Delta lnTB_{ij,t} = \theta_i + \beta_1 \Delta lnRGDP_{ij,t} + \beta_2 \Delta lnRPGNI_{ij,t} + \beta_3 \Delta lnRER_{ij,t} + \beta_4 \Delta lnMWD_{ij,t} +$$

$$\lambda[lnTB_{ij,t} - \alpha_{0i} - \beta_1 lnRGDP_{ij,t-1} - \beta_2\, lnRPGNI_{ij,t-1} - \beta_3\, lnRER_{ij,t-1} - \beta_4 lnMWD_{ij,t-1}] + u_{it}$$

$$\Delta lnTB_{ij,t} = 0.03 + 1.74\Delta lnRGDP_{ij,t} - 0.242\Delta lnRPGNI_{ij,t} - 0.006\Delta lnRER_{ij,t} - 0.922\Delta lnMWD_{ij,t} -$$

(0.965) (1.185) (-0.207) (-0.178) (-23.927)

$$0.42\ [\ lnTB_{ij,t} + 2.093 + 2.326 lnRGDP_{ij,t-1} - 2.314 lnRPGNI_{ij,t-1} + 0.047 lnRER_{ij,t-1}$$

(-11.047) (-2.839) (-6.052) (7.072) (-6.134)

$$+\ 0.839 lnMWD_{ij,t-1}] \quad (5)$$

(-19.53)

The estimated Unrestricted Error Correction Model (UECM) of equation (4) and equation (5) presents the long-run and the short-run relationship between trade balance of Bangladesh and the explanatory variables of the model of study. Values in parentheses represent the *t*-statistics for the respective coefficients. In both the long-run and the short-run, the signs of the coefficients of two variables-real exchange rate (*RER*) and import-weighted distance (*MWD*)–are same and negative. In the long-run, coefficients of all the variables are highly significant, but among coefficients of short-run variables, only *MWD* is significant. It means that in the short-run, only the import-weighted distance (*MWD*) as proxy of transport cost has significant impact on the trade balance of Bangladesh, indicating that Bangladesh tends to import relatively more from neighbouring countries than to export and results in negative effect on its trade balance. The same is true in the long-run, though in both the cases, trade balance of Bangladesh is less elastic to transport cost, indicating when distance between Bangladesh (country-*i*) and partner country (country-*j*) increases by 1 per cent, the bilateral trade balance, expressed as ratio of export to import, decreases by less that 1 per cent (respectively 0.84 and 0.92 in short-run and long-run).

The long-run coefficient of relative GDP (*RGDP*) is negative (-2.326) and highly significant. This implies that trade balance of Bangladesh deteriorates in the long-run when GDP of partner countries increases relatively more than that of

Bangladesh. It means partners' production and exporting capacity increases at a higher rate than that of Bangladesh. In bilateral trade, this usually results in more export to Bangladesh or less import from Bangladesh, and hence, adversely affects the balance of trade of Bangladesh in the long-run.

The long-run coefficient of the relative per capita GNI (*RPGNI*) is positive (2.314) and highly significant. As the per capita GNI in the extended model represents absorption capacity of a country, therefore, higher relative per capita GNI (*RPGNI*) implies higher absorption capacity of the country. Due to increase in absorption capacity, it is expected that the country imports more. Trading partners of Bangladesh with higher *RPGNI*, relatively import more from Bangladesh, improving Bangladesh's balance of trade in the long-run. The relative per capita GNI gives the income differential between country pair, denoting the differences in factor endowment between trade pair. So, from the trade perspective, the positive sign of this coefficient also indicates that the *Heckcher-Ohlin effect*[2] dominates the *Linder effect*[3] in the case of Bangladesh.

The coefficients of the short-run differenced estimation of the relative GDP (*RGDP*) and relative per capita GNI (*RPGNI*) carry signs opposite to long-run and are not significant. This indicates that short-run change in relative national income or per capita income does not have any significant impact on the trade balance of Bangladesh.

The long-run coefficient of real exchange rate is negative and highly significant, which implies that the more the index of RER_{ij} drops, the more there is depreciation of Bangladeshi Taka (as exporter currency) with respect to the currencies of its partners. This will increase the export competitiveness of Bangladesh and hence will improve its trade balance (TB_{ij}), though the real exchange rate elasticity is very low at 0.047 in the long-run. The impact of *RER* on trade balance of Bangladesh in the short-run is found not to be significant, indicating no effects of a depreciation (or appreciation) of Bangladesh currency with its partner on its trade balance.

The coefficient of the error correction term λ (denoted as RESID01 in Appendix A7), which is residual of the long-run equation, has the correct sign, is highly significant and lower than 1 in absolute value (-0.42). This confirms a valid representation of the error correction mechanism. The coefficient of the

---

[2] The proposition of *Heckscher-Ohlin* Effect is that a country has comparative advantage in the production of that commodity which uses more intensively the country's more abundant factor.

[3] *Linder hypothesis suggests* that the demand structure in two countries will be similar for the similarities of per capita income.

error correction term suggests a rather slow adjustment to the long-run steady state relationship from any short-run deviation; only 42 per cent of the disequilibrium errors are corrected within one year.

The long-run elasticity of trade balance with respect to relative GDP (*RGDP*) and real exchange rate (*RER*) is estimated to be 2.33 and 0.047 respectively, whereas the short-run elasticity of trade balance with respect to the *RGDP* and *RER* is estimated to be 1.74 and 0.0058 respectively. The short-run elasticities of trade balance with respect to both relative GDP and real exchange rate are lower than those the long-run elasticities. The relative income elasticity of trade balance is found highly elastic, whereas real exchange rate elasticity is lower than one, indicating an inelastic response of trade balance of Bangladesh to real exchange rate.

3.4 Results of the GMM Estimation

Appendix A9 reports the summary statistics of the one-step and two-step GMM estimation. It is evident that the estimation results, using the GMM methods, are consistent with the results of the unrestricted error correction model. All the variables appear to have significant impact (as per reported *p*-values in the parentheses) on trade balance in period-*t* with expected signs. The signs of the coefficients of the explanatory variables match those of UECM, implying the same interpretations.

The diagnostic tests (Sargan test) results, presented by J-statistics in Appendix A8, do not provide any evidence against the model specifications, suggesting that the model performed reasonably well in the specification. Under the null hypothesis that the over-identifying restrictions are valid, the Sargan statistic is distributed as a $\chi(p-k)$, where k is the number of estimated coefficients and p is the instrument rank.

IV. CONCLUSION

The study has evaluated the dynamics of the trade balance of Bangladesh. Using recently developed dynamic panel data econometric techniques, the study finds existence of cointegration, that is, stable long-run relationship between trade balance of Bangladesh and its determinants. Short-run dynamics also show convergence of trade balance to its long run equilibrium, using Unrestricted Error Correction Mechanism (UECM) and Generalised Method of Moments (GMM) estimator. The robustness check of the model ensures the validity of the specification of the extended model.

REFERENCES

Arellano, M. and S. Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies*, 58: 277-297.

Arellano, M., and O. Bover. 1995. "Another Look at the Instrumental Variable Estimation of Error-components Models." *Journal of Econometrics*, 68(1): 29-51.

Bhamani-Oskooee, M. 1991. "Is There a Long-Run Relation Between the Trade Balance and the Real Effective Exchange Rate of LDCs?" *Economic Letters*, 36: 403-407.

Blundell, R., and S. Bond. 1998. "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models." *Journal of Econometrics*, 87(1): 115-143.

———2000. "GMM Estimation with Persistent Panel Data: An Applications to Production Functions", *Econometric Reviews*, 19(3): 321-340.

Breitung, Jörg. 2000. "The Local Power of Some Unit Root Tests for Panel Data." in B. Baltagi (ed.), Nonstationary Panels, Panel Cointegration, and Dynamic Panels *Advances in Econometrics*, 15, Amsterdam: JAI,pp. 161–178.

Choi, I. 2001. "Unit Root Tests for Panel Data." *Journal of International Money and Finance*, 20: 249–272.

Cosar, E. Erdogan. 2002. "Price and Income Elasticities of Turkish Export Demand: A Panel Data Application", *Central Bank Review*, 2: 19-53.

Engle, R. F and C. W. J. Granger. 1987. "Cointegration and Error Correction: Representation, Estimation and Testing." *Econometrica*, 55: 251-276.

Groen, Jan J. J. and Frank R. Kleibergen. 1999. "Likelihood-Based Cointegration Analysis in Panels of Vector Error Correction Models." Tinbergen Institute Discussion Papers 99-055/4. Tinbergen Institute.

Haddad, Hedi Ben. 2005. "Structural Identification of Permanent and Transitory Shocks in Panel VEC Models" Downloaded from internet on March 10, 2008.

Hsiao, C. 1986. *Analysis of Panel Data.* Cambridge University Press.

Im, K. S., M. H. Pesaran and Y. Shin. 2003. "Testing for Unit Roots in Heterogeneous Panels." *Journal of Econometrics*, 115: 53–74.

IMF (International Monetary Fund). *Direction of Trade Statistics* (DOTS), 1980-2005, *www.imfstatistics.org/DOT.*

———2006. *International Financial Statistics (IFS) CD-Rom 2006.*

———*International Financial Statistics (IFS) Yearbook*, 1980-2006, IMF.

Johansen, S. and K. Juselius. 1990. "Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money." *Oxford Bulletin of Economics and Statistics,* 52: 169-210.

Kao, C. and M. Chiang. 1999. "On the Estimation and Inference of a Cointegrated Regression in Panel Data." Working Paper. Center for Policy Research, Syracuse University, New York.

Khan, M. Zakir Saadullah. and M. Ismail Hossain. 2010. "A Model of Bilateral Trade Balance: Extensions and Empirical Tests." *Economic Analysis and Policy*, 40(3): 377-391.

Larsson, Rolf and Johan Lyhagen. 1999. "Likelihood-Based Inference in Multivariate Panel Cointegration Models." Working Paper Series in Economics and Finance 331. Stockholm School of Economics.

Levin, A., C. F. Lin and S. J. Chu. 2002. "Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties." *Journal of Econometrics*, 108:1-24.

Maddala, G. S. and S. Wu. 1999. "A Comparative Study of Unit Root Tests with Panel Data and A New Simple Test," *Oxford Bulletin of Economics and Statistics*, 61: 631–52.

Pedroni, P. 1999. "Critical values for cointegration tests in heterogeneous panels with multiple repressors." *Oxford Bulletin of Economics and Statistics*, special issue, 61: 653-670.

Pedroni, P. 2004. "Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis." *Econometric Theory*, 20: 597–625.

Raihan, Selim. 2007. *Dynamics of Trade Liberalization in Bangladesh - Analysis of Policies and Practices*. Dhaka: Pathak Shamabesh.

Reilly, B. and R. Witt. 1996. "Crime, Deterrence, and Unemployment in England and Wales: An Empirical Analysis." *Bulletin of Economic Research*, 48: 137-155.

World Bank. 2007. *World Development Indicators (WDI) 2007 CD-Rom.* Washington, D.C.: World Bank.

World Bank website: *www.econ.worldbank.org/EXTERNAL/TOPICS/TRADE*

APPENDIX A1

THE EXTENDED TRADE BALANCE MODEL

The trade balance model that incorporates the major factors determining the trade balance of a country as suggested by the conventional theories is, assuming *i* represent Bangladesh and *j* represents its trading partner, given as follows:

$$TB_{ij} = TB_{ij}(Y_i, Y_j, y_i, y_j, RER_{ij}, D_{ij}) \quad \text{(i)}$$

where, (TB_{ij}) is the bilateral balance of trade of Bangladesh with its *j-th* trading partner expressed as the ratio of exports of Bangladesh to its *j-th* trading partner, X_{ij}, to imports of Bangladesh from its *j-th* trading partner, M_{ij}, i.e., (X_{ij} / M_{ij}), Y_i (Y_j) indicates the GDP or GNI of country *i* (*j*), y_i (y_j) is per capita income of country- *i* (*j*), RER_{ij} measures the bilateral real exchange rate of Bangladesh and its *j-th* trading partner and is defined as $RER_{ij} = [ER_{ij} (P_i/P_j)]$, where ER_{ij} is the bilateral nominal exchange rate, defined as the price of taka in terms of foreign currency, that is, the number of units of foreign currency per unit of taka; P_i and P_j are the price index of Bangladesh and foreign (country-*j*'s) price index of all goods respectively. It is evident that an increase in RER_{ij} signifies real appreciation of taka, and D_{ij} measures the distance between Dhaka and the capital city (or economic centre) of Bangladesh's *j-th* trading partner.

Equation (i) provides the benchmark model which is used to formulate an extended model. The basic idea of the extended model is that in bilateral trade the absolute size of the country measured by income is not so important, rather the relative size (relative to trading partners) determines the export and the import demand. In the baseline model, GDP measures both productive and absorption capacity of a country. Here the extended model differs from the idea of the baseline model. The GDP of the exporting country measures productive capacity, while the per capita GNI better measures absorption capacity of the importing country.

As the trade balance of Bangladesh is denoted by the ratio of its export and import, in bilateral trade the GDP of Bangladesh relative to its partner country-*j* has impact on its trade balance. The GDP ratio of trading pair (GDP_j / GDP_i) shows the relative productive capacity of partner country (country-*j*) compared to Bangladesh. This also measures the relative size of Bangladesh compared with its trading partner.

The ratio of per capita income (y_j / y_i) is a strong determinant of import demand, since it represents the relative absorption capacity of trading country pairs. The ratio of per capita income also represents the relative factor endowment of a country. Ratio of per capita income (y_j / y_i) greater than one implies that country-*j* is more labour endowed than country-*i*, taking the classical assumption of homogeneity of labour in all countries.

Therefore, in the extended model, relative GDP ($GDP_j / GDP_i = Y_j / Y_i$) and relative per capita income (y_j / y_i) are considered in lieu of the first four variables of the model of equation (1). These new variables capture the size of the country in terms of income and population, and also in terms of per capita income difference, since the ratio y_j / y_i is unit free representation of the per capita income differential. The RER_{ij} in the baseline model captures the relative price level of two trading partners and their bilateral exchange rate and is an important determinant of trade balance.

The Gravity model first brought the distance between trade partners as a proxy for transportation cost. Transportation cost is an important determinant of trading decision, which also captures the impact of adjacency of a country to its trading partner(s) or the common border between them, which are considered as separate variables of trade between two countries by some researchers following "gravity" factors.

As proxy for transportation cost, the absolute "distance" of Bangladesh from its trading partners (D_{ij}) does not have enough explanatory power, since a country does not trade equally with all partners. Along with other factors, the transportation cost also has impact on the trading decision and it is always subject to their trade volume or trade levels. Estimation based on the absolute distance as proxy for transportation cost is not appropriate, rather the trade-weighted distance proxies the transport cost much better and represents a robust indicator.

In international trade, export is usually in free on board (f.o.b) terms and import in c.i.f. That is, the transport cost is associated mainly with import. In weighing the distance with respect to trade, import is the appropriate delegate. Therefore, the extended model takes bilateral import-weighted distance (MWDij) as proxy for transportation cost. These arguments lead to the following extended model[4]:

$$TB_{ij} = TB_{ij}\left(\frac{Y_j}{Y_i}, \frac{y_j}{y_i}, RER_{ij}, MWD_{ij}\right)$$

or $$TB_{ij} = TB_{ij}\,(RGDP_{ji}, RPGNI_{ji}, RER_{ij}, MWD_{ij}) \qquad \text{(ii)}$$

where, $RGDP_{ji}$ = relative GDP = $Y_j / Y_i = GDP_j / GDP_i$ and

$RPGNI_{ji}$ = relative per capita GDP = y_j / y_i

Equation (ii) is an extension of the baseline model and consists of variables in relative values that can better explain the trading relationship between countries. Especially for

[4] For derivation of the function, see Khan and Hossain (2010).

developing (small) countries, particulary where income is low, resources are scarce, it is hard to generate exportable surplus, and the absolute economic factors do not determine the balance of bilateral trade, rather the relative position of a country compared with its partners with respect to such factors determines the trade balance.

APPENDIX A2
UNIT ROOT TESTS STATISTICS OF THE VARIABLES OF THE MODEL AT LEVEL

Tests	ln_TB	ln_RGDP	Ln_RPGNI	Ln_RER	Ln_MWD
Levin, Lin & Chu t*					
With intercept	-0.41414	6.07641	0.92263	-4.74934	1.35578
	(0.3394)	(1.0000)	(0.8219)	(0.0000)	(0.9124)
With intercept and trend	6.24423	6.62894	11.6857	1.24922	4.16010
	(1.0000)	(1.0000)	(1.0000)	(0.8942)	(1.0000)
Breitung t-stat					
With intercept					
With intercept and trend	-1.68803	4.74181	3.04019	0.42307	0.16412
	(0.0457)	(1.0000)	(0.9988)	(0.6639)	(0.5652)
Im, Pesaran and Shin W-stat					
With intercept	-1.65576	6.34199	1.19950	1.08577	0.44437
	(0.0489)	(1.0000)	(0.8848)	(0.8612)	(0.3284)
With intercept and trend	-2.25830	1.31350	2.20806	-2.07525	-1.18060
	(0.0120)	(0.9055)	(0.9864)	(0.0190)	(0.1189)
ADF - Fisher Chi-square					
With intercept	117.088	61.3602	68.0761	84.5562	98.6681
	(0.1166)	(0.9992)	(0.9939)	(0.8657)	(0.4621)
With intercept and trend	113.258	81.3247	65.9646	119.267	96.0687
	(0.1722)	(0.9139)	(0.9966)	(0.0918)	(0.5363)
PP - Fisher Chi-square					
With intercept	326.872	80.5810	92.5552	88.5250	313.938
	(0.0000)	(0.9230)	(0.6889)	(0.7873)	(0.0000)
With intercept and trend	399.459	46.0856	59.0578	93.7460	347.275
	(0.0000)	(1.0000)	(0.9996)	(0.6570)	(0.0000)

Note: (a) The null hypothesis states that there is unit root.
(b) The critical *p*-values are reported in parentheses.

APPENDIX A3

UNIT ROOT TESTS STATISTICS OF THE VARIABLES OF THE MODEL AT FIRST DIFFERENCE

Tests	Δln_TB	Δln_RGDP	ΔLn_RPGNI	ΔLn_RER	ΔLn_MWD
Levin, Lin and Chu t*					
With intercept	22.0645	3.92717	9.99049	-0.40906	18.9504
	(1.000)	(1.0000)	(1.0000)	(0.3412)	(1.0000)
With intercept and trend	30.8378	5.68738	16.1905	1.34086	33.6793
	(1.0000)	(1.0000)	(1.0000)	(0.9100)	(1.0000)
Breitung t-stat					
With intercept					
With intercept and trend	-0.61119	-2.03469	-2.99233	3.24370	-0.91364
	(0.2705)	(0.0209)	(0.0014)	(0.9994)	(0.1805)
Im, Pesaran and Shin W-stat					
With intercept	-8.31699	-3.87369	1.0000	-3.31091	-6.95856
	(0.0000)	(0.0001)	(0.0003)	(0.0005)	(0.0000)
With intercept and trend					
	-5.60960	-4.36742	-2.62377	0.35238	-5.08692
	(0.0000)	(0.0000)	(0.0043)	(0.6377)	(0.0000)
ADF - Fisher Chi-square					
With intercept	240.811	140.861	131.990	121.303	213.123
	(0.0000)	(0.0045)	(0.0177)	(0.0725)	(0.0000)
With intercept and trend					
	179.180	145.138	114.430	77.1665	151.619
	(0.0000)	(0.0022)	(0.1535)	(0.9563)	(0.0002)
PP–Fisher Chi-square					
With intercept	1318.07	408.104	513.491	417.576	1423.85
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
With intercept and trend					
	4779.21	376.768	487.958	318.778	5110.02
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: (a) The null hypothesis states that there is unit root.
(b) The critical *p*-values are reported in parentheses.

APPENDIX A4

SUMMARY OF THE PEDRONI AND KAO PANEL COINTEGRATION TESTS

Tests	Statistic	*p*- value
1. Pedroni *v*-statistics		
Within-dimension		
Without intercept and trends	1.489637	0.0682
With intercept and no trends	0.516928	0.3026
With both intercept and trends	-2.624205	0.9957
Weighted Statistics		
Without intercept and trends	-0.49267	0.6889
With intercept and no trends	-1.04625	0.8523
With both intercept and trends	-4.165469	1.0000

(Cont. Appendix Table A4)

Tests	Statistic	*p*- value
2. Pedroni ρ-statistics		
Within-dimension		
Without intercept and trends	3.121585	0.9991
With intercept and no trends	4.295131	1.0000
With both intercept and trends	6.908167	1.0000
Weighted Statistics		
Without intercept and trends	4.093678	1.0000
With intercept and no trends	5.113948	1.0000
With both intercept and trends	7.658127	1.0000
Between-dimension		
Without intercept and trends	7.453073	1.0000
With intercept and no trends	8.331071	1.0000
With both intercept and trends	10.41993	1.0000
3. Pedroni PP-statistics		
Within-dimension		
Without intercept and trends	-11.44158	0.0000
With intercept and no trends	-14.60171	0.0000
With both intercept and trends	-13.64243	0.0000
Appendix A3 continued		
Weighted Statistics		
Without intercept and trends	-7.120331	0.0000
With intercept and no trends	-10.19422	0.0000
With both intercept and trends	-10.26033	0.0000
Between-dimension		
Without intercept and trends	-10.14571	0.0000
With intercept and no trends	-13.72776	0.0000
With both intercept and trends	-13.13526	0.0000
4. Pedroni ADF-statistics		
Within-dimension		
Without intercept and trends	-10.99856	0.0000
With intercept and no trends	-14.2851	0.0000
With both intercept and trends	-13.86086	0.0000
Weighted Statistics		
Without intercept and trends	-7.593041	0.0000

(Cont. Appendix Table A4)

Tests	Statistic	*p*- value
With intercept and no trends	-11.18262	0.0000
With both intercept and trends	-11.18651	0.0000
Between-dimension		
Without intercept and trends	-9.848496	0.0000
With intercept and no trends	-12.99761	0.0000
With both intercept and trends	-11.96162	0.0000
5. Kao Test		
ADF- without trend	-2.688792	0.0036

APPENDIX A5

SUMMARY OF THE JOHANSEN FISHER PANEL COINTEGRATION TESTS

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)					
	Hypothesized No. of CE(s)	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
Without trend					
	None	1248.	0.0000	788.1	0.0000
	At most 1	612.0	0.0000	431.1	0.0000
	At most 2	290.6	0.0000	190.1	0.0000
	At most 3	195.5	0.0000	159.5	0.0001
	At most 4	144.9	0.0009	144.9	0.0009
With linear trend					
	None	991.7	0.0000	682.9	0.0000
	At most 1	478.0	0.0000	332.6	0.0000
	At most 2	233.0	0.0000	172.3	0.0000
	At most 3	135.0	0.0023	107.9	0.1228
	At most 4	144.2	0.0004	144.2	0.0004

* Probabilities are computed using asymptotic Chi-square distribution.

APPENDIX A6
ESTIMATION OF THE LONG-RUN MODEL

Dependent Variable: LN_TB(-1)
Method: Panel Least Squares
Sample (adjusted): 1981 2005
Periods included: 25
Cross-sections included: 50
Total panel (unbalanced) observations: 1185
White cross-section standard errors and covariance (no d.f. correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_RGDP(-1)	-2.325969	0.384321	-6.052157	0.0000
LN_RPGNI(-1)	2.313639	0.327163	7.071823	0.0000
LN_RER(-1)	-0.047488	0.007742	-6.134066	0.0000
LN_MWD(-1)	-0.838876	0.042943	-19.53452	0.0000
C	-2.093463	0.737370	-2.839093	0.0046

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.756116	Mean dependent var	-0.756841
Adjusted R-squared	0.744688	S.D. dependent var	1.990465
S.E. of regression	1.005751	Akaike info criterion	2.893845
Sum squared resid	1144.047	Schwarz criterion	3.125225
Log likelihood	-1660.603	Hannan-Quinn criter.	2.981058
F-statistic	66.15952	Durbin-Watson stat	0.818448
Prob(F-statistic)	0.000000		

APPENDIX A7
RESULT OF THE RESIDUAL UNIT ROOT TESTS OF THE LONG-RUN MODEL

Panel unit root test: Summary
Series: RESID02
Sample: 1980 2005
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic selection of lags based on MSIC: 0 to 5
Newey-West bandwidth selection using Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.06716	0.0011	50	1113
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.09981	0.0010	50	1113
ADF - Fisher Chi-square	170.190	0.0000	50	1113
PP - Fisher Chi-square	277.178	0.0000	50	1164

Note: ** Probabilities for Fisher tests are computed using an asymptotic Chi.
-square distribution. All other tests assume asymptotic normality.

APPENDIX A8
UNRESTRICTED ERROR CORRECTION MECHANISM FOR THE MODEL

Dependent Variable: D(LN_TB)
Method: Panel Least Squares
Sample (adjusted): 1981 2005
Periods included: 25
Cross-sections included: 50
Total panel (unbalanced) observations: 1164
White cross-section standard errors and covariance (no d.f. correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LN_RGDP)	1.740155	1.468092	1.185318	0.2361
D(LN_RPGNI)	-0.241845	1.169585	-0.206779	0.8362
D(LN_RER)	-0.005838	0.032811	-0.177919	0.8588
D(LN_MWD)	-0.922475	0.038554	-23.92689	0.0000
RESID01	-0.420411	0.038055	-11.04745	0.0000
C	0.029915	0.030998	0.965072	0.3347

Effects Specification

Cross-section fixed (dummy variables)			
R-squared	0.656231	Mean dependent var	0.008631
Adjusted R-squared	0.639492	S.D. dependent var	1.295533
S.E. of regression	0.777868	Akaike info criterion	2.381578
Sum squared resid	671.0319	Schwarz criterion	2.620649
Log likelihood	-1331.078	Hannan-Quinn criter.	2.471769
F-statistic	39.20383	Durbin-Watson stat	2.259405
Prob(F-statistic)	0.000000		

APPENDIX A9
SUMMARY OF THE GMM ESTIMATIONS OF THE MODEL

Dependent Variable *ln_TB*
Transformation: First Differences

Explanatory Variables	One-Step GMM Estimators	Two-Step GMM Estimators
Δ*LN_TB(-1)*	0.158 ***	0.156 ***
	(0.00)	(0.00)
Δ*LN_RGDP*	-4.313 ***	-4.175 ***
	(0.00)	(0.00)
Δ*LN_RPGNI*	5.872 ***	5.823 ***
	(0.00)	(0.00)
Δ*LN_RER*	-0.072 **	-0.071 ***
	(0.04)	(0.00)
Δ*LN_MWD*	-1.073 ***	-1.080 ***
	(0.00)	(0.00)
J-statistics	379.17	48.00
Instrument rank	304.0	50.00

Note: (a) The critical probabilities are reported in parentheses.
(b)*** and ** indicate statistical significance at the 1%, 5% and 10% level respectively.
(c) The instruments set employed include logarithm of variables in the model dated (t-1) and (t-2).
Sargan test statistic is a test of over-identifying restrictions for instrument validity.