academicJournals

Vol. 7(14), pp. 1126-1143, 14 April, 2013
DOI: 10.5897/AJBM12.801
ISSN 1993-8233 © 2013 Academic Journals
http://www.academicjournals.org/AJBM

African Journal of Business Management

Full Length Research Paper

The effects of exchange rate on the trade balance in Ghana: Evidence from co-integration analysis

Keshab R. Bhattarai[1]* and Mark Armah[2]

[1]Business School, University of Hull, Cottingham Road, HU6 7RX, United Kingdom.
[2]Department of Economics, University of Cape Coast, Ghana.

Accepted 13 March, 2013

This paper examines the effects of exchange rates on the trade balance of Ghana. First, by deriving the real exchange rate as a function of preferences and technology of two trading economies and then by applying small price taking economy assumption to the Ghanaian economy, using annual time series data from 1970-2000 we estimate the trade balance as a function of the real exchange rate, domestic and foreign incomes. Co-integration analyses of both single equation models and VAR-Error correction models confirm a stable long run relationship between both exports and imports and the real exchange rate. The short-run elasticities of imports and exports indicate contractionary effects of devaluation, in terms of the Marshall-Lerner-Robinson conditions, though these elasticities add up to almost 1 in the long run estimates. The overall conclusion drawn from the study is that, for improved balance of trade in Ghana, coordination between the exchange rate and demand management policies should be strengthened and be based on the long run fundamentals of the economy.

Key words: Exchange rate, trade policy, Ghana, co-integration.

INTRODUCTION

Ghana had disastrous performance on economic growth in the two decades between 1970 and 1990. Real per capita income fell by a factor of two during this period. This is reflected in a pattern of trade that continuously deteriorated from 1970 to 1990 in real terms, but started to pick up in recent years, only after it reformed and liberalised the economy and made the exchange rate regime responsive to market fundamentals. Despite these successive reforms and devaluations, the tendency for imbalances has widened even further. Why these reforms in the exchange rate system have not been effective is an interesting issue to investigate.

The exchange rate has been used as a tool for regulating flows of trade and capital by many developing economies, which tend to have persistent deficits in the balance of payments because of a structural gap between the volumes of exports and imports. These economies tend to have inelastic demand for both exports and imports. In addition, the rate of growth of imports is often higher than the rate of growth of exports resulting in rising imbalances in trade. There have been many discussions in the literature about the determinants of real and nominal exchange rates and how these affect the trade and growth in an economy. Should an economy adopt a fixed or flexible exchange rate system or should it target for the real or the nominal exchange rate?

Models of real exchange rates reflect the relative prices of one country in terms of preference of households, technology of firms and institutional arrangements as well as taxes and tariffs between two countries. The real exchange rate is, then, the outcome of general equilibrium in markets for goods and services (Singer,

*Corresponding author. E-mail:- K.R.Bhattarai@hull.ac.uk; markarmah44@yahoo.com.
JEL classification: C22, C52 and F31.

1950; Meade, 1955; Johnson, 1957; Armington, 1969; Whalley, 1985). Financially, nominal exchange rates can be fixed by authorities or allowed to change according to the differences in the purchasing power parity and the differences in the interest rates (Johnson, 1954; Fleming, 1962; Dornbusch, 1976; Krugman and Miller, 1992; Taylor, 1995). Under a flexible exchange rate system both real and nominal exchange rates are aligned to each other through the market mechanism. Under the fixed exchange rate system these automatic (Buiter and Miller (1992)) adjustments are not guaranteed leaving room for appreciation or depreciation of currency, with its consequence for the relative competitive position of the economy.

Since a correct exchange rate has been (Krugman (1979)) one of the most important factors for economic growth in the economies of Southeast Asia and volatility in exchange rates has been one of the major obstacles to economic growth of many African and Latin American economies, it is interesting to investigate whether correcting the exchange rate system could solve some of the structural rigidities, imbalances in trade and slow growth of the Ghanaian economy.

The fact that Ghana experienced economic crises partly reflects the breakdown of a stable exchange rate system and more importantly reflects imprudent policies adopted by governments in the past, that rendered it less competitive in the world. One after another economies started artificially adjusting exchange rates, aiming to correct the balance in international trade. These arrangements have destabilised the international payment system and led to exchange rate crises. These global phenomena are partly responsible for the Ghanaian crises.

The Ghanaian problem illustrates how a free exchange rate system can destabilise an economy and why it is important to maintain the basic fundamentals right in order to let an economy grow over time.

Evolution of exchange rate system in Ghana

Ghana's policies on the exchange rate have been influenced by the contrasting political regimes that have been in place since independence in 1957. Exchange rate management in Ghana is summarised in Table 1.

From the table, we can see that, from independence in 1957 to 1982, Ghana adopted a fixed exchange rate regime in the management of its exchange rate. During this period, the Ghanaian cedi was pegged to the main convertible currencies, notably the British pound and the American dollar.

With the launching of the economic recovery programme (ERP), the government made a series of devaluations of the cedi between 1983 and 1986. In particular, the cedi was devalued in stages from ¢ 2.75: US$1.00 in 1983 to ¢90.00: US$1.00 by the third quarter of 1986. The new foreign exchange policy was characterised by a scheme of bonuses on exchange receipts and surcharges on exchange payments.

The foreign exchange bureaux system was established in 1988, an attempt to absorb the parallel market into the legal foreign exchange market. These "forex" bureaux are fully licensed entities operated by individuals, groups or institutions. Their operation alongside the auction meant that the foreign exchange market was characterised by two spot foreign exchange rates.

The exchange rate system, as discussed above, has had profound influence on the flows of exports and imports in Ghana. The pattern of trade has changed significantly since the trade reforms were initiated. In particular, the export to GDP ratio was higher (between 32.1 and 49.2%) in 1996 - 2000 than in 1994- 1995 where the export to GDP ratio actually fell from 25.3 to 24.5%. In the later period, however, the import to GDP ratio was higher (between 40.09 and 69.59%) than in 1994-1995 (between 32.56 and 32.93%) (Table A1 in Appendix 2).

The nominal exchange rate is known not to be the only influencing variable on the real exchange rate, and the effect of the nominal exchange rate on the real exchange rate has not been clear. Some classical economists hold the view that nominal exchange rate regimes are neutral, but that view is rejected by the neo-Keynesian group. The latter argue that the increased variability or otherwise of the real exchange rate is caused by a shift from either the fixed or flexible exchange rate regime that is adopted. The computed correlation coefficient between the nominal exchange rate and the real exchange rate in Ghana seems to confirm the neo-Keynesian view (Table A3 in Appendix 2). This result suggests that the variability of the real exchange rate is largely accounted for by the changes in the nominal exchange rate (Musila, 2002).

One of the most important problems identified in developing economies, especially in Africa, is the deficit in the government budget and balance of payments. These countries have sought aid in the form of grants and loans from the IMF, the World Bank and other financial institutions to meet these deficits. As a result, developing countries governments have been put under enormous pressure to abandon inward - oriented, export pessimism, import substitution industrialisation (ISI) development strategies and to stake the future of their people on increasingly 'unprotected' participation in the international market. The free-market adjustment programmes have advocated liberalisation of markets, allowing prices to be set through the free play of market forces, promoting export-oriented growth and ensuring that the exchange rate was set at a competitive level for exports. In most cases, developing countries have devalued their currencies to reduce the deficit in the balance of payments.

Ghana was successful in using the exchange rate as a tool for macroeconomic stability since its independence

Table 1. Exchange rate policy episodes in Ghana (1957-2011).

Episode	Period	Policy
1	1957-1966	Fixed to the British Pound.
2	1966-1982	Fixed to the American Dollar.
3	1983-1986	Multiple exchange rate system.
4	1986-1987	Dual exchange rate system-auction determined, dual retail auction rate
5	1987-1988	Dutch auction system.
6	1988-1989	Foreign exchange bureaux.
7	1990-1992	Wholesale and inter-bank auction system.
8	1992-date	Inter-bank market. The Bank of Ghana (BoG) selling and buying rates were determined by the average daily retail rates of commercial banks.

Source: Bank of Ghana, IMF.

in 1957 until the 1980s. However, since the mid 1980s trade and budget deficits have become larger and persistent (See trade balance in Table A1 and graph of trade balance ($million) and overall budget deficit (GDP%) in Figure A1 in Appendix 2), various exchange rate policies, including policies under the Economic Recovery Programme (ERP) have been pursued for stabilisation. Nonetheless, there is debate whether devaluation really does improve a country's trade balance.

This paper examines whether changes in the real exchange rate, domestic and foreign national income affect the trade balance, in both short and long run. Section two reports recent development issues and gives an overview of trade and exchange rate policies. It is followed by the theoretical justification of the study, in Section three. Section four discusses model specification and estimation methods. Section five presents the data and an econometric analysis of the short and long run impacts of exchange rates on imports and exports. Sections six and seven constitute summary, policy discussion and conclusion, respectively.

Recent development issues and an overview of exchange rate policies

Ghana adopted the fixed exchange rate system in the 1960s, immediately after independence. The Bretton Woods system supported the policy of fixed exchange rates. In particular, the Ghanaian cedi was pegged at two cedis to the British pound. Adjustments were only supposed to occur when there were fundamental balance of payments disequilibria. The choice of a fixed exchange regime in Ghana was, therefore consistent with the thinking of the time. Due to the inheritance of huge foreign exchange reserves from the colonial era, Ghana exercised practically no control over the foreign exchange markets which were in the hands of a few commercial houses and the commercial banks.

Tavlas (2003) offers a review of exchange rate issues particularly the types of exchange rate regimes, and also a critique of Goldstein (2002) and Corden (2002).

There are other analyses and reviews of the real exchange rate, such as those of Perroni and Whalley (1996) and Edwards (1999, 2002) (Real exchange rate is also known as fundamental equilibrium exchange rate or the actual real exchange rate (Mussa et al., 1994)). In particular, Mussa et al. (1994) pointed out that exchange rate misalignment issues figure prominently in the exchange rate regime literature. When fundamentals (including macroeconomic policies) change, the equilibrium real exchange rate changes and, if the nominal exchange rate remains fixed the result is misalignment between the real exchange rate and the new equilibrium rate. It follows that exchange rate misalignment can occur because of misaligned policy and because macroeconomic policies are included in the set of fundamentals.

Various articles have sought to identify effective exchange rate regimes (Rogoff and Obstfeld, 1996) in a world increasingly charac-terised by high capital mobility (See Tavlas and Ulan (2002) for detailed discussion and references). According to Goldstein and Isard (1992), policy advice from official circles (example, IMF and World Bank) proposed that countries could choose among a broad spectrum of exchange rate arrangements and that exchange rate commitments should be tailored to the characteristics and circumstances of individual countries.

Sowa and Acquaye (1998) have pointed out that the massive industrialisation and modernisation programme implemented by the government in early 1960s depleted the country's external reserves and Ghana began to see the signs of foreign exchange constraints. In September 1986, Ghana reformed its exchange rate policy with the support of the IMF and the World Bank under the ERP/SAP. Initially this was a two-tier system which aimed particularly at an official fixed rate to take care of imports and exports of selected goods and a weekly auction rate for the remaining two thirds of Ghana's external transactions. In February 1987, the two systems were unified with all transactions determined at weekly auction(Oduro and Harrigan, 2000).

In spite of the increased flexibility in the exchange rate in the years after the reforms and in recent years, the trade deficit has increased and the balance of payments has continued to show strains (See Table A1 in Appendix 2). Recent trends in the overall balance of payments and its major components are depicted in Table A1. The table also shows the sources of financing, both domestic and foreign. The overall balance was in surplus by US$ 250.8m in 1995 and in a small deficit (US$20.4m) in 1996. In 1998, it registered a surplus again but declined again in 1999. In 2000, a large deficit of US$258.5m was registered yet again. This erratic behaviour of the economy has led to many questions being asked about the wisdom of implementing the ERP/SAP and has fuelled the already intense debate on the rationale of the reforms.

Theoretical justifications of study

The standard analysis of exchange rate changes and the trade balance uses the specification of the domestic demand for imports and the foreign demand for exports derived from a postulated 2 good-2 country utility maximisation framework (Samuelson, 1949; Meade, 1955; Mundell, 1962; Fleming, 1962; Dornbusch, 1976; Miller and Spencer, 1977; Whalley, 1985; Nguyen and Whalley, 1989; Bhagwati and Srinivasan, 1992; Krugman and Miller, 1992; McKinnon, 1993; Taylor, 1995; Harrison et al., 1997; Bhattarai, 2001; Greenaway et al., 2002)). The 2 good- 2 country assumption splits the goods into those that are produced at home and those produced abroad. A simple theoretical model for the determination of the exchange rate is outlined as follows and in Appendix 1.

Real exchange rate model

Labour supply in country 1: $L_1 = L_{11} + L_{12}$

Household preference: $U_1 = X_{11}^{\alpha} X_{12}^{1-\alpha}$

$\alpha \succ 0;$

Production of good 1 by country 1: $X_{11} = a_{11} L_{11}$

Production of good 2 by country 1: $X_{12} = a_{12} L_{12}$

Production Possibility Frontier of country 1:

$$L_1 = \frac{X_{11}}{a_{11}} + \frac{X_{12}}{a_{12}}$$

Labour supply in country 2: $L_2 = L_{21} + L_{22}$

Household's preference in country 2: $U_2 = X_{21}^{\beta} X_{22}^{1-\beta}$

$\beta \succ 0;$

Production of good 1 by country 2: $X_{21} = a_{21} L_{21}$

Production of good 2 by country 2: $X_{22} = a_{22} L_{22}$

Production possibility frontier of country 2:

$$L_2 = \frac{X_{21}}{a_{21}} + \frac{X_{22}}{a_{22}}$$

Where a_{ij} denotes the productivity of labour in country *i* in producing good *j*, α and β are the consumers' preferences in countries 1 and 2 respectively.

When we solve the model taking into consideration the preferences of household and firm technology, trade equilibrium requires the real exchange rate (*RER*) in the general equilibrium setting, to be the price ratios in the two countries; these in turn reflect the ratio of labour productivity (parameters) in the two countries. The solution is given as:

$$MRS_{12}^{1} = MRS_{12}^{2} = \frac{a_{11}}{a_{12}} = \frac{P_{11}}{P_{12}} = \frac{P_{21}}{P_{22}} = \frac{a_{21}}{a_{22}} = MRT_{12}^{1} = MRT_{12}^{2} \quad ;$$

$$\frac{a_{12}}{a_{11}} P_{11} = P_{12} = P_{22} = \frac{a_{21}}{a_{22}} P_{21}.$$

Therefore, the real exchange rate will depend on relative productivity of labour in the model,

$$\frac{P_{22}}{P_{11}} = \frac{a_{12}}{a_{11}} \frac{a_{22}}{a_{21}}$$

The framework is based on the assumption that the consumer chooses a bundle of goods that maximises utility subject to a budget constraint. In the 2 good-2 country model, the sum of imported bundles over consumers in the foreign country yields aggregate demand for exports of the domestic country while the sum of imported over consumers in the domestic country yields aggregate import demand.

The present work is based on a 2 good-2 country utility maximisation framework which has a major advantage of accommodating general functional form or demand consistent with utility maximisation. The only condition imposed by utility maximisation in this model is that the compensated own price effect (elasticities with respect to the exchange rate) should be negative.

Details of the analytical solution are given in Appendix 1. For subsequent econometric analysis Ghana is assumed to be a small price taking economy in the global context.

Model specification and estimation methods

The functional forms of the exports and import models used in this paper are standard in the empirical trade literature and are used in Haque et al. (1990) (HKM hereafter) and Musila (2002) (Empirical applications of this specification are widely discussed in Goldstein and

Khan (1985)). Unit root, cointegration and stability tests following Dickey-Fuller (1976), Johansen (1995), Philips and Perron (1983) and Johansen (1988) are carried out using PcGive. A logarithmic functional form is adopted because it allows imports and exports to react proportionately to changes in their arguments. In addition, Khan (1974) pointed out that this specification avoids the problem of drastic falls in elasticities. HKM (1990) argue that to capture partial adjustment behaviour, a lagged term in both dependent variables should be included in the estimated equations. Hence, there is the inclusion of lags on exports and imports, respectively, in the model; which assumes a small open economy similar to the Ghanaian economy.

The export and import demand equations are,

$$\ln(x)_t = \delta_0 + \delta_1 \ln(re)_t + \delta_2 \ln(y)_t^* + \delta_3 \ln(x)_{t-1} + \varsigma_t \quad (1)$$

$$\ln(z)_t = \gamma_0 + \gamma_1 \ln(re)_t + \gamma_2 \ln(y)_t + \gamma_3 \ln(z)_{t-1} + \mu_t \quad (2)$$

Where,
x = real exports of goods and services;
z = real imports of goods and services;
re = $\frac{eP^*}{P}$ = real exchange rate;
y = income proxied by the real GDP of Ghana;
y^*= trading partners' income proxied by the real GDP (The author chose United States, Germany, United Kingdom and Japan for the developed countries because they constitute a greater share of Ghana's trade) of four major industrial countries.

ln (.) denotes natural logarithm operator;
P^* denotes foreign price approximated by a trade weighted GDP deflator;
P denotes domestic price approximated by the GDP deflator;
and e denotes the nominal exchange rate:
δ_0, γ_0 are constant / intercept terms;
δ_1, γ_1 are the price elasticities of exports and imports respectively; and
δ_2, γ_2 are the income elasticities of exports and imports respectively,

Where,
ς, μ denotes disturbance terms and;
t is the time subscript.

Equations (1) and (2) are estimated and used to evaluate the effect of changes in the exchange rate on the trade balance.

Estimation techniques

To be meaningful a regression model should reflect the relationship among stationary variables, with constant mean and variance. If the data are non stationary, logs or differences need to be taken to make them stationary. Engle and Granger (1987) have shown that regression among non-stationary variables can be valid only when these variables are cointegrated. They also showed that an error- correction mechanism (ECM) exists for each cointegrated model. By the nature of time series data, it is important to check first for non- stationarity and thus, ascertain whether the variables have unit roots. This is necessary to avoid spurious correlation and misleading and incorrect regression results that might otherwise arise despite the absence of any correlation between the underlying series.

If a series must be differenced d times before it becomes a stationary non-deterministic AR/ARMA representation, then it contains d unit roots and is said to be integrated of order d, denoted by I(d). In general, using this definition, any linear combination of the two series will also be I(d). However, Engle and Granger (1987) argue that if there exists a vector β such that the disturbance term from the regression ($u_t = y_t - \beta x_t$) is of a lower order of integration *I*(d-b), where b is positive, then x_t and y_t are cointegrated of order *CI*(d, b). Thus, if the two series x_t and y_t are both I(1) and u_t ~I(0), then the two series would be cointegrated of order CI(1, 1). The co-integration of y_t and x_t also implies the existence of a restriction on the standard vector autoregressive (VAR) model and therefore, the estimates obtained from the VAR can be misleading (Engle and Granger, 1987). They further argue that when y_t and x_t are cointegrated, the relationship between them can be expressed as an error-correction model (ECM) and estimated correctly. With this context, a more appropriate simple dynamic representation of the ECM is of the form:

$$A(L)\Delta y_t = \mu + B(L)\Delta x_t - (1-\pi)\left[y_{t-p} - \hat{\beta}_0 - \hat{\beta}_1 x_{t-p}\right] + \omega_t \quad (3)$$

where A (L) is the polynomial lag operator $1 - \alpha_1 L - \alpha_2 L^2 - ... - \alpha_p L^p$; B(L) is the lag polynomial operator $\gamma_0 + \gamma_1 L + \gamma_2 L^2 + ... + \gamma_p L^p$; $\pi = \alpha_1 + \alpha_2 + ... + \alpha_p$; Δ is the first difference operator; $\hat{\beta}$ is a vector in the co-integrating equation; $\mu, \alpha,$ and γ are coefficients; ω is the error term and $(1-\pi)$ term provides information on the speed of adjustment of the level variables. This is the preferred representation for estimation since it incorporates both short and long run effects (Harris and Sollis 2003) have pointed out that using the dynamic modelling procedure results in a more powerful test for co-integration as well as giving generally unbiased estimates of the long run relationship and the standard t

Table 2. Unit root test of variables (level and first differenced): annual data (1970 -2000).

Variable	Lags	DF/ADF	Order of integration
lnx	2	-0.533	I(1)
∆lnx	1	-3.420*	I(0)
lnz	2	-0.4706	I(1)
∆lnz	1	-3.663*	I(0)
lnre	1	-1.289	I(1)
∆lnre	1	-3.868**	I(0)
lnrei	1	-1.289	I(1)
∆lnrei	1	-3.868**	I(0)
lny	2	-0.3890	I(1)
∆lny	1	-3.101*	I(0)
lny*	1	-1.628	I(1)
∆lny*	1	-5.978**	I(0)

Notes: DF/ADF - Dickey Fuller/Augmented Dickey Fuller; **Significant at 1%; *Significant at 5%. y* is the real GDP of Ghana's major trading partners in industrial countries.

statistics for conducting statistical hypothesis testing. He attributes it to the dynamic model not pushing the short run dynamics into the residual term of the estimated OLS regression. Indeed, in the estimation of the UK money demand, the DF test for interest rate R was based on the significant lagged and found to be important for the test of unit root. Similar results were obtained when lag length was set by the l_{12} formula).

We start by checking the order of integration of the variables. This is reported in Table 2. The Augmented Dickey-Fuller test is used for this purpose, with sufficient lags to whiten the residuals. The results indicate a unit root in the original series but stationarity in the first difference in all of the series. Thus, the level variables are integrated to order one represented as I(1) (Table 2).

The lag length (the value of p) was set by the maximum R^2 approach. This approach uses the model selection procedure that tests to see if an additional lag is significant, that is, if it increases the value of R^2. Harris (1995) argues that this procedure of selecting a lag length is consistent with the formula reported in Schwert (1989), that is, $l_{12} = \text{int}\left\{12(T/100)^{1/4}\right\}$ and the Philips-Perron (PP) tests.

Data and econometric analysis

The data used in this study were obtained from the World Bank CD-ROM (2000), IFS Yearbook (2001) and IMF Direction of Trade Statistics (DOTS). All the variables are real and in logs. The frequency of the data used is annually and runs from 1970 to 2000. The variables used as fundamentals were determined by three basic considerations, namely the availability of data, theory and the fact that the variable would fit well in the model in statistical terms.

Table 3. Export and import functions: Cointegration estimates for Ghana (Annual Data, 1970-2000).

Cointegrating equation: ECT			
Exports (x)		**Imports (z)**	
ln(x)	1.000	ln(z)	1.000
ln(re)	0.717(2.67)**	ln(re)	0.468(1.75)***
ln(y*)	-0.544(-0.98)	ln(y)	0.106(1.57)
D91	0.829(2.10)*	D91	0.698(1.97)***
Constant	34.83	Constant	20.64

Wald Test(χ^2) 12.7199(0.0053)**; Wald Test(χ^2) 9.9415(0.0191)*. Figures in parenthesis are t-values. ** denotes 1% level of significance;* denotes 5% level of significance and *** denotes 10% level of significance.

In most theoretical studies, the real exchange rate is defined as the ratio of the prices of tradable to non-tradable goods. The real exchange rate was constructed as $re = \frac{eP^*}{P}$, where e is the official (nominal) exchange rate, P* is proxied by the trading partners' trade weighted GDP deflator, and P is Ghana's GDP deflator. The definitions of exports and imports of goods and services are based on the national accounts and the definition as contained in the IMF Direction of Trade Statistics (DOTS) and the World Bank CD-ROM (2002).

As has been established already, the variables are integrated of order I(1) at the 5 and 1% significant levels. A dummy variable D91 was used to account for the effect of reforms, notably in exchange rates and trade (Exchange rate and trade reforms included the gradual abolition of the controlled rate regime to a somewhat managed rate regime and the abolition of extra tariffs on importable).

A cointegration analysis using the Engle and Johansen (1995) procedure to determine the long run relationship between the variables was conducted. Having confirmed the variables were cointegrated, we then applied the error correction model to estimate equations (1) and (2) as set out in section 4. We used PcGive version 10.3 econometric software package for the estimation.

Estimation results

The results of the cointegrated and the error correction model (ECM) tests are presented in Tables 3 and 4. Table 3 shows the long run cointegrating estimates.

It is clear from Table 3 that the null hypothesis of long run cointegrating vectors (a stable relationship among the endogenous variables) is accepted at 1 and 10% significant levels. In particular, the long run export and import demand functions can be written as:

$$\ln x = 0.717 \ln re - 0.544 \ln y^* + 0.829 D91 + 34.83$$
$$\ln z = 0.468 \ln re + 0.106 \ln y + 0.698 D91 + 20.64$$

Table 4. Short- run estimates: error correction model (ECM) (Annual Data 1970-2000).

Error correction model :ECT			
Dependent variable =∆ln(x)		**Dependent variable=∆ln(z)**	
$\Delta ln(re)_{-2}$	0.161(2.37) *	$\Delta lnre_{-2}$	0.192(2.87)**
$\Delta ln(y^*)_{-2}$	- 0.019(-0.118)	$\Delta ln(y)_{-2}$	0.007(0.04)
$\Delta ln(x)_{-2}$	-0.171(-1.09)	$\Delta ln(z)_{-2}$	-0.254(-1.51)
ECT	-0.846(-4.16)**	ECT	-0.003(0.013)
D91	0.151(2.64) *	D91	0.139(2.13)*

Notes: Figures in parenthesis are t-values; ** denotes 1% level of significance;* denotes 5% level of significance.

The estimated long run elasticities of prices of export and imports have the expected signs and are significant at the 1 and 10% levels respectively. For both equations (The estimates passed the entire diagnostic test but these are not reported here), the Wald tests decisively reject the null that the long run coefficients are zero.

This relationship indicates that a 10% devaluation in the real exchange rate increases the value of exports by only 7.2% and raises the value of imports by 4.68%. The positive elasticity of imports reflects the inelastic nature of Ghanaian imports. This is a clear manifestation of the fact that the price elasticities (greater than 1) meet the Marshall-Lerner-Robinson (MLR), the condition for a successful devaluation in the long run. The devaluation has impact on a trade balance in the longer term. Although the trade balance may improve because of the long run stable relationship among the variables, such improvement is likely to be small.

The long run relationships for income in both equations have the expected signs. However, their coefficients are not statistically significant at conventional levels. The relationship indicates that a 10% increase in the real income of the major trading partners of Ghana (industrial countries), that is foreign income would reduce the value of Ghana's exports by about 5.44 percentage points while a 10% increase in the real income of Ghana also increases the value of its imports by just 1% (0.106) in the long run. The inclusion of the dummy (D91) to reflect the impact of the reforms is effective. In particular, the coefficients have the expected signs and are significant at conventional levels (Table 3). This result shows the effect of the structural changes that have taken place in the Ghanaian economy as a result of the reforms. In a nutshell, the real exchange rate rather than real incomes are important in the determination of the export and import demand for Ghana in the long-run. It is also clear that the very high magnitude of the elasticities with respect to the exchange rate suggests that exchange rate policies have been effective but they alone would not improve the trade balance unless pursued with other policies, notably appropriate aggregate- demand policies.

The unit root tests indicate that the short- run dynamic model must be specified in the differences of the relevant variables. The results of the estimated short- run export and import demand functions are presented in Table 4.

Diagnostics

Exports

R^2 =0.582; FPE =0.0194033; SE =0.126409; F (5, 22) =6.131[0.001];
F_{ar} (2, 20) =0.34181 [0.7146]; F_{arch} (1, 20) =0.058094 [0.8120];
F_{het} (9, 12) =1.2585 [0.3477]; RESET F (1, 21) =11.584 [0.0027]; Normality (2) =3.0523 [0.2174].

Imports

R^2 =0.381; FPE =0.0253010; SE = 0.143878; F (5, 22) =2.585[0.057];
F_{ar} (2, 20) =1.7212[0.2056]; F_{arch} (1, 20) =0.088495[0.7693];
F_{het} (9, 12) = 0.22581[0.9832]; RESET F (1, 21) = 0.51991[0.4792]; Normality (2) = 7.5872[0.0225].

Diagnostic analyses reported for both the export and import functions are significant at 95 percent critical value (except the F-test that all the slope coefficients are zero), and therefore, there is nothing to suggest that the model is mis-specified.

A diagnostic check for structural breaks in the model is evidenced in the parameter non-constancy of estimates. The sequential one-step ahead Chow test and one-step ahead residuals tests were conducted. Plots of these residuals and Chow tests for both export and import equations are presented in Figures A2 and A3 respectively, for the estimated short-run ECM. The plots of the one-step ahead residual for export and import equations show that there are no problems in the observations. In addition, the Chow tests imply parameter stability for the period of study.

The results presented in Table 4 show that the elasticity of exports with respect to the real exchange rate has the expected positive sign and is statistically significant at the 5% level. The price elasticity of imports with respect to the real exchange rate also has the expected sign, but is statistically significant at the 1% level.

However, the sum of the absolute values of the two elasticities is less than unity (0.353). This suggests that the MLR condition for successful devaluation is not met in the short run (Musila (2002) found similar results for Malawi). Therefore, any nominal devaluation of the exchange rate would not improve the trade balance in the short to medium term. This situation may be attributed to the relatively low elasticity value of the export demand function which is explained by the fact that Ghana's exports are mainly basic agricultural products which

command low prices in the world market. This clearly implies that Ghana need to diversify its economy away from agriculture towards the manufacturing or services sectors.

The estimated coefficients of the error correction term (ECT) in each of the two equations have the expected signs. However, the coefficient of the ECT for exports is significant at the 1% level whilst that for imports is insignificant at conventional levels. Thus, if in the long run the value of exports increased by 1%, over its equilibrium path, then its growth has to fall by about 0.846% in the short run to force exports back to its long run growth path. Similarly, the results of the import demand equation suggests that an increase of 1% in imports over its long run equilibrium growth path would require an adjustment (fall) of about 0.003% to bring imports back to their long run growth path. The greater volatility of exports compared to that of imports again reflects the structure of the Ghanaian economy.

The results indicate that foreign income, though negatively related to Ghanaian exports, is not significantly different from zero and therefore not an important determinant of export demands in the short run. The results further show that domestic income is also not an important determinant of import demand. It has the expected sign but is significantly not different from zero. One possible explanation might be that both exports and imports are inelastic relative to domestic and foreign income. These low income elasticities indicate that Ghanaian exports are inferior commodities in the global market. The growth of income in the rest of the world does not transmit to Ghana. Ghana's exports consist mostly of basic agricultural produce that is not processed and it is therefore subject to the dictates of its trading partners in the international market. Another possible explanation is that Ghana's imports might not depend on its past income and therefore does not do more to strengthen its exports with its trading partners. Again, the result shows that the real exchange rate in the short run does affect the export and import demand. This might be explained by the rapid fluctuations in the nominal exchange rate (devaluations) that have occurred with its concomitant increases in price levels.

As has been stated earlier, the dummy variable D91 is included to capture the impact of the economic reforms (exchange rate and trade policy reforms) through the implementation of the ERP/SAP. As expected, the overall impact of the reform was positive for exports, reflecting the significant structural change in the demand for exports. The implementation of the reforms also impacted positively on imports with a significant structural shift occurring in import demand as well (refer to coefficient of D91 in Table 4). Increased exports were accompanied by increased imports. Accordingly, the reforms embarked on by the government (trade and exchange rate) since 1983 did open up the economy in terms of trade (Tables A2 and A4). However, the reforms did not improve the trade balance in the short run as expected (Figure A1).

Impulse response analysis of Ghanaian trade: co-integrated VAR analysis

Due to the likelihood of simultaneity bias in the use of the single equation procedure, we employed the multiple estimation method to correct it. In employing the Johansen (1988) procedure, to determine the number of cointegrating vectors, we first estimated the unrestricted VAR with sufficient lags to whiten the residuals. We started with a lag length of three and were pared down after checking the significant levels of the coefficients. The F-test for reducing the number of lags from three to two is accepted.

We also checked the properties of the residual in the preferred VAR model. The diagnostic tests are presented in Table 5a. The table reports individual tests for export and imports and also the system wide test. The test results show that they are all insignificant at the 5% level.

Cointegrated Results

The null hypothesis of no cointegration is rejected in favour of the alternative that there are at most two cointegrating vectors at the 1 and 5% levels of significance. This is evident by the λ_{trace} and $\lambda_{\max}$ statistics, respectively. In addition, when adjusted for the degrees of freedom, the two test statistics reject the null also at 1 and 5% significant levels (Table 5b). Therefore, we proceeded with the assumption of two cointegrating vectors. This conclusion is supported by the plot of the first two vectors in the cointegration space. The two cointegrating vectors look fairly stationary, with fitted and actual series tracking each other reasonably closely (Figure A5 in Appendix).

The Johansen method for the error correction mechanism, in the case of multiple equation models, is represented by $\Pi = \alpha\beta'$, where β is the long run relationship among the variables and α denotes the adjustment toward the long-run relationships. The estimated cointegration vectors for a 3 x 3 VAR are given in Table 6.

The long run general joint restriction that the lags of the explanatory variables are the same and the hypothesis that there is no trend in the original series are strongly rejected. The static long run relationship for export and import demand functions respectively, as presented in Table 7 can be written as:

$$\ln x = 1.9875 \ln y^* + 0.0330 D91 + 0.58630 Trend + 70.31$$

$$\ln z = 2.0271 \ln y - 0.1201 D91 + 0.52139 Trend + 46.03$$

$$\ln re = 0.0347 \ln y + 3.6748 \ln y^* + 0.33908 D91 + 0.10914 Trend + 87.72$$

Table 5a. Diagnostic tests.

Variable	Equation	Test	Test distribution and statistics
lnx	VAR	Portmanteau (4)	4.3599
		Serial Correlation	F(2,14) 2.6820(0.1033)
		Normality	X^2(2) 7.8310(0.0199)
		Arch 1-1 Test	F(1,14) 0.0508(0.8249)
lnz	VAR	Portmanteau (4)	3.2508
		Serial Correlation	F(2,14) 0.6198(0.5522)
		Normality	X^2(2) 1.1586(0.5603)
		Arch 1-1 Test	F(1,14) 0.0109(0.9181)
lnre	VAR	Portmanteau (4)	3.99028
		Serial Correlation	F(2,14) 3.2124(0.0664)
		Normality	X^2(2) 1.4263(0.4901)
		Arch 1-1 Test	F(1,14) 0.3809(0.5470)
System-wide tests		Portmanteau (4)	33.8133
		Serial Correlation	F(18,23) 1.4928(0.181)
		Normality	X^2(4) 10.755(0.0963)

Table 5b. Cointegration results.

	H₀:rank=P	λ_i	λ_{trace}	***Adj. for df***	$\lambda_{\max}$	***Adj. for df***
System tes*t*	P=0	-	90.06[0.000]**	71.42[0.000]**	43.83[0.001]**	34.76[0.000]**
	P<=1	0.77937	46.23[0.000]**	36.67[0.001]**	29.35[0.001]**	23.28[0.010]**
	P<=2	0.63653	16.88[0.007]**	13.39[0.034]*	16.88[0.007]*	13.39[0.034]*

Notes: **Significant at 1 percent level;* denotes 5% level of significance; λ_i column reports the eigenvalues.

Table 6. Normalised (to diagonal) cointegrating vectors.

lnx	1.0000	-0.84632	-0.80383
lnz	-1.6080	1.0000	-0.36484
ln(re)	-0.075171	-0.36554	1.0000
$ln(y)_{-1}$	0.84993	0.93255	1.3207
$ln(y)_{-2}$	-0.0091221	-0.89787	1.3309
$L(y^*)_{-1}$	0.026187	1.3107	-0.66011
$L(y^*)_{-2}$	0.29997	0.44759	-0.95487
D91	-0.20073	0.27205	-0.35635
Trend	0.24387	-0.065084	0.77065

Impulse response functions are presented in Figure A6 in Appendix 2. A shock to the export function largely reflects similar hump- shaped response in both the exports and imports. Although exports fall immediately, imports first rise by 75% and fall gradually. The real exchange rate falls sharply and then begins to rise (hump-shaped as well). Evidently, little similar dynamics can be observed between the response in the export and import functions as a result of a shock to the system.

Indeed, an unanticipated increase in the real exchange rate shows export and imports behaved similarly (increase) while the real exchange rate decreases.

SUMMARY AND POLICY ISSUES

This paper sets out to examine the effects of the exchange rate on the trade balance of Ghana. Cointegrating and error correction modelling technique have been used to estimate the demand equations for exports and for imports. The data used are annual observations obtained from the Direction of Trade Statistics (DOTS) and the World Bank CD-ROM World Development Indicators (2002). The study explored whether the devaluation of the country's currency (cedi) would improve the trade balance. The results indicate that the price elasticities of the export demand and import demand equations in the long run are consistent with the theoretical predictions of utility maximisation based model which this study adopts. However, the elasticities of exports and imports relative to the real exchange rate in the short-run are very small suggesting supply and

Table 7. Long-run cointegrating equations in VAR (exports, imports and real exchange rate).

	Export (x)	Imports(z)	Real exchange rate(re)
lny	-	2.0271(1.8014)	0.03476(1.1586)
lny*	1.9875(1.8014)	-	3.6748(1.4035)
D91	0.0330(0.72117)	-0.1201(0.45896)	0.33908(0.56188)
Trend	0.58630(0.39232)	0.52139(0.24968)	-.10914(0.30567)
Constant	70.31	46.03	87.72

Notes: Figures in parenthesis are the standard errors.

demand side rigidities in export and import demand flows of Ghana. In the short run estimated export and import elasticities with respect to the real exchange rate do not satisfy the Marshall-Lerner-Robinson (MLR) condition for a successful devaluation. Therefore, any nominal devaluation of the cedi is bound to weaken the trade balance at least in the short to medium term. In the long run, the results show that a stable linear relationship exists among the exports, imports, and trade balance, domestic and foreign income. Ghana has no choice other than to adhere to the fundamentals of foreign exchange rate market to solve its perennial problems of deficit, by applying prudent fiscal and monetary policies and exchange rate policies based on purchasing power parity. These policy rules will also improve the confidence of consumers and investors in the economy and improve Ghana's competitiveness in the global market.

Conclusion

The results from this study show that the trade balance of Ghana will not improve in the short run unless it adopts policy rules in the foreign exchange market but it may be costly if such adjustment were to occur unaided in the long run. The standard theoretical propositions in the trade and exchange rate literature for a small open economy, such as Ghana, are tested using results from time series based single equation, VAR-cointegration models. The results obtained are very similar to the findings of earlier studies on contractionary devaluation as reported in Khan (1974), Musila (2002), the IMF and the World Bank. However, the estimates for Ghana also show that even in the long run, the MLR condition for a successful devaluation is barely met and therefore, in Ghana's case the gains would not be enough to offset the losses in the trade balance in the short run.

The results also show that in the short to medium term as well as in the long term, income levels are not important determinants either of the import demand or the export demand of Ghana. Imports are inelastic and the exports, being predominantly of primary commodities are an inferior commodity in the global market. The results show that it is the exchange rate that is the significant factor in the short term. In the long-run however, the study reveals that only the real exchange rate significantly affects the trade balance.

In short, the econometric model shows that the policies that have been adopted by Ghana have not been effective when evaluated in terms of the MLR conditions for a successful devaluation. Furthermore, the model and the associated results indicate that more effective policies may be founded on a sharper appreciation of the interaction and the interrelationships between the policy instruments (exchange rate and aggregate demand management) which have been considered here**.** Changes to exchange rates is in fact a part of the demand management policy; in theory external demand in Ghana could be increased by devaluation of the Ghanaian Cedi as it raises exports and checks increase in imports. However, such measure may increase the cost of living of Ghanaians and may have detrimental consequences on their welfare because of associated shrinkage in the value of Cedi in the international market. Thus manipulating exchange rates as a part of demand management policy can be unsafe and may generate unwanted outcome. On the other hand, expansionary fiscal and monetary policies may lead to achieving the objectives of exchange rate managements if used appropriately. Fiscal expansion with lower taxes, higher spending and deficit would increase demand for consumption and investment as well as for imports. Exports may increase if the increase public spending is targeted to the export oriented sectors. Expansionary monetary policy by lowering the interest rate results in increase in investment and durable consumption and may cause an expansion of export sectors. Thus, demand management policies could be considered complementary to trade rebalancing policies when exchange rate is determined to be the fundamentals of the market.

It would be interesting to see how far these low elasticities relate to the preferences of households, the technology of firms, and the policy instruments under consideration by the government, taking account of the structural realities of the Ghanaian economy, in order to establish an incentive structure for Ghana that is conducive to macroeconomic stability and a higher rate of

growth. These issues will be taken up in subsequent work.

REFERENCES

Armington PS (1969). A Theory of Demand for Products Distinguished by Place of Production, IMF Staff Papers 16:159-76.

Bhagwati JN, Srinivasan TN (1992). Lectures on International Trade, MIT Press.

Bhattarai K (2001). Welfare Gains to UK from a Global Free Trade, the European Research Studies 4(3-4).

Buiter WH, Miller M (1992). Exchange rate economics. Int. Lib. Crit. Writ. Econ. 1: 233-265.

Corden WM (2002). Too Sensational: On the choice of Exchange Rate Regimes Cambridge, MA: MIT Press.

Doornik JA, Hendry DF (2001). Give Win: An Interface to Empirical Modelling, Version 2, Timberlake Consultants Ltd. London.

Dornbusch R (1976). Expectations and Exchange Rate Dynamics, J. Polit. Econ. 84(6).

Edwards S (1999). How Effective are Capital Control? J. Econ. Perspect. 13:65-84.

Edwards S (2002). Capital Mobility, Capital Controls, and Globalisation in the Twenty First Century, Ann. Am. Acad. Pol. Soc Sci. 579:261-70.

Engle RF, Granger CWJ (1987). Cointegration and error correction: Representation, estimation and testing, Econometrica 55:251-76.

Fleming JM (1962). Domestic financial policies under fixed and under floating exchange rates, IMF staff paper 9, November pp.369-379.

Goldstein M, Isard P (1992). Mechanisms For Promoting Global Monetary Stability In: Goldstein M, Isard P, Mason P and Taylor M (eds), Policy Issues in the Evolving International Monetary System, IMF Occasional Paper, 26(Washington, D.C: International Monetary Fund).

Goldstein M, Khan MS (1985). Income and Price Effects in Foreign Trade, in Handbook of International Economics, Vol. 2, ed. by Roland WJ and Kenen PB. Amsterdam: North-Holland.

Greenaway D, Morgan W, Wright P (2002). Trade Liberalisation and Growth in Developing Countries, J. Dev. Econ. 67:229-244.

Haque NU, Karjal L, Montiel P (1990). Estimation of Rational Expectations Macroeconomic Model for Developing Counties with Capital Controls (Unpublished; Washington: International Monetary Fund).

Harris R (1995). Using Cointegration Analysis in Econometric Modelling, Prentice Hall, Harlow.

Harris R, Sollis R (2003). Applied Time Series Modelling and Forecasting, John Wiley & Sons Ltd, West Sussex.

Harrison GW, Rutherford TF, Tarr DG (1997). Quantifying the Uruaguy Round, Econ. J. 107(444):1405-1430.

Hendry DF, Doornik JA (2001). Empirical Econometric Modelling Using PcGive, Volumes I and II, Timberlake Consultants Ltd. London.

IMF, Direction of Trade Statistics Reports, Various issues, Washington D.C

IMF, International Financial statistics Yearbook, various issues, Washington D.C.

Johansen S (1988). Statistical analysis of cointegration and Statistics vectors, J. Econ. Dyn. Control 12:231-254

Johansen S (1995). A Statistical analysis of I(2) variables, Econom. Theory 11:25-59.

Johnson HG (1953-54). Optimal tariffs and Retaliation, Rev. Econ. Stud. 21(2):142-43.

Khan MS (1974). Imports and Export Demands in Developing Countries, Staff Papers, International Monetary Fund (Washington) 21:678-93.

Krugman P (1979). A Model of Balance of Payment Crisis, J. Money Credit Banking 11(3):311-325.

Krugman P, Miller M (1992). Exchange Rate targets and Currency Bands, Econ. J. 102(415):1548-1550.

McKinnon RI (1993). The order of Economic Liberalization: Financial Control in the Transition to a Market Economy, JHUP, Baltimore.

Meade JE (1955). Problems of Economic Union, Am. Econ. Rev. 45(4):700-704.

Miller MH, Spencer JE (1977). The Static Economic Effects of the UK Joining the EEC: A G eneral Equilibrium Approach, Rev. Econ. Stud. 44(1):71-93.

Mundell RA (1962). Capital mobility and stabilisation policy under fixed and flexible exchange rates, Can. J. Econ. Polit. Sci. 29:475-85.

Musila JW (2002). Exchange Rate Changes and Trade Balance in Malawi, Can. J. Dev. Stud. 23(1):87-103.

Mussa M, Goldstein M, Clark PB, Mathieson D, Bayoumi T (1994). Improving the International Monetary System: Constraints and Possibilities, International Monetary Fund Occasional Paper, 116. (Washington DC: International Monetary Fund).

Nguyen TT, Whalley J (1989). General Equilibrium Analysis of Black and White Markets: A Computational Approach, J. Public Econ. 40:331-347.

Oduro AD, Harrigan J (2000). Exchange Rate Policy and the Balance of Payments 1972-96 In: Aryeetey E, Harrigan J and Nissanke M (ed.), Economic Reforms in Ghana: The Miracle and the Mirage, James Currey Ltd., Oxford.

Perroni C, Whalley J (1996). How Severe is Global Retaliation Risk under Increasing Regionalism, AER Papers and Proceedings. 86(2).

Phillips PCB, Perron P (1988). “Testing for a Unit Root in Time Series Regression,” Biome. 75: 335–346.

Rogoff K, Obstfeld M (1996). Foundation of International Macroeconomics, MIT Press.

Samuelson PA (1949): International factor price equalisation, Econ. J. pp.181-197.

Schwert GW (1989) Tests for unit roots: A Monte Carlo investigation, J. Bus. Econ. Stat. 7:147-159.

Singer HW (1950). The distribution of trade between investing and borrowing countries, Am. Econ. Rev. 40:472-485.

Sowa NK, Acquaye IK (1998). Financial and Foreign Exchange Liberalisation in Ghana, Centre for Policy Analysis Research Papers. No.10 Accra: CEPA.

Tavlas GS, Ulan M (eds) (2002). Exchange Rate Regimes and Capital Flows, Special Issue of The Annals of American Academy of Political and Social Science, 579. Philadelphia.

Tavlas S (2003). The Economics of Exchange Rate Regimes: A Review Essay, Blackwell Publishing Ltd, Oxford.

Taylor M (1995). The Economics of Exchange Rates, Journal of Economic Literature, March, vol 33, No. 1, pp. 13-47.

Whalley J (1985). Trade Liberalization Among Major World Trading Areas, MIT Press, Cambridge.

World Bank CD-ROM (2002). World Development Indicators, Washington D.C.

APPENDIX 1. Determination of real exchange rate as a function of preferences, technology and endowments between two countries.

Country 1 (Ghana)	**Country 2 (Rest of the World)**
By optimising using the Lagrangian procedure, we have:	Again, using the Lagrangian procedure, we have:
$\angle_1 = X_{11}^{\alpha} X_{12}^{1-\alpha} + \lambda\left[L_1 - \frac{X_{11}}{a_{11}} - \frac{X_{12}}{a_{12}}\right]$	$\angle_2 = X_{21}^{\beta} X_{22}^{1-\beta} + \lambda\left[L_2 - \frac{X_{21}}{a_{21}} - \frac{X_{22}}{a_{22}}\right]$
$\frac{\partial \angle_1}{\partial X_{11}} = \alpha X_{11}^{\alpha-1} X_{12}^{1-\alpha} - \frac{\lambda}{a_{11}} = 0$ (1a)	$\frac{\partial \angle_2}{\partial X_{21}} = \beta X_{21}^{\beta-1} X_{22}^{1-\beta} - \frac{\lambda}{a_{21}} = 0$ (2a)
$\frac{\partial \angle_1}{\partial X_{12}} = (1-\alpha) X_{11}^{\alpha} X_{12}^{-\alpha} - \frac{\lambda}{a_{12}} = 0$ (1b)	$\frac{\partial \angle_2}{\partial X_{22}} = (1-\beta) X_{21}^{\beta} X_{22}^{-\beta} - \frac{\lambda}{a_{22}} = 0$ (2b)
(1a)/(1b)	(2a)/(2b)
$MRS_{12}^1 = \left(\frac{\alpha}{1-\alpha}\right)\frac{X_{12}}{X_{11}} = MRT_{12}^1 = \frac{a_{12}}{a_{11}} = \frac{P_{12}}{P_{11}}$	$MRS_{12}^2 = \left(\frac{\beta}{1-\beta}\right)\frac{X_{22}}{X_{21}} = \frac{a_{22}}{a_{21}} = MRT_{12}^2 = \frac{P_{21}}{P_{22}}$
$X_{12} = \left(\frac{1-\alpha}{\alpha}\right)\frac{a_{12}}{a_{11}} X_{11}$ (1c)	$X_{22} = \left(\frac{1-\beta}{\beta}\right)\frac{a_{22}}{a_{21}} X_{21}$ (2c)
but,	but,
$L_1 = \frac{X_{11}}{a_{11}} + \left(\frac{1-\alpha}{\alpha}\right)\frac{a_{12}}{a_{11}a_{12}} X_{11}$	$L_2 = \frac{X_{21}}{a_{21}} + \frac{X_{22}}{a_{22}}$
By substitution, we have	By substitution, we have
$= X_{11}\left(\frac{1}{a_{11}} + \frac{(1-\alpha)}{\alpha}\frac{1}{a_{11}}\right) = \mathrm{X}_{11}\left(\frac{1}{\alpha \mathrm{a}_{11}}\right)$	$= X_{21}\left(\frac{1}{a_{21}} + \frac{(1-\beta)}{\beta}\frac{1}{a_{21}}\right) = X_{21}\left(\frac{1}{\beta a_{21}}\right)$
$X_{11} = \alpha a_{11} L_1$ (1d)	$X_{21} = \beta a_{21} L_2$ (2d)
Substituting (1d) into (1c), results	Substituting (2d) into (2c), results
$X_{12} = \left(\frac{1-\alpha}{\alpha}\right)\frac{a_{12}}{a_{11}} \alpha a_{11} L_1$	$X_{22} = \left(\frac{1-\beta}{\beta}\right)\frac{a_{22}}{a_{21}} \beta a_{21} L_2$
$X_{12} = (1-\alpha) a_{12} L_1$	$X_{22} = (1-\beta) a_{22} L_2$
$\frac{X_{12}}{X_{11}} = \frac{(1-\alpha)}{\alpha}\frac{P_{12}}{P_{11}}$	$\frac{X_{21}}{X_{22}} = \frac{\beta}{(1-\beta)}\frac{P_{21}}{P_{22}}$
$MRS_{12}^1 = \frac{P_{12}}{P_{11}} = \frac{a_{12}}{a_{11}}$	$MRS_{21}^2 = \frac{P_{21}}{P_{22}} = \frac{a_{21}}{a_{22}}$

Global market clearing:

$X_{11} + X_{21} = X_1,\ P_{11} = P_{21}$ $\quad MRS_{12}^1 = MRS_{12}^2 = \frac{a_{11}}{a_{12}} = \frac{P_{11}}{P_{12}} = \frac{P_{21}}{P_{22}} = \frac{a_{21}}{a_{22}} = MRT_{12}^1 = MRT_{12}^2;$

$X_{12} + X_{22} = X_2, P_{12} = P_{22}$ $\quad \frac{a_{12}}{a_{11}} P_{11} = P_{12} = P_{22} = \frac{a_{21}}{a_{22}} P_{21}$ ➔ $\frac{P_{11}}{P_{22}} = \frac{a_{11}}{a_{12}}\frac{a_{21}}{a_{22}}$

APPENDIX 2

Table A1. Balance of payments of Ghana, 1994-2000 (US$m).

	1994	1995	1996	1997	1998	1999	2000
Current account							
bal(incl. grant)	-254.6	-144.7	-324.7	-549.7	-443.1	-932.5	-412.6
(%GDP)	4.68	2.24	4.68	7.98	5.92	11.9	7.94
exports	1542.4	1582.7	2256	2345.5	2596.3	2910.2	2843.9
(%GDP)	25.3	24.5	32.1	32.4	33.9	31.9	49.2
of which: cocoa total	320.2	389.5	552.1	470	617.4	N/A	N/A
(% contribution)	25.9	27.2	35.1	31.6	34.1	N/A	N/A
minerals(incl. Gold)	588.2	678.8	641.4	613	717.8	N/A	N/A
(% contribution)	13.4	13.3	9.3	11.5	9.4	N/A	N/A
timber total	165.4	190.6	146.8	172	171	N/A	N/A
(% contribution)	13.4	13.3	9.3	11.5	9.4	N/A	N/A
other non traditional products	86.6	100	143.6	157.1	228	N/A	N/A
(%contribution)	6.9	6.9	9.2	10.5	12.6	N/A	N/A
Imports	2022.2	2126.2	2777.3	3823.8	4131.6	4583.8	3790.8
(% GDP)	32.56	32.93	40.09	52.99	46.74	49.21	69.59
Trade Balance	-615.5	-538.7	-666.5	-978.4	-104.1	-142.1	-935.9
*(% GDP)	9.9	8.3	9.9	13.9	1.41	1.84	11.7
Services Balance	-273.3	-282.1	-299.6	-340.1	-235	-198.1	-93
(% GDP)	4.4	4.38	4.4	4.8	3.2	2.6	1.2
Capital account bal.(incl.errors & omissions)	1	1	1	1	1	1	1
*(% GDP)	0.016	0.015	0.015	0.014	0.014	0.013	0.013
Overall Balance	172.1	250.8	-20.4	26.7	107.9	-89.6	-258.5
*(% GDP)	2.77	3.88	0.3	0.38	1.46	1.17	3.24
GDP	6209.1	6457.4	6754.6	7038.1	7368.9	7693.6	7978.3
Financing							
Domestic	-26.7	-27.7	531.1	728	672.6	N/A	N/A
Foreign	-85	-42.6	-195.7	-430.3	-376.2	N/A	N/A

Source: World Bank CD Rom (2002) University of Hull; IFS Yearbook 2001. *Percentage figures calculated by author using GDP values obtained from the World Bank CD Rom, 2002.

Table A 2. Ghana's trade analysis (1994-2000).

	1994	1995	1996	1997	1998	1999	2000
Exports (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Indust. countries of which:	72.5	70.3	67	63.6	64.9	62.7	58.8
United States	12.6	11.3	9.5	8.3	7.1	9.3	11.3
United Kingdom	13	14.4	15.6	11.6	11.8	11.4	7.6
Germany	14.8	11.8	8.9	9.1	6.8	5	6.2
Japan	3..9	3..9	3.8	4.4	3.3	2.9	2.5
Develop. Countries of which:	23.4	25.1	27.8	30.8	29.5	31.3	33.8
Nigeria	2.8	2.9	3	3.4	3.2	3.1	4.3
Cote d'voire	0.2	0.5	0.3	0.1	0.1	0.1	0.1
Togo	0.4	0.4	0.5	0.5	0.6	0.5	0.4
Imports (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Indust. Countries of which:	59.8	57.6	61.3	59.7	56.1	55.3	51.9
United States	6.7	6.8	10.2	10.5	7.2	8.2	6.6
United Kingdom	15.8	16.4	16.2	15.1	11.8	9.7	9
Germany	5.6	7.6	5.4	6	5	5.6	4.5
Japan	6.8	4	3.4	2.5	2.6	3	1.5
Develop. Countries of which:	39.1	41.3	37.7	39.3	42.8	43.5	46.6
Nigeria	17	15.3	13.4	14.3	14.2	15	19.3
Cote d'voire	3.2	4	4.3	5.1	8.1	4.7	4.8
Togo	0.4	0.4	0.4	0.4	0.5	0.5	0.6

Percentage figures calculated by author using data from Direction of Trade Statistics (DOTS), Various issues.

Table A3. Correlation matrix for the endogenous variables.

	NER	RE	EXPORT	IMPORT	GDP
NER	1				
RE	0.985652	1			
EXPORT	0.759654	0.74217	1		
IMPORT	0.72921	0.680486	0.909757	1	
GDP	0.873181	0.87579	0.758854	0.747134	1

Notes: NER, RE and GDP denote nominal exchange rate, real exchange rate and gross domestic product respectively.

Table A4. Export, imports and trade balance ($million) (1970-2000).

YEAR	NOMINAL EXCHANGE RATE	EXPORT ($mill)	IMPORT ($mill)	GDP DEFLATOR	TRADE BALANCE ($mill)
1970	1.02041	458.03	410.67	42.239	47.36
1971	1.034859	337.66	418.33	44.431	-80.67
1972	1.333392	429.52	290.5	51.303	139.02
1973	1.165	626.86	450.28	62.011	176.58
1974	1.15	729.44	818.59	77.243	-89.15
1975	1.15	807.21	790.69	100.000	16.52
1976	1.15	856.26	965.56	128.053	-109.3
1977	1.15	1010.5	1205.1	214.170	-194.6
1978	1.76358	890.6	955.6	371.159	-65
1979	2.75	1041.2	894.4	512.010	146.8
1980	2.75	1432.6	1071.3	773.781	360.9
1981	2.75	1154.2	1093.7	1359.020	60.5

Table A4. Contd.

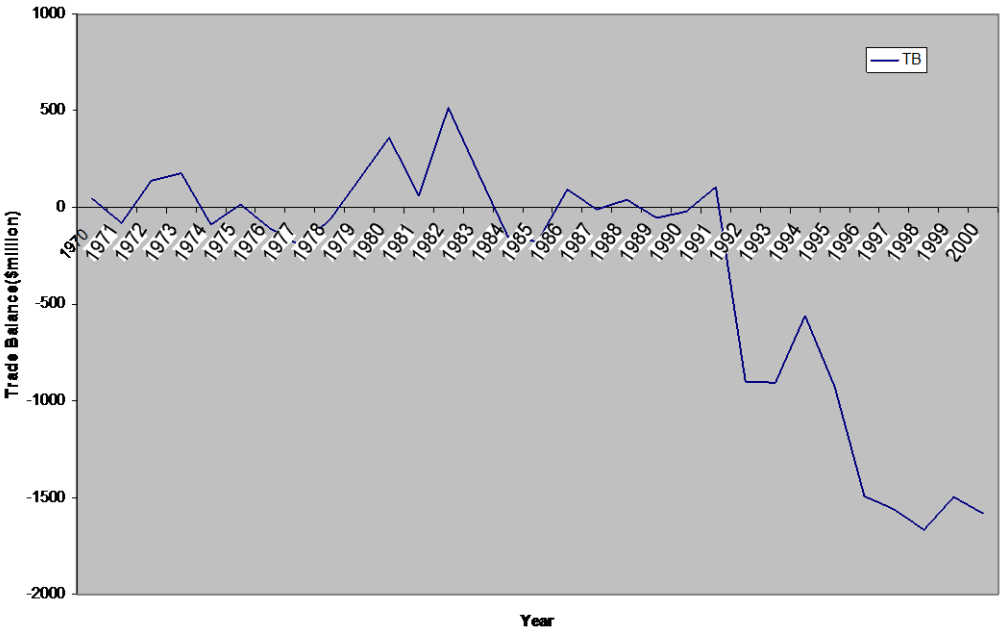
1982	2.75	1227.8	712.7	1738.058	515.1
1983	8.829975	895.3	719	3876.933	176.3
1984	35.98619	415.9	568.7	5245.972	-152.8
1985	54.365	617	793.6	6329.182	-176.6
1986	89.20417	876.4	783.4	8968.817	93
1987	153.7333	976.5	987.9	12484.729	-11.4
1988	202.3458	1075.3	1034.8	16654.984	40.5
1989	270	1069.7	1124.2	21367.398	-54.5
1990	326.3317	1365.9	1387.6	28026.891	-21.7
1991	367.8308	617	511	33643.859	106
1992	437.0867	1237	2139	37395.172	-902
1993	649.0608	1137	2043	49273.371	-906
1994	956.7108	1482	2041	64045.773	-559
1995	1200.429	1609	2557	91714.391	-928
1996	1637.232	1692	3185	128251.328	-1493
1997	2050.167	1725	3285	153206.688	-1560
1998	2314.147	1756.1	3421.6	179326.078	-1665.5
1999	2669.299	1754.2	3251	204366.047	-1496.8
2000	5455.056	1563	3145.7	260021.703	-1582.7

Source: IMF Direction of Trade Statistics (DOTS); various issues.

Table A4b. Indicators of the Ghanaian economy.

Year	1983	1993	2002	2003
Total Debt /GDP	41.1	81	119.1	103.5
Total debt service/export	30.4	24.6	7.3	23.1
Export price index	94	76	81	88
Import price index	102	96	96	97
Terms of Trade`	92	79	85	90
current budget balance	-1.9	5.5	0.2	4.1
Overall surplus/deficit	n/a	-5.6	-5.9	-4.5

Source: World Bank Group (2003).



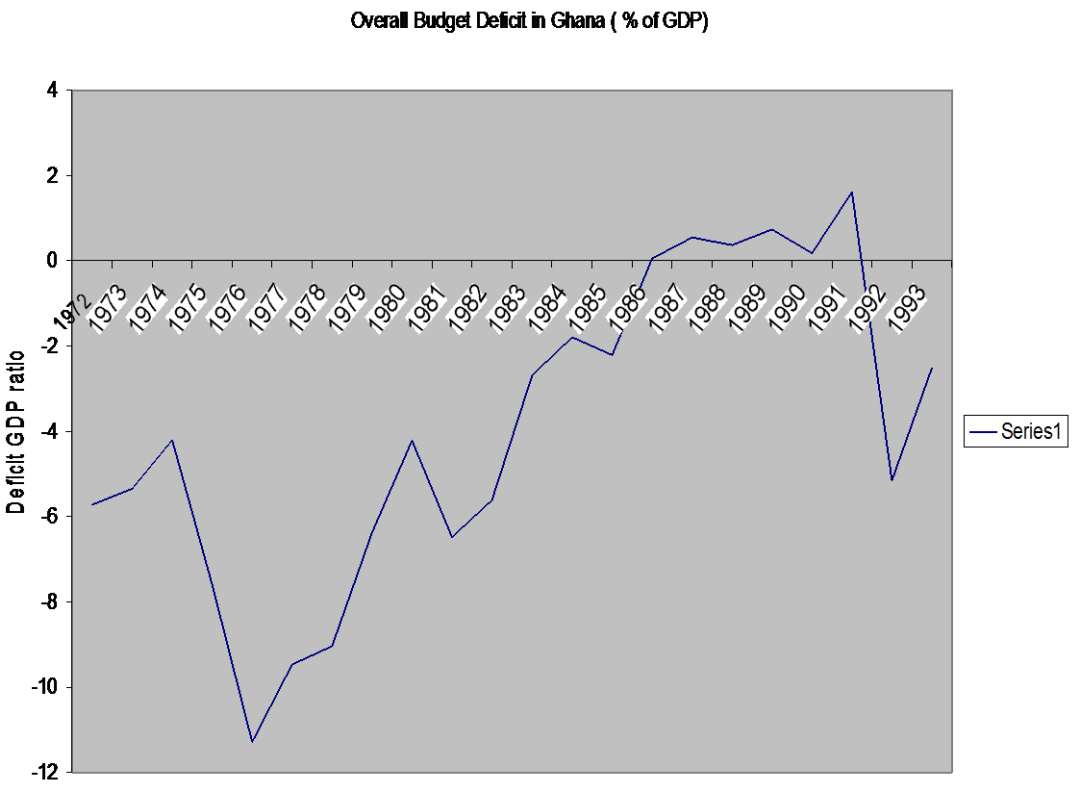


Figure A1. Graph of Trade Balance ($millions) and overall Budget Deficit (GDP%).

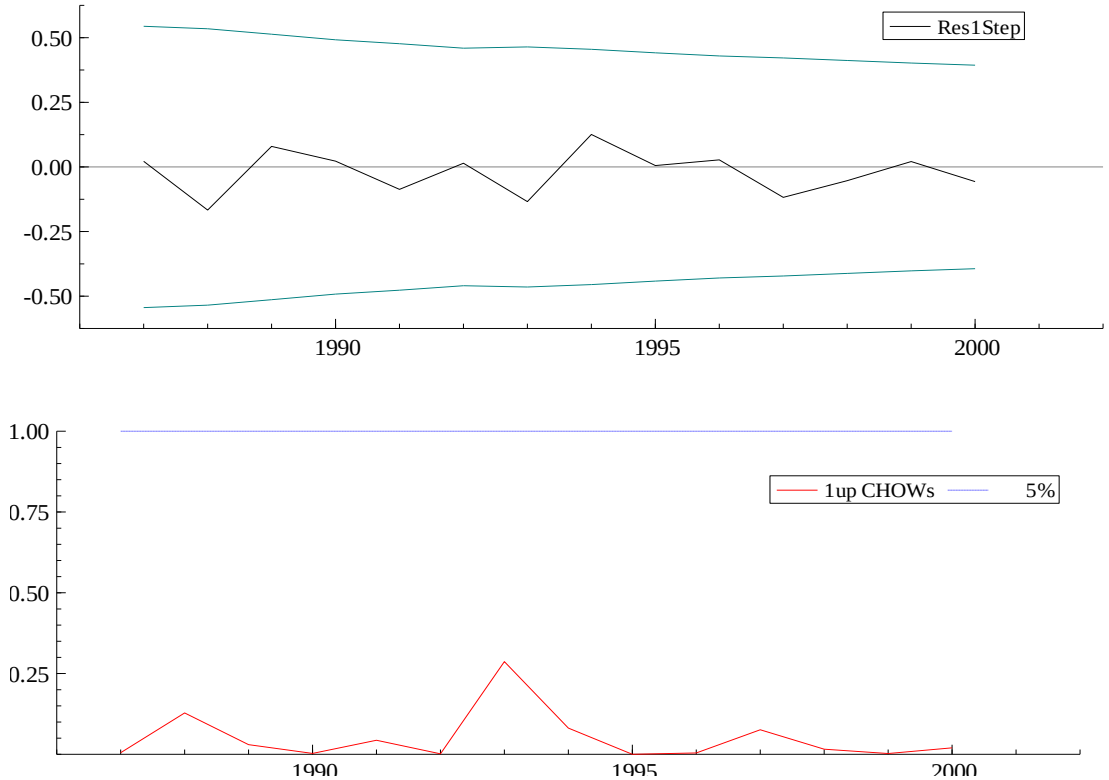


Figure A2. Diagnostic testing of the short run ECM: one step ahead residuals and Chow tests for export.

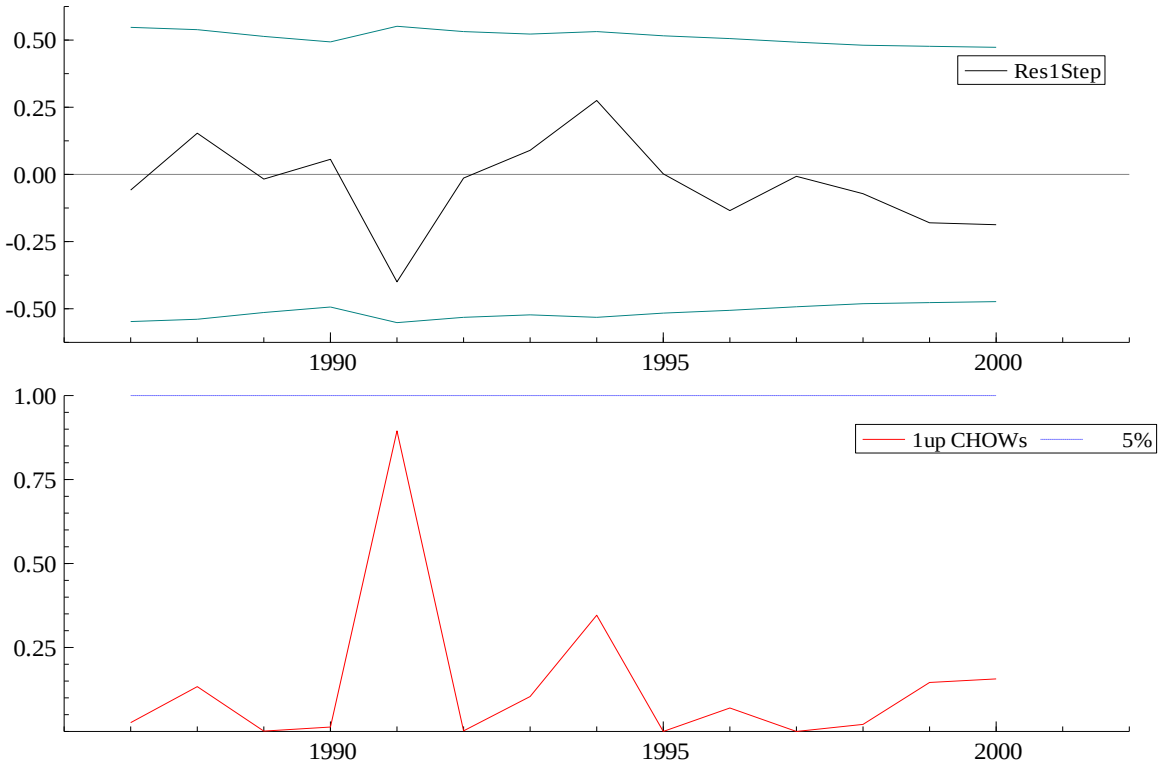


Figure A3. Diagnostic testing of the shot run ECM: one step ahead residuals and Chow tests for imports.

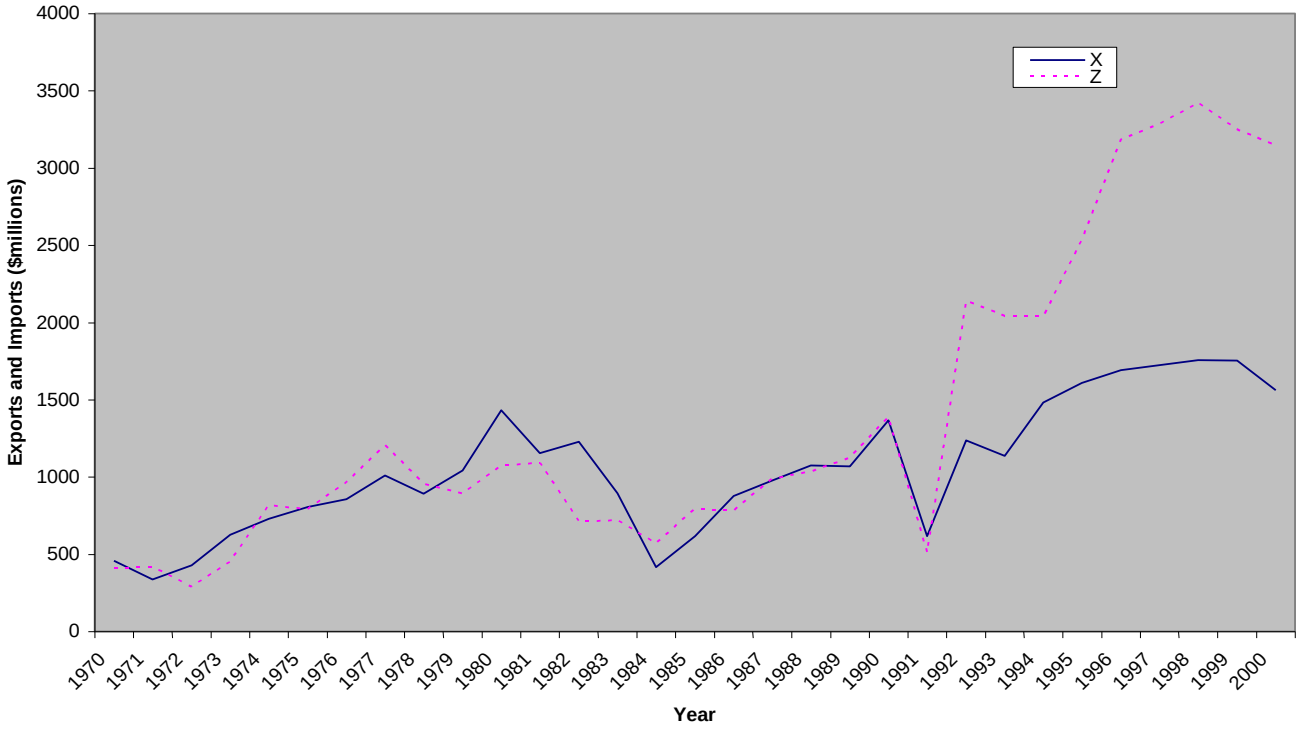


Figure A4. Graph of export and import showing the trade gap ($millions).

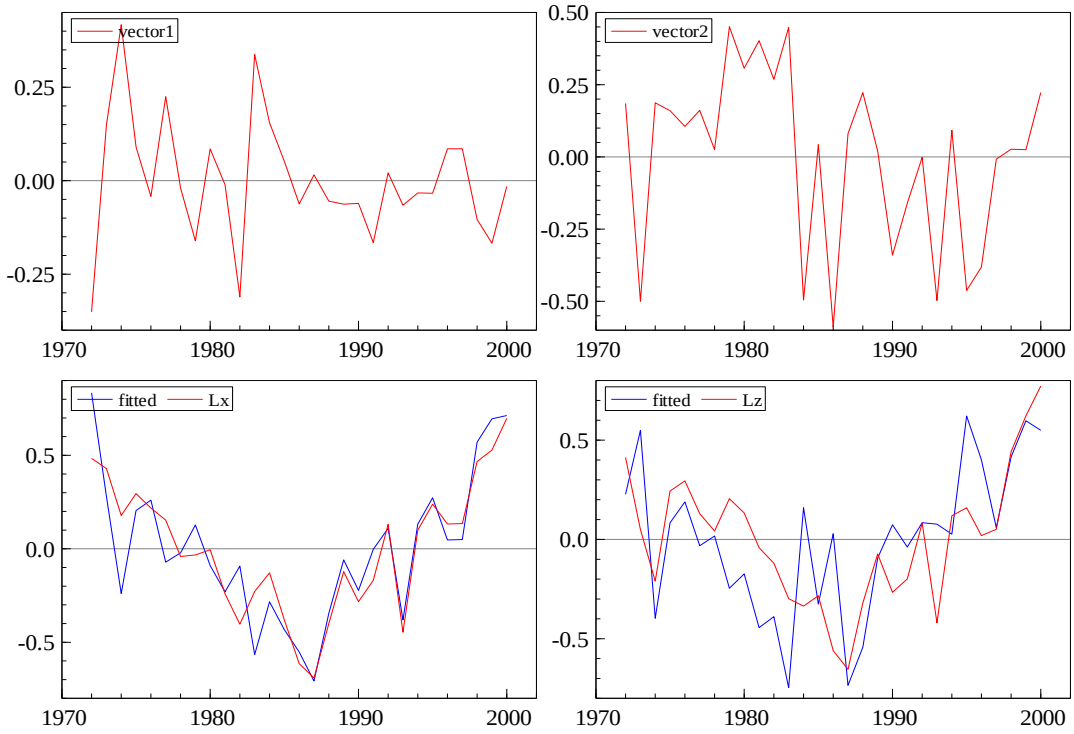


Figure A5. Graph of cointegrating vectors.

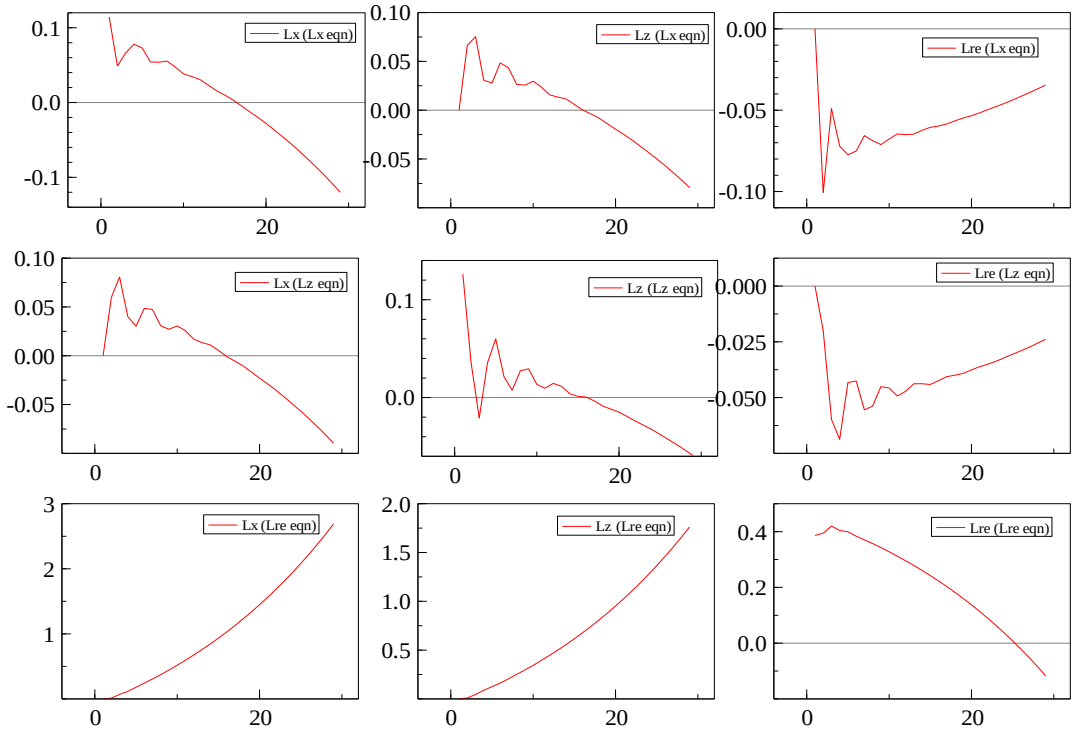


Figure A6. Impulse response analysis from the reduced form VAR model.