ESTIMATING LONG RUN RELATIONSHIPS BETWEEN THE TRADE BALANCE AND THE TERMS OF TRADE IN SELECTED CARICOM COUNTRIES

By

Ryan Straughn
Central Bank of Barbados

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Ryan Straughn
Research Department, Central Bank of Barbados, Bridgetown

ABSTRACT

This paper examines the impact of the terms of trade on the trade balance in 3 Caribbean Community and Common Market (CARICOM) countries, with the inclusion of the real national income and the real stock of money in the model. The econometric procedure employed is the Johansen approach to estimation of multivariate cointegration systems with the aim of testing the empirical validity of the Bickerdike-Robinson-Metzler (BRM) and Marshall-Lerner (ML) condition, as well as the examination of the absorption and monetary approaches. The results indicate that there exists a significant long run "statistical equilibrium" between the trade balance, the terms of trade, the real national income and the real money stock for all three countries. However, these findings along with the impulse response functions indicated that neither the BRM nor the ML condition is supported by the data for any of the three countries, whilst the findings with respect to income and money did not uniformly reject or accept the hypotheses of the absorption or monetary approaches in the long run.

Keywords: Marshall-Lerner Conditions, Cointegration, Vector Autoregression, Impulse Response Functions.

1. INTRODUCTION

Despite the voluminous literature, the effects of changes in exchange rate regimes on the balance of payments, particularly those in relation to the trade balance, are still to be understood clearly. There is still much debate as to whether devaluation or depreciation[1] of country's (domestic) currency actually improves the trade balance, and if so, does it do so in the long run? In the Caribbean, this issue is especially critical against the backdrop of ongoing trade negotiations for the creation of the Free Trade Area of the Americas (FTAA). Therefore, it is relevant for formulation of sound policy to understand the short-run and long run relationship between such variables. Over the years, the use of nominal devaluations have been a key component of many structural adjustment programmes by various economic authorities to correct external imbalances and/or misalignment in exchange rates, or to improve a country's international industrial competitiveness. For many a developing country, the proper investigation of this area is especially important, since the lack of properly developed capital markets has meant trade flows have continued to drive the balance of payment account.

Conventional wisdom says that a nominal devaluation will improve a country's trade balance. This effect is deeply rooted in a static and partial approach to the balance of payments that has come to be known as the *elasticities approach*. The Bickerdike-Robinson-Metzler (BRM) model has been recognised in the literature as proving a sufficient condition (the *BRM condition*) for trade balance improvement when exchange rates devalue. The *Marshall-Lerner (ML) condition*, a particular solution of the BRM condition, hypothesises that currency depreciation or devaluation can improve a country's trade balance. The ML condition states that for a positive effect on the trade balance, and implicitly for a stable foreign exchange market, the absolute value of the sum of the demand elasticities for imports and exports must exceed unity. Accordingly, if the ML condition holds, there is excess supply of foreign exchange when the exchange rate is above the equilibrium level and excess demand when it is below. Thus the BRM and ML conditions have become the underlying assumptions for those who support devaluation as a means to stabilise the foreign exchange market.

The primary objective of this paper is to examine the role of the terms of trade in determining the long run trade balance behaviour for Barbados, Jamaica and Trinidad and Tobago in a model that includes the real national income and the real stock of money. Specifically, the author will examine whether the trade balance is affected by the terms of trade, through changes in exchange rates and whether the hypotheses such as the BRM or the ML conditions hold for the current data. The empirical relevance of the *absorption* and *monetary* approaches are also tested indirectly for the current data.

The remainder of the paper is organised as follows. Section 2 gives a brief review of the literature. Section 3 outlines some methodological issues related to three approaches to balance of payment adjustment and examines the time series properties of the data. Section 4 presents empirical cointegration results along with the simulated impulse response functions. Section 5 concludes the paper.

2. REVIEW OF THE LITERATURE

Within the body of literature on international trade, it is not surprising to still find arguments about whether currency deprecation or devaluation will improve the balance of trade. The three main approaches that have been identified in the literature are the elasticities,

[1] Devaluation is defined as the administered reduction in the exchange rate of a currency against other currencies under a FIXED EXCHANGE-RATE SYSTEM; whilst depreciation is defined as a fall in the value of a currency against other currencies under a FLOATING EXCHANGE-RATE SYSTEM.

absorption and monetary approaches; all bare testimony to this with each having its own arguments. Paraphrasing Miles (1979), proponents of the elasticities approach describe the necessary and sufficient conditions for an improvement in the trade balance in terms of the elasticities of demand and supply. If the demand and supply elasticities are sufficiently large and small respectively, then depreciation should improve the trade balance. Proponents of the absorption approach, describe how devaluation may change the terms of trade, increase production, switch expenditures from foreign to domestic goods, or have some other effect in reducing domestic absorption relative to production and thus improve the trade balance. International monetarists such as Mundell (1971), Dornbusch (1973) Frenkel and Rodriguez (1975) all argue that devaluation reduces the real value of cash balances and/or changes the relative price of traded and nontraded goods, thus improving both the balance of trade and the balance of payments.

Whilst there is an abundance of empirical evidence to suggest that the Marshall-Lerner conditions are indeed met, at least for industrial countries, there have also been circumstances under which devaluation has not been successful. One famous case was the deterioration of the U.S. trade balance in 1972 following the devaluation in 1971. This effect was termed the "J-curve" phenomenon[2] because of the path the trade balance would follow over time. Krueger (1983) argued that the phenomenon emanates from the fact that at the time of devaluation, goods already in transit and under contract have been purchased, and the completion of those transactions dominates the short-term change in the trade balance. Junz and Rhomberg (1973) identified at least five lags in the process between exchange rate changes and their ultimate effects on real trade: lags in *recognition* of the changed situation, in the *decision* to change real variables, in *delivery* time, in the *replacement* of inventories and materials, and in *production*. Their empirical evidence supports lags of up to five years in the effects of changes in exchange rates on market shares of countries in world trade.

Bahmani-Oskooee (1985) in his study of the experiences of Greece, India, Korea and Thailand concluded that although the elasticities condition is no longer interpreted to imply that devaluation or depreciation might fail, there is an alternative basis on which questions have been raised about the short-term effects of exchange rate changes on the trade balance.

The ML condition often requires the estimation of export and import demand models, which can be tedious and often requires proxying world export prices, effective exchange rates, and identifying trading partners, etc. For many countries especially those Caribbean Community and Common Market (CARICOM) countries under investigation in this paper, the relevant data for constructing such variables are not readily available. Studies by Miles (1979) and Bahmani-Oskooee (1985), rather than examining price elasticities, attempted to establish a link between the real effective exchange rate and the trade balance. These approaches have relied upon estimating reduced form models and have failed to examine the time series properties of the data. Arize (1994) has shown that there is a long run relation between the trade balance and the real effective exchange rate using data for nine Asian developing countries.

Past contributions to the econometric literature provide the tools with which to determine whether there is a long run relationship between variables that contain unit roots. The existence of a long run relationship between the trade balance and the terms of trade can be tested by estimating an ordinary least squares (OLS) regression and examining the

[2] The J-curve effect is the tendency for a country's balance of payments deficit to initially worsen following a devaluation of its currency before moving into a surplus. This is because the full adjustment of trade volumes to devaluation involves a time lag: there is an immediate fall in export prices and a rise in import prices so that current exports earn less foreign exchange and current imports absorb more foreign exchange, thereby increasing the size of the payment deficit (the downturn of the J-curve). Over time, the lower export prices will increase overseas demand and exports earning will rise, while higher import prices reduces domestic demand for imports, leading to an improvement in the balance of payments (the upturn of the J-curve).

residuals from this regression for stationarity. According to Engle and Granger (1987), such a regression will suffice to yield consistent estimates of the long-run coefficients, regardless of the dynamic structure of the model and regardless of whether any of the right-hand side variables are correlated with the disturbances.

Using the Engle and Granger approach, Bahmani-Oskooee (1991) found for Argentina, the Bahamas, Greece and the Philippines that there exists a long run relationship between the trade balance and the real effective exchange rate, thus showing that the approach can be considered an alternative to testing the ML conditions. Cointegration links the economic notion of a long run relationship between economic variables to a statistical model of those variables. Bahmani-Oskooee (1985) also pointed out that "the fact that the cointegration approach could be considered an alternative to the elasticities approach increases our scope of analysis, especially for LDCs for which estimating elasticities require data for import and export prices, income, etc. These data are not readily available for some LDCs…world income has to be proxied for all countries". Testing for cointegration between the trade balance and the terms of trade is consistent with examining "the statistical links between the two series" as suggested by Haynes and Stone (1982:704). In addition, cointegration is considered an alternative to testing the ML conditions because both the cointegration approach and the ML conditions are indeed long run analyses.

3. THEORETICAL CONSIDERATIONS

In this section the Bickerdike-Robinson-Metzler (BRM) model and its theoretical implications are presented along with those of the Marshall-Lerner conditions. Also, presented here is some discussion of the literature that has interpreted, reformulated and criticised the *elasticities approach*. There will be some focus on the *absorption* and the *monetary approaches* to the balance of payments.

The Elasticities Approach

The BRM model is a partial equilibrium version of a standard two-country (domestic and foreign), two-goods (exports and imports) model, where the effects of exchange rate changes are analysed through the separation of markets for exports and imports. The model is thus defined as follows. The domestic demand for foreign exports (imports) is a function of the nominal price of imports measured in domestic currency,

$$M^d = M^d(P_m). \qquad (3.1)$$

Here, $P_m = EP_m^*$, where E is the nominal exchange rate, (the domestic price of foreign currency) and P_m^* is the foreign currency price (level) of domestic imports. Likewise, the foreign demand for domestic exports can be similarly defined as,

$$M^{d^*} = M^{d^*}(P_x^*). \qquad (3.2)$$

where M^{d^*} is the quantity of foreign imports and P_x^* is the foreign currency price (level) of domestic exports. Analogously, $P_x^* = P_x/E$ where P_x is the domestic currency price (level) of exports. Similar to the demand functions, the exports supply functions are defined depending only on nominal prices. The domestic and foreign exports supply function are defined as,

$$X^s = X^s(P_m) \qquad (3.3)$$

$$X^{s^*} = X^{s^*}(P_m^*) \qquad (3.4)$$

where X^s and X^{s^*} are the quantity of domestic and foreign supplies of exports, respectively. The market equilibrium conditions for exports and imports are then,

$$M^d = X^{s^*} \qquad (3.5)$$

$$M^{d^*} = X^s \qquad (3.6)$$

From equations (3.1) through to (3.4), the domestic trade balance, in domestic currency is,

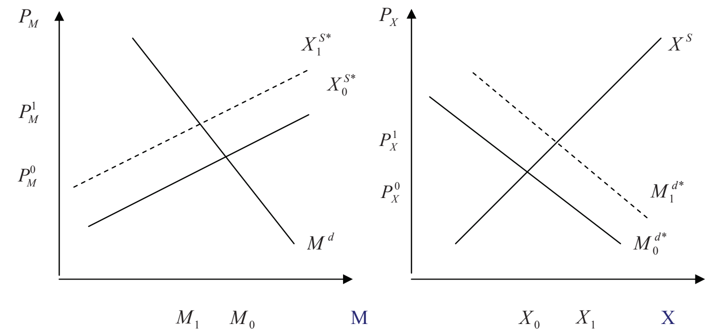
$$B = P_x X^s - P_m M^d \qquad (3.7)$$

In order to properly illustrate the model in equation (3.7), a comparative-static framework with two separate markets for domestic demand for imports and supply of exports is used when the functions are assumed to be normal downward and upward sloped, respectively. With the assumption of an initial equilibrium, that is, B=0, the question is, does devaluation of the domestic currency improve the trade balance as defined by (3.7)? In the current model, there are two important points to be noted about exchange rates. Firstly, since non-traded goods do not exist, the real exchange rate is measured by the terms of trade. Secondly, any nominal devaluation (assumed to be exogenous) becomes a real devaluation since domestic and foreign price levels are assumed to remain constant, or they are determined exogenously.

As depicted in Figure 3.1, at equilibrium, domestic exports equal X_0 and imports equal M_0. The prices are P_x^0 and P_m^0 respectively. Devaluation does not change the domestic supply of exports and demand for imports schedules since domestic prices have not changed. What occurs is a movement along both curves X^s and M^d where domestic supply of exports increases and the demand for imports decreases. However, the foreign demand for imports and supply of exports schedules shift upward from $M_0^{d^*}$ and $X_0^{s^*}$ to $M_1^{d^*}$ and $X_1^{s^*}$ respectively.

Figure 3.1: A Two-country and Two Goods Model

Import Market Export Market



In order to maintain the foreign currency prices of goods, as defined above, the domestic currency prices will have to increase in the same proportion as the devaluation to P_m^1 and P_x^1 for imports and exports respectively. As a result both the foreign demand for imports and supply for exports schedules should shift by the same percentage as the rate of devaluation. The new equilibrium level is reached when both markets clear. Thus, devaluation raises the market-clearing domestic currency price in both markets, increases the volume of domestic exports, and reduces the volume of domestic imports.

Differentiating (3.7) and converting to elasticities, a general algebraic condition is derived.[3] This condition relates the response of the trade balance to exchange rate changes and the domestic and foreign price elasticities of imports and exports:

$$\frac{dB}{dE} = P_x X^s \left[\frac{(1+\varepsilon)\eta^*}{\varepsilon+\eta^*}\right] - P_M M^d \left[\frac{(1-\eta)\varepsilon^*}{(\varepsilon^*+\eta)}\right], \qquad (3.8)$$

[3] See derivation in Appendix A.1.

where η and ε denote the price elasticities (in absolute values) of domestic demand for imports and supply of exports. By Walras's Law, it is sufficient to find equilibrium in one market since by the market clearing conditions of (3.5) and (3.6) the excess demand in any one market would be offset by the excess of supply in the other market. Thus without the loss of generality, the solution could be given in terms of any of the two markets. Analogously, η^* and ε^* denote respective foreign price elasticities. As can be shown, if B=0 (initial equilibrium), then $dB/dE > 0$ if and only if:

$$\frac{\eta\eta^*(1+\varepsilon+\varepsilon^*)-\varepsilon\varepsilon^*(1-\eta-\eta^*)}{(\varepsilon+\eta^*)(\varepsilon^*+\eta)} > 0, \qquad (3.9)$$

The particular case of interest is the "small country" case where, $\varepsilon^* = \eta^* = \infty$ (Lindert and Kindleberger, 1982, ch. 15), which implies that the foreign export supply and export demand are perfectly elastic and the left hand side of condition (3.9) becomes $(\varepsilon+\eta)$. Another way to state this case is to say that a country is a price-taker in both its import and export markets and accordingly, currency devaluation (depreciation) has no effect on world prices (in foreign currency), or its exports and imports. This implies that only changes in volumes affect its trade balance.

From condition (3.9) letting $\varepsilon \to \infty$ and $\varepsilon^* \to \infty$ implies that the left-hand side of (3.9) becomes $\eta^* + \eta - 1$. This is the so-called Marshall-Lerner condition (Marshall 1923; Lerner 1944). Thus, for a trade balance improvement after currency devaluation, $\eta^* + \eta > 1$ must hold. The standard presentation of the ML condition is $|\eta^* + \eta| > 1$. This simply states that if domestic and foreign supply elasticities are strictly elastic and if income remains constant, then a devaluation causes an improvement in the balance of trade when the domestic plus the foreign import demand elasticities, in absolute value, exceeds one. This has been considered in the literature as a sufficient condition for stability in the foreign exchange market.

The Absorption Approach

The core of this approach is the proposition that any improvement in the trade balance requires an increase of income over total domestic expenditures, that is, it focuses its analysis mainly on economic aggregates, typical of the Keynesian analysis, whilst the elasticities approach based its results on the effects of exchange rate changes on individual microeconomic behaviour (Marshallian supply and demand analysis).

The theory of the trade balance can be defined in terms of a basic macroeconomic identity, which expresses the different links between the trade balance and the macroeconomic aggregates. Assuming no transfers or services (the total national income becomes the gross domestic product and the current account the trade balance) one can write the following,

$$Y - A = TB_{dc} = X_{dc} - M_{dc} \qquad (3.10)$$

where Y is the gross domestic product, A is absorption[4], TB_{dc} is the trade balance in domestic currency, X_{dc} and M_{dc} are the value of exports and imports, respectively, in domestic currency. The absorption approach analyses the direct effects of exchange rate changes on relative prices, income, and absorption, and ultimately on the trade balance. This approach takes implicitly the Keynesian income-expenditure assumption that exports volumes are independent (autonomous) of national income, and that imports depend directly and positive on national income. This positive dependence is said to occur in two ways. One is that often a country's production needs imported inputs; the other is that imports respond to total

[4] Absorption is the total demand for goods and services *by* all residents (consumers, producers and government) of a country (as opposed to total demand *for* the country's output).

absorption (Alexander, 1952). The more a country spends on goods and services, the more a country will be inclined to spend on that portion that is bought from abroad. This behaviour is summarised by the well-known Keynesian *foreign trade multiplier*.

Under the absorption approach, it is assumed that there is the existence of the Keynesian short-run world and the nominal and real effects of devaluation can be stated as follows. Devaluation reduces the relative prices of domestic goods in domestic currency and produces two effects. Firstly, there is a substitution effect that causes a shift in the composition from foreign goods towards domestic goods; that is, the exchange rate change causes an expenditure-substituting effect, and with the usual Keynesian assumption of unemployment, domestic production increases. Secondly, there is an income effect, which would increase absorption, and then reduce the trade balance. The income effect is related to both the increase in domestic output (income), which acts through the "marginal propensity to absorb" (consume) and "marginal propensity to invest," and the change in the terms of trade. In general, this approach argues that a country's devaluation causes a deterioration in its terms of trade, and thus a deterioration in its national income. The presumption is that devaluation will result in a decrease in the price of exports measured in foreign currency[5]. However, the fact that the terms of trade deteriorates does not necessarily imply that the trade balance is also going to deteriorate. "It can worsen the trade balance if the foreign currency price of exports sinks far enough relative to the price of imports to outweigh the trade balance improvement implied by the rise in export volumes and the drop in import volumes" (Lindert and Kindleberger, 1982, p. 312). In all, the final effect of a devaluation on the trade balance will depend on the combined substitution and income effects. As predicted by the absorption approach, the trade balance will improve, but it would be smaller (because of the income effect on absorption) than that predicted by the BRM model.

The Monetary Approach

Since the 1950s, two monetary perspectives have been distinguished in the literature: the monetary approach and the Keynesian monetary view. Some of the basic assumptions underlying each of these perspectives are the following. With regard to the former: (1) there is full employment; (2) there are perfect substitutes for domestic and foreign goods and assets. This approach has been called the "global monetarist" (Whitman, 1975). With regard to the Keynesian view: (1) there is unemployment; (2) price sluggishness occurs so that purchasing power parity may not hold; and (3) money is a close substitute for other assets.

The monetary approach utilises the balance of payment identity is written here as

$$CA + KA = \Delta F \quad (3.11)$$

where CA is the current account, KA is the capital account and ΔF is the change in a country's foreign reserves, denominated in foreign currency. Note, however, that the identity only holds under a fixed exchange rate regime. "This is in marked contrast with the Keynesian view of the balance of payments namely that the monetary authorities sterilise the impact on the domestic money supply of international reserve flows ensuing from payments imbalance" (Hallwood and MacDonald, 1994, p. 140). Under a clean-floating regime the central bank refrains from intervention in the foreign exchange market. Accordingly, $\Delta F = 0$.

The absorption approach, the monetary approach can be defined in terms of basic identities, here, in terms of the central bank's balance sheet. Simplified, it can be written as

$$D + F_{dc} = MB = R + C \quad (3.12)$$

[5] Since countries are assumed "large" with elastic supplies, then under the assumption of constant domestic prices, a devaluation will reduce the relative price of domestic exports in foreign currency. The price of imports in foreign currency remains constant, or it can decrease if the foreign supply is not perfectly elastic. The key condition for a worsening of the domestic terms of trade is that the decrease in the price of exports is greater than the decrease of the price of imports.

where the left-hand side represents the assets and the right-hand side the liabilities. MB is the monetary base, or *high-powered money*, D is the domestic credit (or the domestic asset component of MB), F_{dc} is the stock of foreign reserves (or the foreign-backed component) in domestic currency, R is the money reserves and C is the currency in public hands. Now, let M be the domestic money supply and to simplify, let $M = MB$ (the money multiplier is implicitly assumed constant and equal one), then

$$D + F_{dc} = M \quad (3.13).$$

In an open economy, this identity means that the residents "can have an influence on the total quantity of money via their ability to convert domestic money into foreign goods and securities or conversely turn domestic goods and securities into domestic money backed by foreign exchange reserves" (Hallwood and MacDonald, 1994, p. 137). Taking first differences of (3.13) and rearranging, we get

$$\Delta F_{dc} = \Delta M - \Delta D \quad (3.14)$$

where ΔM is the flow demand of money balances or hoarding. Therefore, it follows that if the balance of payments identity in equation (3.11) holds, then the following equality has to be satisfied.

$$CA_{dc} + KA_{dc} = \Delta F_{dc} = \Delta M - \Delta D \quad (3.15)$$

where CA_{dc} and KA_{dc} are CA and KA in domestic currency, respectively. The left-hand side of (3.15) states that if a country has a deficit in both the current and the capital account, then it has to be losing foreign reserves, whilst the right-hand side implies that it loses foreign reserves when domestic credit exceeds hoarding.

In comparison with the elasticity and absorption approaches, and assuming that $KA_{dc} = 0$ and consider $CA_{dc} = TB_{dc}$, then the following identity must also hold.

$$X_{dc} - M_{dc} = Y - A = TB_{dc} = \Delta F_{dc} = \Delta M - \Delta D \quad (3.16)$$

This is a fundamental identity that puts together the elasticity, absorption and monetary approaches to the balance of payments. Therefore, according to Mundell (1968), if one considers all the variables in (3.16) in an *ex post* sense, the three approaches are equivalent. It is worthy to note, however, that this identity omits reference to the underlying behavioural relationships and adjustment mechanisms in each of these approaches.

What makes the monetary approach different from the elasticities and absorption approaches is that the role of the exchange rate is reduced to its temporary effect on the money supply. The reason being that the monetary approach assumes "a change in the exchange rate will not systematically alter relative prices of domestic and foreign goods and it will have only a transitory effect on the balance of payments" (Whitman, 1975, p. 494).

Of particular interest in this research paper is the question, what is the 'transitory' (or short run) effect of the devaluation under the monetary approach? In the short run, this approach predicts that an increase in prices, as caused by a nominal devaluation, may reduce the real money stock, and then improve the trade balance. The mechanism works as follows. A devaluation will proportionally increase the domestic prices[6], then people will reduce spending/absorption relative to income in order to restore their real money balances and holding of other financial assets. In brief, hoarding will increase[7]. As a result, the trade balance, and directly the money account, will improve. As stated above, this effect will be entirely temporary. Once people have restored their desired financial holdings, real money balances " expenditures will rise again and…[any] new surplus…[in the stock of money caused by the trade balance surplus] will be undermined" (Cooper, 1971, p.7). This result

[6] The small country assumption is implicit here.

[7] Notice, however, that if the monetary authorities increase the money supply, for example, through an increase in the domestic credit, the effect on the money account may be undermined.

assumes that the monetary authority keeps the domestic credit constant. This is a typical presumption of the IMF's type of stabilisation programmes for developing countries. If domestic credit increases after a devaluation to satisfy the new demand for money, the effects of the devaluation on the trade balance would be undermined.

4. ECONOMETRIC MODELLING

All the data sets used in this paper consists of annual time series data for Barbados, Jamaica and Trinidad and Tobago from 1970 until 2000. The time series include observed values of exports and imports, the nominal exchange rates, narrow money (M1), the real gross domestic product and the consumer price indices (CPI) for all three countries. All data are obtained from the International Financial Statistics, IMF (CD ROM). All the time series used in this paper have been deflated using the respective CPI. Additionally, all series are logged (natural logarithm). All the estimation results and plots reported in this paper come from outputs of Microfit and PcGive econometric software.

The trade balance measure, NX, is represented by the ratio of exports to imports. TOT is a measure of the terms of trade and is defined as the ratio of the prices of a country's imports relative to its exports, both in measured in domestic currency. In this paper, it is assumed that changes in the terms of trade reflect the changes in a country's real exchange rate, therefore, the terms of trade are proxied by price of imports (effective exchange rate multiplied by foreign price level) scaled by price of exports (domestic price level).

Unit Root Testing and Misspecification

This section tests the nature of the time series, that is whether they are generated by stationary or nonstationary processes and examines their order of integration. The standard augmented version of the Dickey-Fuller (DF), referred to as ADF, unit root test was implemented in all series in levels. The presence of a deterministic trend in the regression equation was determined via graphical inspection. From these inspections, it was inferred that all the variables for the three countries each exhibit some trending behaviour in their levels but not in their first differences. Therefore, the unit root test equation for the variables in levels all included a constant and a trend component. This allows for the presence of a trend in the variables and the unit root test compares an $I(1)$ process with drift under the null hypothesis to a trend stationary process under the alternative. Specifically, the test regression is of the following form:

$$\Delta x_t = \alpha x_{t-1} + \delta + \gamma t + \phi_1^* \Delta x_{t-1} + ... + \phi_k^* \Delta x_{t-k} + \varepsilon_t \qquad (4.1)$$

with null and alternative hypotheses

$$H_0 : \alpha = 0$$
$$H_A : \alpha < 0$$

Under H_0 the variable in question possesses a unit root and under H_A it is stationary around a linear trend.

For the variables in first differences, graphical analysis indicated that the series had no overall linear trend. Therefore the test regression in this case does not need to include a linear trend component. Since the variables are first differenced the unit root regression has the form

$$\Delta^2 x_t = \alpha \Delta x_{t-1} + \delta + \phi_1^* \Delta^2 x_{t-1} + ... + \phi_k^* \Delta^2 x_{t-k} + \varepsilon_t \qquad (4.2)$$

with the same null hypothesis as above. However, under the alternative hypothesis the process for Δx_t is stationary with constant mean. The null hypothesis is that Δx_t is stationary with no drift.

There remains one practical question, namely how the order of augmentation in (4.1) and/or (4.2), as appropriate, should be determined. This is important, because the critical values for the Dickey-Fuller tests have been obtained on the assumption of white noise disturbances, and they are not valid in the presence of autocorrelation. In this paper, the order of augmentation is specified using an information criterion, such as the Akaike Information Criterion (AIC) or the Schwarz Bayesian Criterion (SBC) with the maximum order considered specified in advance. With this in mind, the order of augmentation, *p* in (4.1) or (4.2) was chosen so that disturbances ε_t are uncorrelated white noise. Although Microfit output for the ADF command does not return significance tests for individual ϕ_i^*, it does however include information criteria for different values of *p*. Both the AIC and SBC were used in conjunction with each other to determine the order of augmentation, but these are not reported.

Also in this section, some of the misspecification tests that were carried out are reported in Table 1. The specification and misspecification tests were used to determine the appropriate lag structure for each model and to identify the deterministic components to be included in the model, for instance, whether or not to include an intercept in the cointegration space to account for the units of measurement of the endogenous variable or to allow for deterministic trend in the data. The SBC, AIC and a likelihood ration test were used in conjunction to determine the lag structure of the model, however these are not reported. Also note that in the testing procedure a trade-off among all three criteria was needed. Once the lag structure and the deterministic components of the model are chosen, additional specification and misspecification tests were implemented.

As can be seen from Table 1, the results from the ADF tests applied to the variables in levels suggest that the null hypothesis of a single unit root cannot be rejected in favour of stationarity for the first-differenced series. The results in Table 1 indicate that all the null hypotheses were rejected. Thus according to the test and initial conjectures, it seems all the variables are integrated of order one, at least at zero frequency. That is, all the variables seem to behave as $I(1)$ processes. Therefore, the implementation of the econometric procedure will be carried out on the assumption that all series exhibit nonstationary behaviour, in particular, that they behave as $I(1)$ processes.

From the results in Table 1, it can be seen that all but three of the variables (in levels only), were found to have homoscedastic error variances, namely the terms of trade proxy variable for Jamaica and the real GDP variables for Barbados and Trinidad and Tobago; the presence of serial correlation was detected only in the real GDP variable for Jamaica whilst autoregressive conditional heteroscedastic effects were only found in the real GDP variable for Jamaica, (in levels only). Though not reported in the table, tests for normality of the residuals were carried out and it was found that the normality assumption hold for all the variables.

Cointegration Testing (Johansen Approach)

The method of conducting cointegration tests in the paper is the Johansen approach (1988). This is particularly promising because it is based on the well-established likelihood ratio principle and avoids some of the drawbacks of the single-equation cointegration procedures. Monte Carlo evidence as reported by Gonzalo (1994) supports the relative power of Johansen methodology over alternative techniques. Further, Arize and Durrat (1994), states that the Johansen approach offers a test statistic for the number of cointegrating vectors and allows for direct hypothesis tests of the coefficients entering the cointegrating vector. For the purposes of this paper, cointegration implies that quantifiable stationary relationships such as that ML conditions hold. The statistical model is as follows.

Assume $z_t, t = 1,...,T$, which denotes a (p x 1) vector of random variables, follows a p-dimensional VAR model with Gaussian errors, the conditional model, conditional on the observations $z_{-k+1},...,z_0$, which are fixed (k is the lag length for the system), can be written as

$$z_t = \mu + A_1 z_{t-1} + ... + A_k z_{t-k} + \varepsilon_t \qquad (4.3)$$

where $A_1, A_2,..., A_k$ are (p x p) matrices, μ is a vector of constants in z_t, the model can be written in its error correction form;

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + ... + \Gamma_{k-1} \Delta z_{t-k+1} + \Pi z_{t-k} + \mu + \varepsilon_t, \ t = 1(1)T \qquad (4.4)$$

where $\Gamma_i = -(I - A_1 - ... - A_i)$, for $i = 1(1)(k-1)$; and $\Pi = -(I - A_1 - ... - A_k)$. Equation (4.4) is known in the literature as the vector error correction mechanism (VECM), where the short run dynamics are captured by the series in differences and the long run relationships by the series in levels, Now if z_t is integrated of order one, that is $I(1)$, then the matrix Π is of reduced rank

$$\Pi = \alpha\beta' \qquad (4.5)$$

where α (weights or *error correction* parameters) and β (cointegrating vectors) are (p x r) matrices of rank r. Under this hypothesis, the process Δz_t is stationary, z_t is nonstationary but $\beta' z_t$ is stationary. In other words, one or more linear combinations of variables in z_t exist and have a finite variance. These linear combinations are called cointegrating vectors or long-run equilibrium relationships.

The variable formulation of the statistical model, as stated in equation (4.3) is given by the vector $z_t = (nx_t, tot_t, m_t, y_t)'$, where nx_t is a measure of the trade balance, tot_t is a measure of the terms of trade[8], m_t is the money stock and y_t is the real gross domestic product. This vector is thought to capture the effects of the exchange rate on the trade balance in a model that puts together the elasticity, absorption and monetary approaches to balance of payments equilibrium.

For the purposes of this research paper, the interpretation of the cointegrating VAR process for the three respective countries will be done via the use of impulse response functions (IRFs). These functions simulate the dynamic effect of a shock on the variables of the system over time. However, it needs to be emphasised that the ordering of the variables in the cointegrating VAR can have a substantial impact on the orthogonalised impulse response functions. For this reason, some econometricians and statisticians have been sceptical about them. The impetus for the use of the VARs in applied economics was to avoid the assumptions about what variables were endogenous and what were exogenous in a particular economic system. To rely on a particular ordering of variables for the IRFs is in effect, an assumption of a particular causal ordering for the contemporaneous values of the variables. Since the economies of the three countries are characterised as small open economies, then this implies that these economies face exogenously determined terms of trade This small open economy assertion also implies that current and lagged values of the real GDP, the real money stock and the trade balance does not enter the equation for the terms of trade. Therefore, in terms of the orthogonalised impulse response functions computed from (4.4), it is assumed that shocks to the current terms of trade proxy variable influences income and money, and that shocks to these three variables influence the trade balance. However, all economists may not necessarily accept this causality assumption.

[8] It is assumed that changes in the terms of trade reflect the changes in a country's real effective exchange rate. Therefore, the terms of trade is proxied by the price of imports (effective exchange rate multiplied by the foreign price level) scaled by the price of exports (domestic price level).

5. ESTIMATION AND ANALYSIS OF RESULTS

Cointegration Results

Table 2 shows the results of the cointegration likelihood ratio test based on the maximal eigenvalue and the trace of the long run matrix, which are used to determine the number of cointegrating relationship. The SBC and AIC were also used in conjunction with these tests in the determination of the $rank(\Pi)$, however, only the SBC is reported. The table also shows the estimated cointegrated vectors in Johansen estimation normalised for the respective trade balances.

The maximal eigenvalue tests and the trace test both for the three countries reject the null hypothesis of $r = 0$, (no cointegration) at the 5 percent level of significance in favour of the alternative $r \leq 1$, with reported values of 36.6993, 46.9258, 51.7083 and 64.9611, 71.4856, 88.1325 for Barbados, Jamaica and Trinidad and Tobago respectively. The null hypothesis of $r = 1$ cannot be rejected in favour of the alternative $r \leq 2$ by either test, since the reported values are smaller than the associated critical values. These results in conjunction with the information criterion reported imply that statistically, there exists a long run equilibrium relationship between the trade balance, the terms of trade (real effective exchange rate), real money stock and real income, even though there are no discernible differences between hypotheses as indicated by the SBC. However, based on the results, *r*, the number of cointegrating relationships was set at one and the vectors were estimated.

Table 2: Cointegration Tests and Estimates

COUNTRY	NULL ALTERNATIVE		$r = 0$ $r \leq 1$	$r = 1$ $r \leq 2$	$r = 2$ $r \leq 3$	$r = 3$ $r \leq 4$
Barbados	Maximal Eigenvalue		36.6993	16.3962	6.7725	5.0930
	Trace Test		64.9611	28.2617	11.8655	5.0930
	SBC	$r = 0$ 138.8190	$r = 1$ 143.6993	$r = 2$ 143.5917	$r = 3$ 142.0342	$r = 4$ 142.9328
	CV: $lbnx = 1.0973 - 0.2146 lbtot - 2.5466 lby + 2.1316 lbm$					
Jamaica	Maximal Eigenvalue		46.9258	18.1713	5.1713	0.6256
	Trace Test		71.4856	24.5558	5.7969	0.6265
	SBC	$r = 0$ 52.8381	$r = 1$ 54.0314	$r = 2$ 52.8524	$r = 3$ 52.8524	$r = 4$ 52.0032
	CV: $ljnx = -0.4287 - 0.5061 ljtot + 5.1728 ljy - 5.3339 ljm$					
Trinidad and Tobago	Maximal Eigenvalue		51.7083	18.1287	12.0989	6.1966
	Trace Test		88.1325	32.4242	18.255	6.1966
	SBC	$r = 0$ 113.0349	$r = 1$ 125.7059	$r = 2$ 124.8825	$r = 3$ 124.3403	$r = 4$ 124.7427
	CV: $ltnx = 2.4818 - 1.2321 lttot - 8.392 lty + 8.129 ltm$					

Notes: *r* denotes the number of cointegrating relationships or cointegrating vectors (CV). The critical values for the maximal eigenvalue hypotheses test are as follows: the $C_{0.05}$ are 31.0, 24.4, 18.3 and 11.5, respectively, whereas those for the trace test are as follows: the $C_{0.05}$ are 58.9, 39.3, 23.8 and 11.5 respectively. SBC denotes the Schwarz Bayesian criterion.

According to Johansen and Juselius (1994), if only one cointegrating relationship exists, the problem of identification of the cointegration space does not emerge, and the system is said to be *just identified*. Therefore, one can make direct inference from both the short run and long run estimates that may be present in the estimated error correction mechanisms for the trade balance. Since the error correction models for the three countries were estimated using a vector autoregressive process of lag length 1, then there will be no short run estimates to be interpreted in the respective models.

The estimated equation of the error correction model for the Barbados trade balance is:

$$\Delta lbnx_t = \underset{(3.184)}{0.2479}\left(-0.0271lbnx_{t-1} - 0.0059lbtot_{t-1} - 0.0695lby_{t-1} + 0.0582lbm_{t-1} + 0.0299\right) \quad (5.1)$$

Equation (5.1) shows that the speed of adjustment coefficient is statistically significant, implying that the speed at which the rate of variation in the trade balance (Δbnx_t) adjusts towards the single long run cointegrating relationship is statistically different from zero. The estimated long run equation normalised in terms of the Barbados trade balance is:

$$lbnx = \underset{(3.275)}{1.0973} - \underset{(-0.334)}{0.2146}lbtot - \underset{(-3.472)}{2.5466}lby + \underset{(2.922)}{2.1316}lbm \quad (5.2)$$

Equation (5.2) represents the estimated long run relationship between the trade balance, the terms of trade, real income and money, where the figures in parentheses are *t*-statistics. The estimated long run exchange rate elasticity, represented by the terms of trade proxy variable, has a negative sign and is not statistically significant. Therefore, a (real) devaluation would not lead to an improvement in the trade balance in the long run, thus indicating that the BRM or ML condition for exchange rate stability is not supported by the data. The coefficient of the income variable has a negative sign and is statistically significant, which supports the absorption approach but not the monetarist view that income has a positive effect on the trade balance. Therefore, a one percent increase in real GDP is expected to result in the trade balance worsening by 2.55% in the long run. However, the significant presence of the real money stock variable in the equation contradicts that which is purported by the monetary and absorption approaches. From (5.2), the sign of the money stock variable indicates that it has a positive impact on the trade balance, and in the long run, a one percent increase in narrow money will result in 2.13% improvement in the trade balance.

Equation (5.3) shows the estimated error correction equation for the Jamaican trade balance.

$$\Delta ljnx_t = \underset{(-1.979)}{-0.0568}\left(-0.0368ljnx_{t-1} - 0.0186ljtot_{t-1} + 0.1906ljy_{t-1} - 0.1965ljm_{t-1} + 0.0157\right) \quad (5.3)$$

The speed of adjustment coefficient is statistically significant and therefore statistical inference can be made form the long run relationship that is implied by (5.3).

$$ljnx = \underset{(-5.135)}{-0.4287} - \underset{(-4.594)}{0.5061}ljtot + \underset{(5.449)}{5.1728}ljy - \underset{(-5.513)}{5.3339}ljm \quad (5.4)$$

Equation (5.4) shows the estimated long run relationship that between the variables in the model. This reveals that the estimated long run exchange rate (terms of trade) elasticity has a negative sign and is statistically significant. Accordingly, depreciation will not lead to an improvement in the real trade balance. Further, a one percent increase in the terms of trade results in the worsening trade balance by 0.5% in the long run. As was the case for Barbados above, the ML or the BRM condition does not appear to be supported by the data for Jamaica. The positive sign on the income variable is not in agreement with what was expected by proponents of the absorption approach, however, this result supports the monetarist view. Its statistical significance implies that a one percent increase in the real GDP will result in an increase of 5.17% in the trade balance in the long run. The significant presence of the real money stock variable contradicts that which is argued by the absorption approach. Since Jamaica employs a 'floating'[9] exchange rate policy, the significant presence of the money variable does not necessarily contradict the view of the monetary approach, and therefore, a one-percent increase in the real money stock in the long run results in 5.33% decline in the trade balance.

In the case of Trinidad and Tobago, the error correction equation for the trade balance is as follows.

$$\Delta ltnx_t = 0.4677(-0.0289ltnx_{t-1} - 0.0356lttot_{t-1} - 0.2431lty_{t-1} + 0.2355ltm_{t-1} + 0.0719) \quad (5.5)$$
$$(-2.905)$$

As was the case for Barbados and Jamaica, the speed of adjustment coefficient was significantly different from zero and the estimated long run equation normalised in terms of the Trinidad and Tobago trade balance is

$$ltnx = 2.4818 - 1.2321lttot - 8.392lty + 8.129ltm \quad (5.6)$$
$$(2.968)\ (-0.124)\quad (-4.974)\quad (5.641)$$

Equation (5.6) reveals that the estimated long-run exchange-rate (terms of trade) elasticity has a negative sign and it is not statistically significant. Therefore, a real depreciation is not expected to improve the balance of trade in the long run, even though the coefficient is greater than unity in absolute terms. Thus, indicating that the BRM condition or the ML condition does not hold for Trinidad and Tobago, as was the case for Barbados and Jamaica. Further, the sign of the income variable is also negative, which supports the view argued by proponents of the absorption approach. Statistical significance of the income variable implies that a one percent increase results in a decline in the trade balance of 8.39% in the long run. With regard to the real money stock variable, its significant presence in the estimated long run equation contradicts the view of both the absorption and monetary approaches, which argues the point of money neutrality in the long run. Note here, that even though Trinidad and Tobago employs a floating exchange rate regime, it is not a necessarily clean one, as is the case for Jamaica. Thus, in the long run, a one percent increase in the real money stock improves the real trade balance by 8.13%.

Table 3 reports the results of the specification and misspecification tests carried out on the residuals of the VECM representations. No serial correlation was found to be present in the residuals for any of the three countries. The models were also found to have good functional form, homoscedasticity and no ARCH effects. All the VECM residuals were also found to be stationary and the normality assumption also holds. Thus, indicating that the performance of the VECM representations of the actual data is generally satisfactory.

Table 3: Misspecification Tests for the VECM representations of the trade balances.

DIAGNOSTIC TEST	BARBADOS	JAMAICA	TRINIDAD AND TOBAGO
A: Serial Correlation	$\chi^2(1)$= 0.596 (0.440)	$\chi^2(1)$= 0.012 (0.909)	$\chi^2(1)$= 0.377 (0.539)
B: Functional Form	$\chi^2(1)$= 0.882 (0.595)	$\chi^2(1)$= 0.442 (0.837)	$\chi^2(1)$= 0.889 (0.346)
C: Normality	$\chi^2(2)$= 5.048 (0.080)	$\chi^2(2)$= 3.605 (0.165)	$\chi^2(2)$= 0.449 (0.799)
D: Heteroscedasticity	$\chi^2(1)$= 1.757 (0.185)	$\chi^2(1)$= 0.014 (0.905)	$\chi^2(1)$=0.158 (0.691)
E: ARCH (k)	$\chi^2(1)$= 0.642 (0.423)	$\chi^2(1)$= 0.588 (0.443)	$\chi^2(1)$= 0.022 (0.882)
F: ADF	-5.379	-5.396	-4.569

Notes: A: Lagrange Multiplier test of residual serial correlation.
B: Ramsey's RESET test using fitted the square of the fitted values.
C: Based of a test of skewness and kurtosis of residuals.
D: Based on the regression of squared of squared fitted values.
E: Engle's ARCH test of residuals (OLS) case.
F: Dickey-Fuller unit root tests for residuals. The 95% asymptotic critical value is -4.182.
The figures in parentheses are the statistics associated probability values.

[9] The Government of Jamaica maintains its exchange rate within a predetermined bandwidth, therefore, this regime can be considered to be a fixed one.

4.2 Impulse Response Functions (IRFs) Analysis

In this section the impulse response functions obtained from the error correction mechanisms of the cointegration VAR model are used to evaluate the empirical plausibility of the various theoretical approaches. However, it is not the aim of the author to promote the views of any one approach over any of the others. Figure 4.1 shows the empirical orthogonal impulse response functions for all the variables in the system to a shock in the terms of trade equation, *ceteris paribus*, for Barbados, Jamaica and Trinidad and Tobago respectively.

A positive shock to the Barbados term of trade equation reveals that the trade balance will decline and that the shock would persist for approximately ten years. Similar results are reported for the real GDP and real money stock variables. For Jamaica, a negative shock to the terms of trade equation persist for approximately three years and is accompanied by a worsening of the trade balance. However, the negative shocks affect the real GDP positively and the real money stock negatively, persisting for approximately three years. In the case of Trinidad and Tobago, a negative shock to the terms of trade persists for approximately twelve years and is accompanied by a decline in the trade balance. Nevertheless, the negative shock affects both the real GDP and the real money stock variables positively.

Figures 2 to 4 show the responses of shock to all the variables in the system for Barbados, Jamaica and Trinidad and Tobago respectively. The results reported in Figure 1 appear as the first row of graphs on each of the figures. The results of the simulated impulse response functions indicate that the trade balances will only improve when there are positive and negative shocks to the real money stock equations for Barbados and Trinidad and Tobago, and when there is a negative shock to the real national income equation for the case of Jamaica. The results also show that for the Barbados, the improvement in the trade balance would be accompanied by an increase in the real national income, whilst for Trinidad and Tobago there is a decline in real national income.

Figure 1: shows the Orthogonal Impulse Response functions of a Terms of Trade shock for Barbados, Jamaica and Trinidad & Tobago. From left to right, the graphs represent the terms of trade, the real national income, the real money stock and the trade balance equations respectively.

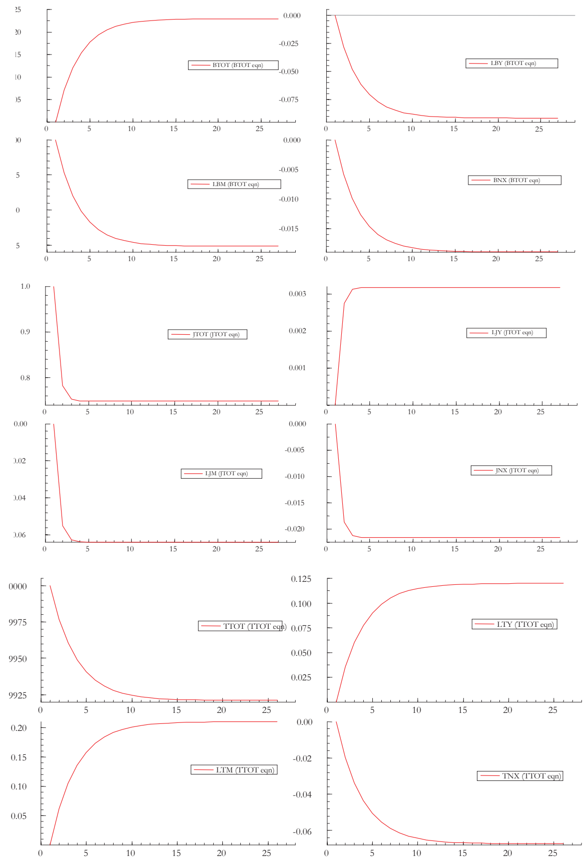


Figure 2: Orthogonalised response of the system to shocks in all equations for Barbados. The first, second, third and fourth lines respectively represent the response of the system variables to shocks in the terms of trade, the real national income, the real money stock and the trade balance equations.

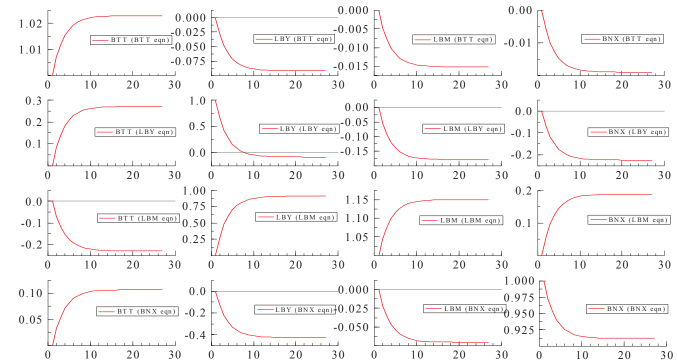


Figure 3: Orthogonalised response of the system to shocks in all equations for Jamaica. The first, second, third and fourth lines respectively represent the response of the system variables to shocks in the terms of trade, the real national income, the real money stock and trade balance equations.

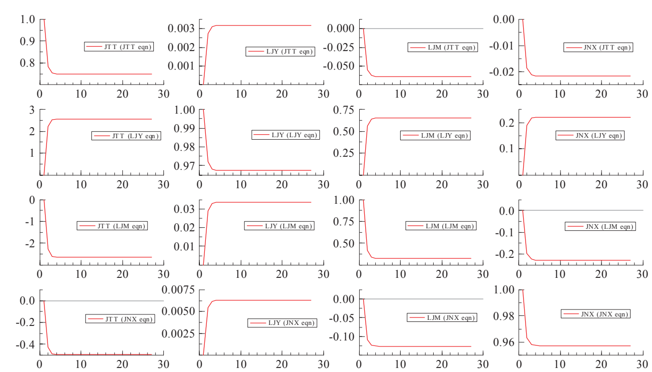
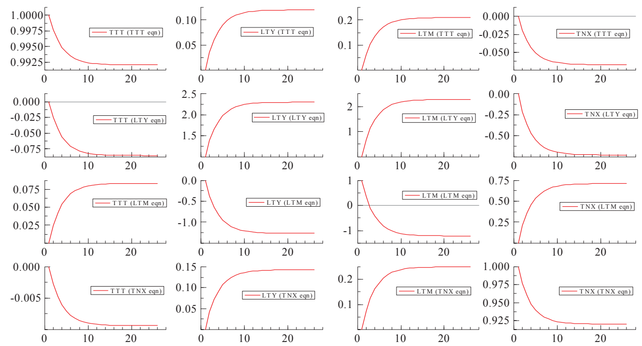


Figure 4: Orthogonalised response of the system to shocks in all equations for Trinidad & Tobago. The first, second, third and fourth lines respectively represent the response of the system variables to shocks in the terms of trade, the real national income, the real money stock and the trade balance equations.



For Jamaica, the negative shock in the real national income equation also results in an increase in the real money stock. Though, the response of the terms of trade to shocks in the real national income and the real money stock equation are presented, these are not considered to be valid, since by the small open economies assumption, the real variables considered in this analysis cannot influence the terms of trade since it is considered to be determined exogenously.

6. CONCLUSION

In summary, the results of the simulated IRFs suggest that only the absorption approach to balance of payments adjustment hold for Barbados or indeed Trinidad and Tobago, as there is only an improvement in the trade balances when there are positive and negative shocks to the real money stock equations respectively; whilst in the case of Jamaica, only the absorption approach appears to be supported by the data, as the trade balance improves as a result of a negative shock to the real national income equation. The results from both the VECM representations and the simulated IRFs showed that the BRM and ML conditions did not hold for the any of the three countries. From this, one would infer that policy makers in the three countries should not attempt exchange rate manipulation in order to improve the trade balance. However, from the view of trade balance modelling, the result suggests that a model seeking to explain the long run behaviour of the trade balance should include money and income. The policy implications inferred by the empirical and simulated results indicate that policy makers, when attempting to improve the trade balance should use a combination of both monetary and/or fiscal policies.

One main limitation of this paper was that capital markets are not considered. There are several directions for future research in this area, especially for countries in CARICOM. One direction is to use panel cointegration models to analyse possible cross-country short and long run effects more thoroughly. Another direction is to extend the econometric methodology to all the countries within CARICOM, as well as to include those countries that will form the FTAA in 2005, so that the short and long run effects of intra and inter-regional trade can also be thoroughly investigated.

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Appendix

A.1 Derivation of the BRM condition

Only new notation will be defined here, the rest of the notation is as defined in the text. The trade balance B, defined in foreign currency is,

$$B = S - M = X - M = P_x^* X^s - P_m^* M^d \quad (A.1.1);$$

where D and S are the demand and supply of foreign currency and are equal to the value if imports and exports respectively. Differentiating gives

$$dB = dS - dD \quad (A.1.2).$$

Now defining the following elasticities with respect to the nominal exchange rate E:

$$\begin{aligned} E_B &= \hat{B}/\hat{E} \\ E_S &= \hat{S}/\hat{E} \quad (A.1.3), \\ E_D &= \hat{D}/\hat{E} \end{aligned}$$

where E_B, E_S, E_D are the elasticities of the trade balance, the value of exports and the value of imports, respectively. The symbols "^" states the percentage change of the respective variable $\hat{E} = (dE/E)$. Expressing equation (A.1.2) in terms of exports so that

$$dB/M = dS/M - dD/M \quad (A.1.4)$$

and dividing by dE/E yields

$$\frac{dB/M}{dE/E} = \frac{dS/M}{dE/E} - \frac{dD/M}{dE/E} \quad (A.1.5)$$

and now expressing (A.1.5) in terms of elasticities

$$E_B = \frac{X}{M} E_S - E_D \quad (A.1.6).$$

This defines the elasticities in the foreign exchange market. The next step is to define the elasticities of prices and quantities with respect to the exchange rate. The solution for the exports market is derived first. The price of exports in domestic currency is $P_x = EP_x^*$. From the export market condition (3.6), the following can de written:

$$X^S = X^S(E.P_x^*) = M^{d*}(P_x^*) \quad (A.1.7).$$

Differentiating yields

$$dX^s = \frac{\partial X^s}{\partial P_x}(EdP_x^* + P_x^* dE) = \frac{\partial M^{d*}}{\partial P_x} dP_x^*$$

or,

$$\frac{dX^s}{X^s} = \frac{\partial X^s}{\partial P_x}\frac{1}{X^s}(EdP_x^* + P_x^* dE) = \frac{\partial M^{d*}}{\partial P_x}\frac{1}{M^{d*}} dP_x^*.$$

Multiplying throughout by $P_x/E = P_x^*$ and dividing by dE/E yields

$$\frac{dX^s/X^s}{dE/E} = \frac{\frac{\partial X^s}{\partial P_x}\frac{1}{X^s}\frac{P_x}{EP_x^*}(EdP_x^* + P_x^* dE)}{dE/E} = \frac{\frac{\partial M^{d*}}{\partial P_x}\frac{P_x^*}{P_x^*}\frac{1}{M^{d*}} dP_x^*}{dE/E};$$

and rearranging yields the response of the quantity if exports to the exchange rate,

$$\frac{dX^s/X^s}{dE/E} = \varepsilon\left(\frac{dP_x^*/P_x^*}{dE/E} + 1\right) = \eta^* \frac{dP_x^*/P_x^*}{dE/E} \quad (A.1.8);$$

where $\varepsilon\left(\varepsilon = \partial X^s/X^s / \partial P_x/P_x\right)$ is the price elasticity of domestic supply of exports and $\eta^*\left(\eta^* = \partial M^{d*}/M^{d*} / \partial P_x^*/P_x^*\right)$ the price elasticity of foreign demand for imports. Solving (A.1.8) for the percentage change of the foreign price of (domestic) exports to the exchange rate gives

$$\hat{P}_x^*/\hat{E} = [\varepsilon/(\eta^* - \varepsilon)] \quad (A.1.9)$$

However, what is required is the percentage change of the domestic price of exports to the exchange rate, which is simply (A.1.9) plus one.

$$\hat{P}_x / \hat{E} = \left[\eta^* / \left(\eta^* - \varepsilon\right)\right] \quad (A.1.10)$$

Sine the supply of foreign exchange, or the value of exports (in foreign currency) equals price time quantity; one can express the total percentage change in the value of exports as

$$\hat{X} = \hat{P}_x^* + \hat{X}^s \quad (A.1.11),$$

and dividing throughout by $\hat{E}$ to find tan expression in terms of elasticities with respect to the exchange rate

$$E_S = \hat{X}/\hat{E} = \hat{P}_x^*/\hat{E} + \hat{X}^s/\hat{E} \quad (A.1.12).$$

The right-hand side of (A.1.12) is defined by equation (A.1.9) and since one needs to express the result in domestic currency (prices), (A.1.10) can be used directly. The second term on the right-hand side of (A.1.12) is obtained by substituting (A.1.9) into the right-hand side of (A.1.8), which gives the response of the quantity of exports to the exchange rate is

$$\frac{\hat{X}^s}{\hat{E}} = \frac{\varepsilon\eta^*}{\eta^* - \varepsilon} \quad (A.1.13).$$

The addition of equations (A.1.10) and (A.1.13) yields the elasticity of the value of exports.

$$E_S = \frac{\eta^*}{\eta^* - \varepsilon} + \frac{\varepsilon\eta^*}{\eta^* - \varepsilon} = \frac{(1+\varepsilon)\eta^*}{\eta^* - \varepsilon} \quad (A.1.14)$$

Following the same steps, one can derive the solution for the import market. The homologous solutions for equations (A.1.10), (A.1.13) and (A.1.14) are

$$\hat{P}_M / \hat{E} = \left[\varepsilon^* / \left(\varepsilon^* - \eta\right)\right] \quad (A.1.15)$$

$$\frac{\hat{M}^d}{\hat{E}} = \frac{\varepsilon^*\eta}{\varepsilon^* - \eta} \quad (A.1.16)$$

and

$$E_D = \frac{\varepsilon^*}{\varepsilon^* - \eta} + \frac{\varepsilon^*\eta}{\varepsilon^* - \eta} = \frac{(1+\eta)\varepsilon^*}{\varepsilon^* - \eta} \quad (A.1.17).$$

Finally, substituting solutions (A.1.14) and (A.1.17) in (A.1.6)

$$E_B = \left(\frac{(1+\varepsilon)\eta^*}{\eta^* - \varepsilon}\right)\frac{X}{M} - \left(\frac{(1+\eta)\varepsilon^*}{\varepsilon^* - \eta}\right),$$

or

$$\frac{dB/M}{dE/E} = \left(\frac{(1+\varepsilon)\eta^*}{\eta^* - \varepsilon}\right)\frac{P_x^* X^s}{P_m^* M^d} - \left(\frac{(1+\eta)\varepsilon^*}{\varepsilon^* - \eta}\right).$$

Now multiplying throughout by M, the response of the trade balance to exchange rate changes (after defining elasticities in absolute values) can be expressed in domestic currency as follows

$$\frac{dB}{dE} = P_x^* X^s \left(\frac{(1+\varepsilon)\eta^*}{\varepsilon + \eta^*}\right) - P_m^* M^d \left(\frac{(1-\eta)\varepsilon^*}{\varepsilon^* + \eta}\right).$$

This is the BRM condition as stated in equation (3.8).