REAL EXCHANGE RATE RESPONSE TO CAPITAL INFLOWS: A DYNAMIC ANALYSIS FOR GHANA

by
Oliver Morrissey, Tim Lloyd and Maxwell Opoku-Afari[1]
School of Economics, University of Nottingham
Nottingham NG7 2RD

Abstract
One of the most challenging problems in developing countries such as Ghana is exchange rate management, that is, 'getting the exchange rate right' especially in the context of exchange rate misalignment. The major research and policy question is *what constitutes the equilibrium real exchange rate* (ERER) and how can it be measured? Acknowledging the importance of fundamentals in determining the equilibrium real exchange rate, the paper concentrates on the effects of capital inflows (by decomposing capital inflows into official inflows, "permanent" inflows and "non-permanent" inflows). Vector Autoregressive (VAR) techniques are used to model the long-run equilibrium real exchange rate in Ghana, and based on a multivariate orthogonal decomposition technique, the equilibrium steady state path is identified which is used in estimating misalignments.

As predicted by the Dutch Disease theory, results indicate that capital inflows tend to appreciate the real exchange rate in the long-run. Capital inflows is the only variable generating real appreciation in the long-run; technology change, trade (exports) and terms of trade all tend to depreciate the real exchange rate. The only variable that has a significant (depreciating) effect on the real exchange rate in the short-run is trade, implying that changes in exports are the major driver of exchange rate misalignment. It is also shown that the real exchange rate is slow to adjust back to equilibrium, implying policy ineffectiveness or inflexibility.

An **Appendix** with detailed econometric results and tests is available on request.

[1] The authors are respectively Professor of Development Economics (and Director of CREDIT), Senior Lecturer (and CREDIT Research Fellow) and Research Student, in the School of Economics, University of Nottingham, U.K. Corresponding author Opoku-Afari, email: lexmo@nottingham.ac.uk.

1. Introduction

Exchange rate management or what is often referred to as '*getting the exchange rate right*' is a challenging macroeconomic policy issue. It is essential that policy makers are able to determine the equilibrium exchange rate in order to identify misalignment and to design measures aimed at addressing this misalignment in line with their policy objectives. There has been a broad consensus in policy circles in developing countries that the overriding objective of exchange rate policy should be to avoid persistence in exchange rate misalignment, which is a common feature in most developing countries. However, in order to manage misalignments it is necessary to successfully identify what constitutes the equilibrium real exchange rate (ERER), and this continues to pose a fundamental difficulty in the modern literature on the real exchange rate. Various studies have tried to estimate the ERER based on a standard theory which says that the ERER is a function of observable macroeconomic variables (the fundamentals), and that the actual exchange rate approaches the equilibrium rate over time. Most of these studies measure the ERER as a static equilibrium instead of treating it as a steady state relation. In the latter case, the equilibrium follows a dynamic path and permanent changes in the fundamentals alter the equilibrium level at each point in time.

An important factor in identifying the equilibrium real exchange rate is the role of capital inflows, which are one of the fundamentals determining the real exchange rate. According to the Dutch Disease theory (Corden and Neary, 1982), excessive capital inflows leads to real appreciation of the exchange rate via its impact on both the tradable and non-tradable sectors of the recipient economy. However, they noted that the extent of appreciation as a result of the capital inflows depends to a large extent on the degree of reversibility of the particular inflow in question. Different inflows with different degrees of reversibility will have different negative consequences on national income and to an extent appreciate the real exchange rate differently. This particular conclusion makes it imperative that to better understand how capital inflows affect the real sector of an economy (i.e real appreciation of the exchange rate, which is called the Dutch Disease in the literature), one needs to decompose capital inflows based on their degree of reversibility. However, most empirical studies have tended to aggregate capital inflows together as one variable, thus blurring the conclusion drawn from these studies as in most cases the results are over generalised. The above underscores the purpose of our study, to particularly decompose capital inflows to capture all these different levels of degrees of reversibility.

Capital inflows have particular resonance in the context of Ghana as, like many developing countries, it has become dependent on foreign aid (the major capital inflow), mainly for budgetary support but also as a means of supporting the local currency. The aid/GDP ratio in Ghana has increased from an average of 4% before the structural adjustment programme (SAP in mid 1980s) to almost 12% by 2000. Similarly, the ratio of aid to government expenditure has increased from some 11% prior to SAP to almost 45% by 1998 (see table 1). One of the neglected side effects of capital inflows is the loss of international competitiveness as a result of real exchange rate appreciation. This was noted by Younger (1992), who looked at the impact of capital inflows on fiscal policies in Ghana in the light of the Dutch Disease hypothesis. This is the effect of capital inflow we test for in this paper, in addition to identifying what constitutes the equilibrium real exchange rate in Ghana, and hence misalignments which have eluded most empirical studies.

Table 1: Selected Aid Intensity Indicators for Ghana (%)

	Aid/GDP	ResGDP	Aid/Investment	Aid/Imports	Aid/Govt.Expd	FDI/GDP	Aid per capita
1970-79	2.77	21.07	31.16	5.33	6.83	0.85	8.32
1980-84	3.76	22.91	79.68	16.65	11.21	0.25	14.09
1985-89	8.71	8.23	78.50	35.46	62.14	0.13	32.93
1990	9.57	12.82	66.17	34.65	72.15	0.25	37.83
1991	13.37	10.95	84.10	49.46	95.27	0.30	57.54
1992	9.56	9.48	74.59	31.20	53.65	0.36	38.85
1993	10.36	9.46	46.55	26.87	49.24	2.10	38.10
1994	10.04	10.03	41.90	25.71	48.68	4.28	32.81
1995	10.12	11.14	50.29	28.74	47.25	1.66	38.10
1996	9.44	12.38	43.65	25.39	44.82	1.73	37.05
1997	7.17	7.72	29.44	17.52	45.12	1.21	27.19
1998	9.39	8.42	40.82	22.98	44.66	0.75	37.97
1999	7.84	7.72					
2000	11.74	21.00					

Source: Author's own calculations with data from the OECD's CD-ROM on Geographical Distribution of Financial Flows to Developing countries.
[1] Resource gap to GDP ratio measured as (Imports-Exports)/GDP

This paper concentrates on the effects of capital inflows in determining the equilibrium real exchange rate (ERER). We develop a dynamic model (using VAR and Structural VAR methods) to estimate the ERER based on the fundamentals. This is in line with the popularly held view that the ERER is a steady state relation and thus moves along a steady state path. This will be particularly helpful to policy makers in Ghana, as most still use the static purchasing power parity (PPP) concept of equilibrium, which has not received much empirical support.

The paper is organised as follows. Section 2 provides a brief review of the existing literature, with the theoretical framework employed for determining long-run equilibrium real exchange

rate in section 3. Section 4 describes the data and how they are measured. Section 5 presents the co-integration methodology, identifies the empirical model and discusses the results. Section 6 presents results from impulse response analysis and discusses the issue of exchange rate misalignment. The final section concludes with some policy recommendations.

2. Theory of Long-run Equilibrium Real Exchange Rate

There are two standard ways to analyse the equilibrium RER. The first is strict purchasing power parity (PPP), which posits that the equilibrium RER for an economy is constant over time, as nominal exchange rates are deemed to adjust rapidly to any price differentials between the economy and its trading partners. This approach has come under considerable criticism following its failure on empirical tests (Elbadawi and Soto, 1997) and has led to a general consensus that absolute PPP does not hold and thus the equilibrium exchange rate cannot be constant over time (Edwards, 1989). The alternative and more widely used approach is that the equilibrium RER follows a path upon which an economy maintains internal and external balance (Edwards, 1994; Williamson, 1994). Edwards (1994) provided the decomposition of the fundamentals into monetary variables (nominal or temporary) and real variables (permanent or fundamental) while Montiel (1999) developed a framework for determining the long-run equilibrium real exchange rate path.

The real exchange rate at any point in time is perceived as transitory; the RER may change if the economy is shocked by dynamic forces that affect equilibrium. The sustainability of the RER depends on whether the observed RER is the result of a sustainable long-run macroeconomic equilibrium. The long-run equilibrium real exchange rate is that RER that is compatible with steady-state equilibrium for the economy's net international creditor position, conditioned on the permanent values of a variety of policy and exogenous variables. These permanent values need to be identified. For the purposes of our framework, the fundamentals will be identified as follows: fiscal policy fundamentals (that is, government spending on both tradable and non-tradable goods and the reduction in fiscal deficit due to increases in taxes), international transfers, capital inflows, productivity shocks, terms of trade changes and commercial policy. The internal balance (*IB*) is defined as the condition where the non-tradables goods market clears in the current period and is expected to be in equilibrium in the future (Edwards, 1989; Montiel, 1999). The *IB* is inversely related to consumption. If we start from an initial *IB* equilibrium, then an increase in private spending results in an excess demand for non-tradable goods at the initial real exchange

rate. To restore equilibrium, a real appreciation is required, promoting supply of non-tradable goods and increasing demand for tradable goods.

Montiel (1999) defined the external balance (*EB*) as the current account balance that is compatible with long-run sustainable capital inflows. The *EB* is given by the trade balance (that is, domestic output of traded goods net of local consumption of these goods) plus net capital inflows, less costs on foreign debt. In equilibrium, there is a positive relationship between consumption and the real exchange rate. Given initial *EB*, an increase in private spending would generate a current account deficit at the original real exchange rate. To restore equilibrium, the real exchange rate must increase (depreciate). The depreciation would then switch demand towards non-traded goods and supply towards traded goods.

While an increase in private spending in the *IB* equation yields an appreciation of the real exchange rate (that is, increase in the supply of non-traded goods), a similar shock in the *EB* equation yields a depreciation and promotes increases in the supply of traded goods. The interaction of *IB* and *EB* produces the long-run equilibrium real exchange rate consistent with the fundamentals determining the real exchange rate. The steady state for the equilibrium real exchange rate (ERER) was solved by Montiel (1999), by assuming that the economy faces an upward sloping supply curve of net external funds and that households optimise over an infinite time horizon. The long-run ERER is determined by government spending (on tradables and non-tradables), capital inflows, the world real interest rate and the rate of inflation in the domestic price of traded goods. The nominal exchange rate does not appear as part of the fundamentals, as at most it would only have a transitory effect on the real exchange rate.

The conclusion that the RER consistent with both *IB* and *EB* is a function of fundamentals perceived to be exogenous as well as policy variables (Montiel, 1999), is what differentiates this approach to determining the equilibrium real exchange rate from the PPP approach. Edwards (1994) and Baffes *et al* (1999) include other policy variables, such as permanent changes in the terms of trade, trade policy, macroeconomic imbalances (such as devaluation, thus creating room for nominal devaluation in the equilibrium equation) and productivity shocks. These will be considered below for the case of Ghana.

Various studies have attempted to estimate the determinants of the real exchange rate (RER) and the effects of RER misalignment in both developed and developing countries alike. Van

Wijnbergen and Edwards (1989), White and Wignaraja (1992), Younger (1992), Olofsgard and Olausson (1993) have all provided support for the hypothesis that capital inflows lead to real exchange rate appreciation. It is also evident that excessive inflows come with macroeconomic management problems (Younger, 1992, for Ghana). Recent work has used cointegration techniques to determine the existence of a long-run equilibrium model. This technique enables us to estimate the long-run steady state parameters, after confirming the existence of equilibrium. As noted by Baffes *et al* (1999), the cointegration technique gives a clearer picture of how the fundamentals determining the RER may move permanently, thus altering the equilibrium value. This supports the claim by Edwards (1989) that the equilibrium is not static but follows a dynamic path. Relevant studies include Elbadawi (1994), Elbadawi and Soto (1997), Ghura and Grennes (1993), Sackey (2001), Stein (1992) and Baffes *et al* (1999).

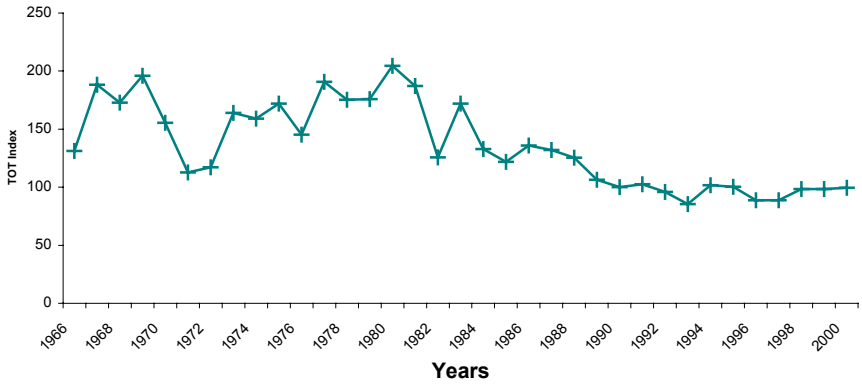
3. Data Description and Measurement

The study used annual data from 1966 to 2000. A brief description of the data and how they affect real exchange rate is outlined below (see appendix for sources and definitions).

Terms of Trade

Terms of trade (TOT) is very relevant to our study. An improvement contributes to increases in real wages and thus allows inter-sectoral shifts in mobile factors of production to the tradables sector. This, in the context of the Dutch Disease theory, will lead to real exchange rate appreciation. Terms of trade thus capture the influence of external demand and supply factors in the tradables sector. There are both income and substitution effects. The income effect of an improvement in terms of trade is that more is spent on all products, resulting in higher prices of non-tradables, causing appreciation in the real exchange rate. The substitution effect leads to a decrease in prices of imported goods and services, falling demand for non-tradables, hence depreciation of the RER. If the income effect associated with the TOT improvement is stronger than the substitution effect, an appreciation of the RER will occur, otherwise the RER will depreciate. This renders the *a priori* expectation of the impact of this fundamental on RER inconclusive. The trends in terms of trade in Ghana are depicted in the figure 1 below.

Figure 1:Trend in Ghana's Terms of Trade (TOT)



It is obvious from the above plot that the period before the SAP was one of relatively favourable terms of trade (in spite of a sharp deterioration in 1971/1972). On the other hand, the period after the SAP has witnessed a steady fall in Ghana's terms of trade. During the same period Ghana's real exchange rate witnessed a continuous depreciation, suggesting that the income effect determines the impact of terms of trade on real exchange rate. In our study, the TOT is defined as the relationship between the external relative prices of exportables and importables.

$$TOT = P_x^* / P_m^* \qquad \textbf{(1)}$$

where P_x^* and P_m^* are the foreign prices of exports and imports respectively.

Government Consumption

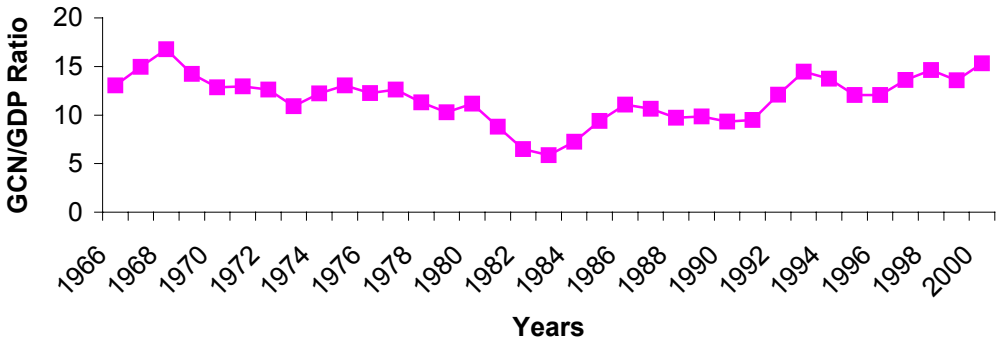
The propensity to consume (invest in) non-tradable goods is essential in explaining the Dutch Disease hypothesis and thus in explaining trends in real exchange rate. An increase in consumption in the non-tradables sector as a result of capital inflows causes further appreciation of the real exchange rate. Due to the unavailability of data on government consumption of non-tradables, we used the ratio of total government consumption (excluding capital expenditures) to the GDP as a proxy in line with other studies (Edwards, 1989).

That is:

$$GCN_t = \frac{GC_t}{GDP_t} \qquad \textbf{(2)}$$

where GC is the total government expenditure and GDP is the gross domestic expenditure.

Figure 2: Trends in Government Consumption



Source: Authors own calculations using data from World Development Indicators CDROM (2002)

Examination of figure 2 shows that periods prior to the SAP (pre-1983) witnessed steady decline in government consumption in the non-tradables sector which theoretically should lead to depreciation of the real exchange rate (*ceteris paribus*), but a look at the real exchange rate trend shows a steady appreciation in this period, hence leaving the determination of the actual impact to be determined empirically. On the other hand, after the SAP, the variable showed an upward trend coinciding with the period of massive capital inflows into the Ghanaian economy. This supports the claim in the literature that marginal propensity to consume in the non-tradables sector with capital inflows is relatively high. The post-SAP period was, however, characterised with an initial real exchange rate depreciation and later a steady appreciation, supporting the Dutch Disease Hypothesis[2].

Degree of Openness

This variable is used to capture distortions in trade policy and the extent of liberalisation. Trade policy restrictions tend to reduce the degree of openness and thus implicitly increase the prices of imports and causes the prices in the non-tradables sector to increase, leading to real appreciation of the real exchange rate. An increase however, will cause depreciation in the real exchange rate. For the purposes of our study we followed the work of Baffes *et al* (1999) and measure the degree of openness using three proxies (namely: Open1, Open2 and Open3)[3]. However, we will seek to interpret these measures as import capacity measure, trade volume measure and import

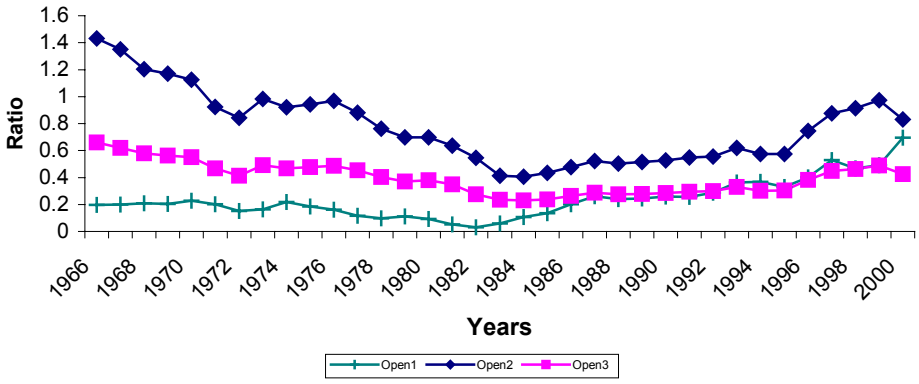
[2] The initial depreciation was the result of deliberate policy to devalue the currency with the commencement of the SAP.

[3] Open1 is defined as imports to GDP ratio, Open2 defined as imports plus exports to GDP ratio whereas Open3 is defined as imports to domestic absorption (DA) ratio (where DA is defined as GDP plus imports minus exports).

absorption measure respectively. This is contrary to how earlier studies have interpreted these measures, but we feel that openness relate to policy that is not captured in these measures.

Looking at figure 3, it is obvious these measures have declined steadily over the period prior to the SAP (pre-1983) and, not surprisingly, this period was characterised by continuous appreciation of the real exchange rate. This trend seems to have reversed after the SAP but has not returned to the 1960's level except for open1 measure. Thus, imports have recovered and indeed increased, but exports do not appear to have reached their 1960s levels. This particular observation is very important in the sense that it helps us to determine which measure is most appropriate for our study.

Figure 3:Trends in Degree of Openness in Ghana



Source: Authors own calculations using data from World Development Indicators CDROM (2002)

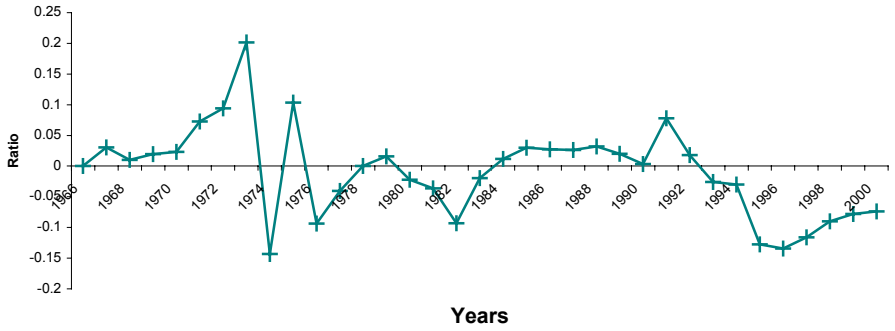
Technological Change[4]

Changes in technology could be product-augmenting or factor-augmenting and the effects will be different across sectors. This suggests different effects of changes in this variable on real exchange rate. We measured technological changes by capturing total factor productivity (TFP) from the Solow-residual using growth accounting methods. This captures the part of growth that is not attributable to growth in either capital or labour.

With improvements in productivity, incomes will increase and generate increase in demand for non-tradables. The resulting increase in the price of non-tradables would appreciate the RER. This, however, encourages an increase in supply of non-tradables, the price of non-tradables will fall and cause depreciation in the RER, if supply increases sufficiently. The trend in this variable is shown in figure 4. We observe that after the initial improvement in technology in the 1960s up

till 1974, this variable began to deteriorate slowly prior to the SAP and then recovered. The recovery was short-lived as a pattern of deterioration emerged after 1992. The impact of these developments is a matter to be determined empirically.

Figure 4:Growth in Total Factor Productivity (TFP) in Ghana



Source: Authors own calculations by estimating the growth accounting Solow-Residual Model for Ghana.

Capital Inflows

The focus of this paper is the impact of capital inflows on real exchange rate. As noted in the literature on the Dutch Disease (Corden and Neary, 1982), the extent of impact of capital inflows on real exchange rate appreciation depends on the degree of reversibility of capital inflow, and consequently its medium to long run impact on national income. Following from this, it is obvious that treating capital inflows as one aggregate measure undermines the dynamics of the Dutch Disease theory. It will be useful to see how different measures of capital inflows impacts on real exchange rate. This will obviously be important for policy analysis.

Following from the above, our paper will decompose capital inflows into three broad measures namely:

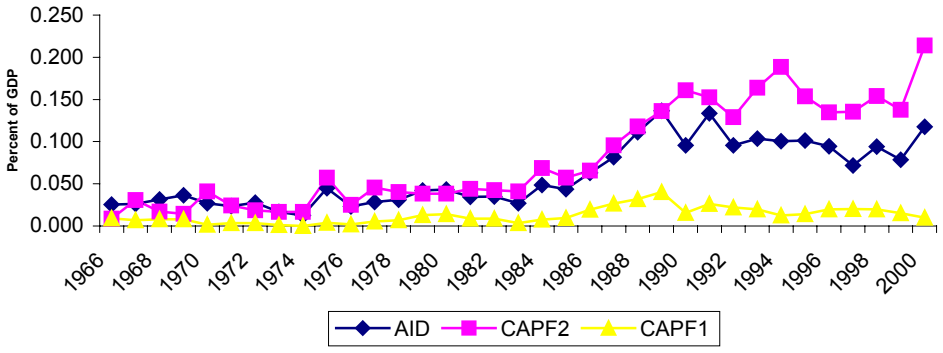
- Those inflows that require repayment mainly aid loans excluding grants (L) and foreign debt (D) as well as non-FDI private capital inflows and other official inflows (OOF)[5]. These components put together will measure that type of capital inflows that are easily reversible and thus "non-permanent". This measure is represented by CAPF1.

[4] See Appendix 6 for methodology in measuring growth in total factor productivity.
[5] Other official inflows (OOF) as defined here basically captures transactions by official sector whose main objective is other than development motivated, or if development motivated, whose grant element is below the 25% threshold which make them eligible to be recorded as ODA. The main classes of transactions included here are official export credits, official sector equity and portfolio investment, and debt re-organisation undertaken by official sector at non-concessional terms (irrespective of the nature or identity of the original creditor).

- The second measure is made up of those inflows we will term as "permanent" inflows. This is made up of aid grants (G), remittances (transfers) and foreign direct investments (FDI). Putting these three measures together will give us the inflows that are not immediately reversible and thus may be termed as "permanent" inflows. We will denote this as CAPF2.
- Finally, we will like to measure the overall effect of official inflows which is made up of Overseas Development Assistance (ODA) including grants, that is, L and G as defined above. This measure is denoted as AID in our estimations. We introduced this component to allow for comparison as most studies used this measure as a proxy for capital inflows.

An increase in these variables is expected to lead to an appreciation in the real exchange rate (the extent of appreciation depends on the degree of reversibility of the inflow). A careful examination of these measures shows a broadly common pattern of behaviour with a stable capital inflow during the pre-1983 (SAP) period. After the SAP in 1983 we saw increases in inflows. It is interesting to note that the appreciation of the real exchange rate in the face of falling inflows could be mainly due to the long period of controls (control of foreign exchange rate market and also price controls). However, after the SAP, and the reforms in the foreign exchange market, the currency depreciated to reflect its true value. The actual impact of the inflows on real exchange rate is reflected in the 1990s where excessive inflows were accompanied by persistent appreciation of the real exchange rate (with brief periods of depreciation).

Figure 5: Trends in Capital Inflows

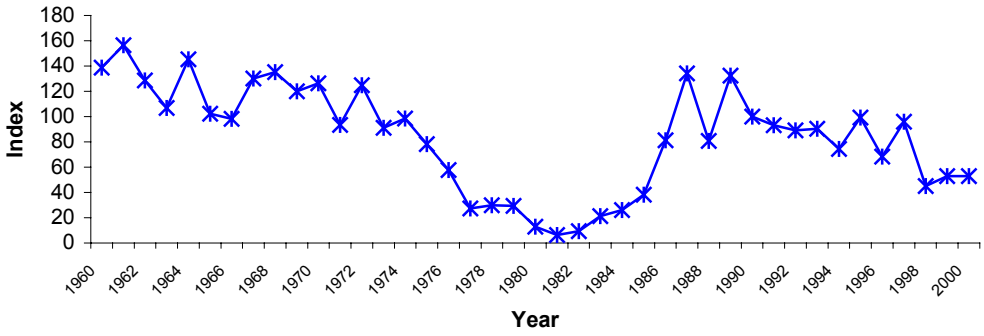


Source: Authors own calculations by using data from the OECD CDROM (2000) on Geographical Distribution of Financial Flows to Aid Recipients.

Real Effective Exchange Rate

Real effective exchange rate (REER) was measured as nominal effective exchange rate (NEER) multiplied by the ratio of a trade-weighted wholesale price index of Ghana's trading partners and the consumer price index in Ghana. Note that REER has been defined in a way that an increase implies a depreciation and a fall implies appreciation. Real Effective Exchange Rate was defined as $REER = NEER\left[P_T / P_{NT}\right]$ where P_T is the price of tradables, P_{NT} is the price of non-tradables and $NEER$ is the nominal effective exchange rate. A plot of the computed REER for Ghana is shown below.

Figure 6:Trade Weighted Real Effective Exchange Rates for Ghana: (1990=100)



Source: Authors own computations using data from Direction of Trade Statistics and World Development Indicators CDROM.
An upward movement here represents depreciation and a downward movement represents an appreciation

4. Empirical Model

The multivariate approach to co-integration analysis as initiated by Johansen (1988) is used in this study. This is achieved by the use of Vector Autoregressive (VAR), systems of dynamic equations that examine the inter-relationships between economic variables using minimal assumptions about the underlying structure of the economy.[6] VAR methods are appropriate because all the fundamentals together determine the ERER. To achieve a dynamic steady state relation, we need a method of estimation that will allow for the interdependence and inter-relations of all the identified fundamentals in arriving at the ERER. This is exactly what the VAR technique provides in this context. In addition, we avoid the *a priori* assumption of endogeneity

[6] For a detailed analysis of the literature on the VAR methodology, see Johansen (1988), Hamilton (1994) and Harris (1995).

and exogeneity of variables, which has a high potential of affecting inferences made in the analysis[7].

Assuming the data are I(1), we may write the VAR in error correction form as:

$$\Delta Z_t = \Pi Z_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-i} + \mu_0 + \phi D_t + \varepsilon_t \qquad \textbf{(3)}$$

where $\Gamma = -I_i + A_1 + \ldots\ldots\ldots + A_i$ (I_i is a unit matrix) and Δ refers to differenced variables, which are I(0) and stationary, μ_0 represents the constant term and the D_t captures seasonal dummies and intervention dummies as will become clearer later in the analysis. As noted in Harris (1995), this way of specifying the system contains information on both the short and long run adjustment to changes in Z_t through the estimates of Γ_i and Π respectively. Of paramount interest in the VAR analysis is the $\hat{\Pi}$ vector which represents a matrix of long-run coefficients, defined as a multiple of two ($n \times r$) vectors, α and β' i.e $\Pi = \alpha\beta'$.

The β' vector represents the co-integrating vectors showing the combinations of long-run relationships amongst the variables while α is a vector of loadings of the co-integrating vectors, denoting the speed of adjustment from disequilibrium. Finding the existence of co-integration is the same as finding the rank (r) of the Π matrix. If it has full rank, the rank $r = n$, and we have n co-integrating relationships, that is, all the variables are I(0).

[7] Due to the restrictive nature of VARs by way of dimension and degrees of freedom, we are not able to include all the variables (fundamentals) outlined earlier on. However, we estimated the same model using a single equation cointegration methodology, which allows for inclusion of more variables. Results from the single equation approach, in general, corroborates findings made in the VAR approach and are reported in the appendix. From the single equation approach we are able to include nominal variables (nominal devaluation of the currency to capture

We estimate the error correction VAR(k) model[8] as:

$$\Delta X_t = \alpha(\beta', \beta'_{tot}, \beta'_{tfp}, \beta'_D, b_0)\begin{pmatrix} X_{t-1} \\ LTOT_{t-1} \\ TFP_{t-1} \\ Ds83_{t-1} \\ 1 \end{pmatrix} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} +$$

$$\sum_{i=0}^{k-1} \gamma_i \Delta LTOT_{t-i} + \sum_{i=0}^{k-1} \delta_i \Delta TFP_{t-i} + \sum_{i=0}^{k-1} \varphi_i \Delta Ds83_{t-i} + \Phi D_t + \varepsilon_t \qquad \textbf{(4)}$$

where $Ds83_t = \begin{Bmatrix} 0: & 1966-1983 \\ 1: & 1984-2000 \end{Bmatrix}$ is a shift dummy which caters for the transitory shock with a level shift in Ghana in 1983. This will then measure the effect of adjustment and/or liberalisation on real exchange rate in Ghana. Due to the permanent effect the Structural Adjustment Programme (SAP) had on most macroeconomic variables in Ghana, this dummy is treated as a weakly exogenous variable in our estimations to be able to capture its long lasting effect (see Juselius, 2003, for the rational behind treating shift dummies as weakly exogenous variables). Similarly, D_t contains the intervention dummy representing the transitory shocks observed in 1974 in our *TFP*, *TOT* and *AID* variables given as $Dt74 = \begin{pmatrix} 1: & 1974 \\ -1: & 1975 \end{pmatrix}$ otherwise zero. The plots of the standardized residuals (in the appendix) of the above estimation without the dummies show that we had outliers with large residuals especially in these years[9]. These dummies were found to reduce the residuals to a satisfactory level. The shift dummy was treated as a weakly exogenous variable since it is clear that the transitory shock also had permanent effect in the data[10].

---

macroeconomic imbalance as used by Edwards, 1989, 1994. Also we are able to include government consumption in the long run model, which were not included in the VAR approach.

[8] Different lags were tested and the information criteria and likelihood ratio tests indicated that two lags seemed optimal. The choice of two lags also reflects the relatively small sample size.

[9] It is also evident from the plots of variables that none of our variables had a linear trend, hence the absence of a trend term in our model. In the light of this, we restricted the constant term to the co-integration equation. Deterministic components (trend, constant and dummies) have a different meaning and interpretations in dynamic models and thus asymptotic distributions of the rank test depends very much on the correct specification of the model with trend, constant or dummies. By doing this we do not allow accumulation of the constant term effect to have a trending effect in our model. The justification for this type of estimation is in Juselius (2003: 99).

[10] A careful examination of the data points to breaks associated with institutional reforms in 1974 and shocks in 1981, both are incorporated with dummy variables. Major shocks and reforms are likely to have a fundamental impact on economic behaviour and need to be included in the systematic part of the model. Ignoring this problem is likely to bias estimates and result in invalid inference (Juselius, 2003: 45). However, if an ordinary intervention does not appear as an outlier, it is possible to treat it as a random shock.

Two other variables are treated as weakly exogenous (by assumption) and restricted to enter only the co-integration equation. These are the terms of trade (*TOT*) and the total factor productivity (*TFP*). The decision to assume *a priori* weak exogeneity for these two variables was based on economic reasoning rather than statistical tests. In the case of Ghana, *TOT* can be seen as determined outside the Ghanaian economy. Ghana is a small open economy and thus has no influence on the price of its exports (inelastic supply of most of the export commodities) as well as imports. Similarly, with relatively low technology levels, little can be done to initiate technological change and *TFP* can also be treated as exogenous to the system. Arguably for Ghana, aid could have been treated as a weakly exogenous variable, but when this was tested and weak exogeneity was rejected (see Appendix), implying treating it as a weakly exogenous variable will lead to a loss of feedback effect in the computation of the equilibrium REER. This leaves our endogenous variables (in logs) represented by $X_t = \begin{pmatrix} LREER_t \\ LOpen_t \\ LKA_t \end{pmatrix}$, where LKA is used to capture capital inflows. In our study, we have three different versions of capital inflows and each of these is estimated separately, yielding three versions of the same model, each with a different measure of capital inflows. The above developments influenced our choice of model. We tested for mis-specification and also the significance of dummies and weakly exogenous variables (see Appendix).

5. Estimation and Test Results

After empirically justifying the above specification of the VAR(*k*) model, we went ahead to determine the appropriate lag length of the VAR (*k*). To arrive at this we used the model reduction approach and, as mentioned above, the optimal lag length was found to be two (that is $k = 2$)[11]. This lag level was sufficient to remove any serial correlation, satisfy the normality test and all the other mis-specification tests, with the benefit of not significantly affecting the degrees of freedom (details in Appendix).

[11] Note that the criteria used are only valid under the assumption that the model is correctly specified. If there are problems with the specification of the model, such as permanent shocks or level shifts in the data and non-constancy of parameters, these should be corrected before choosing the lag length. Hence, our decision to introduce the dummies and account for the weakly exogenous variables in our model before estimation.

Determination of the Co-integrated rank

We initially performed a trace test to help determine the rank of our VAR(2) model. This was used in relation to other criteria to help identify the number of co-integration relations present (see Appendix for details). The choice of rank is clearly supported by the economic hypothesis that these variables together determine the long-run ERER.

Table 2: Trace Test Analysis

p-r	*r*	Eigen Values	Trace Test Statistic	CV (95%) without dummy	Corrected CV (with dummy)
3	0	0.7222384	**77.175**	55.9*	65.9*
2	1	0.4880808	36.183	35.4	45.4
1	2	0.3694327	14.756	17.8	26.4

Notes: The corrected critical value (CV) is adjusted for the inclusion of shift dummy and weakly exogenous variables. The standard 95% critical value reported for the trace test is not relevant as the inclusion of the dummy and weakly exogenous variables violate the asymptotic distribution. Using a simulation programme in RATS, this was corrected and the actual distribution of the trace test is reported in the last column.

After imposing a rank of one, we had a unique relationship and thus the identification became relatively easy. Normalising the only existing co-integration relation on the *LREER* variable (measuring the real effective exchange rate), we identified a co-integrated relation among the fundamentals and REER itself. The relation between these variables translates into a relation explicitly for the long-run equilibrium real exchange rate for Ghana by assuming causality between the fundamentals and real effective exchange rate. This assumption of causality is based on the theoretical hypothesis of the long-run equilibrium exchange rate and not statistically tested. The identification of the long-run relation was direct as we have only one co-integrating relation, which is clearly identified as the long-run equilibrium exchange rate relation. Normalizing on *REER* gives a relation that shows how fundamentals determine the long-run equilibrium exchange rate as discussed in Section 2 of this paper. The identified relation is presented in Table 3.

Table 3: Identified Long-Run Equation

	Eigen Vectors (Transposed)						
	LREER	LOPEN1	LAID	LTOT	DTFP	Ds83	CONST
β_1	-1.141	1.49	-1.76	3.88	7.592	4.276	-17.849
	Normalised β_1 (Transposed)						
	LREER	LOPEN1	LAID	LTOT	DTFP	Ds83	CONST
β_1	1.000	-1.306	1.542	-3.401	-7.531	-3.748	16.521
t-ratio		*(-3.31)*	*(3.56)*	*(-2.55)*	*(-3.55)*	*(-5.29)*	*(2.55)*
	α_{1i}						
DLREER	-0.275						
	(-4.65)						
DLOPEN1	-0.158						
	(-5.45)						
DLAID	-0.125						
	(-3.45)						
	Π-Matrix						
	LREER	LOPEN1	LAID	LTOT	DTFP	Ds83	CONST
DLREER	-0.275	0.359	-0.425	0.936	2.073	1.032	-4.547
	(-4.65)	*(4.65)*	*(-4.65)*	*(4.65)*	*(-4.65)*	*(4.65)*	*(-4.65)*
DLOPEN1	-0.158	0.207	-0.244	0.539	1.193	0.594	-2.618
	(-5.45)	*(5.45)*	*(-5.45)*	*(5.45)*	*(-5.45)*	*(5.45)*	*(-5.45)*
DLAID	-0.125	0.163	-0.192	0.424	0.939	0.468	-2.061
	(-3.45)	*(3.45)*	*(-3.45)*	*(3.45)*	*(-3.45)*	*(3.45)*	*(-3.45)*
Log-Lik	163.00662						

Figures in parenthesis are the t-ratios with the standard normal distributions. The $\alpha's$ have the normal asymptotic distribution and thus all of them are significant. Similarly, the t-ratios for the estimated $\beta's$ have the normal asymptotic distribution.

From Table 3, it is clear that all variables are significant in the long-run relation. The shift dummy variable to capture the shocks in 1983 is very significant, implying SAP and liberalisation had a strong and positive impact on real exchange rate (i.e. led to real exchange rate depreciation). All the α's are significant and error correct any disequilibrium in the long run relation (the real effective exchange rate has about 27% correction in a year). The implication of these significant α's is that all the variables have long-run feedback into the identified relation with a speed of adjustment ranging from 12% to 27%. Similarly, all the variables had significant *t*-ratios (reported in parentheses in equations 5-7), an indication of the relevance of the variables in explaining the identified relation.

The identified long-run equilibrium relation for real effective exchange rate (using aid) for Ghana is derived as[12]:

$$LREER = \underset{(2.55)}{-16.52} + \underset{(-3.31)}{1.31}\, LOPEN - \underset{(3.56)}{1.54}\, LAID + \underset{(-2.55)}{3.40}\, LTOT$$

$$+ \underset{(-3.55)}{7.53}\, TFP + \underset{(-5.29)}{3.75}\, Ds83 \qquad \textbf{(5)}$$

Equations (6) and (7) report long-run relations when aid is replaced with CAPF2 (which is the "permanent" inflows) and CAPF1 (measure of "non-permanent" inflows) respectively. See Appendix for detailed results.

$$LREER = \underset{(1.11)}{4.12} + \underset{(2.71)}{0.61}\, LOPEN - \underset{(6.24)}{1.62}\, LCAPF2 + \underset{(1.21)}{0.977}\, LTOT$$

$$+ \underset{(2.14)}{3.17}\, TFP + \underset{(6.25)}{2.65}\, Ds83 \qquad \textbf{(6)}$$

and,

$$LREER = \underset{(1.92)}{-2.18} - \underset{(-1.62)}{0.11}\, LOPEN - \underset{(-2.16)}{0.52}\, LCAPF1 + \underset{(1.93)}{0.60}\, LTOT$$

$$+ \underset{(1.91)}{0.34}\, TFP + \underset{(2.47)}{2.29}\, Ds83 \qquad \textbf{(7)}$$

While it is striking (and important) to note that the sign of the capital inflow coefficient did not change and corroborates the earlier finding that the extent of appreciation of real exchange rate depends on the degree of reversibility of the capital inflows in question, we need to also acknowledge that especially degree of openness (trade volume) was not robust to these different measures of capital inflows (alternating in its effect on real exchange rate depending on which measure is being used).

[12] We used the trade volume measure of degree of openness in all our estimations. Replacing that with the other remaining two measures did not change the results very much by way of its impact on REER and magnitude.

In partial analysis, and by interpreting the coefficient as elasticities, a percent increase in aid inflows leads to a 1.5% appreciation in the real exchange rate. This effect is significant and supports the Dutch Disease hypothesis[13]. However, the extent of appreciation is slightly higher (1.6%) for "permanent" inflows (CAPF2, made up of mainly aid grants, FDI and remittances). More importantly, the estimations show that when the "non-permanent" measure of capital inflow (CAPF1, made up loans, other non-FDI inflows, equities and portfolio investments) was used, real appreciation of exchange rate was less than these other two measures (0.5%). This buttresses our justification for decomposing capital inflows. It is clear that our method of decomposition is not trivial and thus different types of capital inflows have different extent of impact on real exchange rate. This finding is contrary to that of (Sackey, 2001) who found a depreciation effect of aid on real exchange rate in Ghana and thus concluded that the Dutch Disease is not supported in Ghana. However, as shown above, all categories of capital inflows (aid, "permanent" and "non-permanent" inflows) lead to appreciation of the real exchange rate in Ghana. This contrary result to that of Sackey (2001) calls into question the inconsistencies in the debate in policy circles of the real effects of capital inflows. Our study is an improvement in the sense that, we modelled for the effect of structural breaks in 1983 which was not adequately taken care off in the study by Sackey (2001). In addition, Sackey's study used bilateral nominal exchange rate in computing real exchange rate (which limits the multi-lateralness of the measure) whereas we used nominal effective exchange rate in the computation of the real effective exchange rate.

Technological change (TFP) leads to real depreciation of the exchange rate in the long-run. This implies that the supply-side effect of improved technology or productivity outweighs the demand-side effect; excess supply causes prices of non-tradables to fall and leads to the depreciation of the local currency. This result is contrary to expectation as most studies have found technological progress causing appreciation in the real exchange rate implying the demand-side effect of the improvement dominates. However, with the depreciation of the real exchange rate, there is an indication that, in the long-run, technological progress does have a supply side effect in Ghana, thus causing a fall in the prices of non-tradables hence the depreciation in the REER[14]. It also appears that the extent of depreciation as a result of

[13] This suggests that the aid used to finance government spending had a greater impact on increasing the price of non-tradables than tradables.

[14] The contrary results of depreciation of technological change on real exchange rate may also be attributed to the way of measuring the technological change. In most studies, real GDP growth has been used as a proxy for technological change (Edwards, 1994). However, it must be noted that, according to the Solow-growth accounting

technological change varied markedly among the different measures of capital inflows (as shown in equations 5-7).

The real exchange rate in Ghana depreciated by about 3.4% in response to 1% improvement in the terms of trade[15]. A possible explanation is that the substitution effect outweighs the income effect. While the income effect leads to increased spending on both tradables and non-tradables, the substitution effect leads to a decrease in price of imported goods and services. This falling demand for and downward pressure on the prices of, non-tradables has the effect of depreciating the real exchange rate. Trade volume is also associated with a real depreciation of the exchange rate. This evidence clearly shows that an increase in trade will lead to real exchange rate depreciation in Ghana. We noted here that the extent of depreciation varied as different measures of capital inflows were used. More importantly, the extent reduced drastically when the "non-permanent" inflows were used. In similar analysis, trade volume was also found to be associated with depreciation of the real exchange rate in both the official inflows and the "permanent" inflow equations. This was not the case when the "non-permanent" inflow was used (we found trade volume appreciating the real exchange rate at a lower magnitude and significant only at the 10% level).

The real exchange rate in Ghana tends to converge slowly to its equilibrium level after a gap between observed real exchange rate and its equilibrium level. Depending on the cause of the gap and from which fundamental, the real exchange rate will either move to a new equilibrium level or revert to its old equilibrium level. This depends on whether changes in the fundamentals causing the gap is permanent or transitory. The results show that about 27% of the gap is corrected within a year. This implies that barring any further changes in the fundamentals, full equilibrium will be restored within $3-4$ years in Ghana[16]. On the other hand, the convergence rate was found to be slightly faster in the model of "permanent" inflows (38%) and far lower in the model of the "non-permanent" inflows (18%). This implies equilibrium is restored much faster with distortions created via "permanent" changes in capital inflows than is the case with "non-permanent" capital inflows. A possible explanation could be that official inflows, at least since mid-1980s, are greater in size and somewhat more stable than private inflows.

---

model, if GDP is used in totality, that also includes changes in productivity attributable to capital and labour. However, technological change must be viewed as a residual from this growth accounting model. We computed the growth accounting model for Ghana and used the residual to measure growth in total factor productivity.

[15] As reported in equation 6, terms of trade was found not to be significant in the model of "permanent" inflows.

Similarly, results from the single equation cointegration estimations as reported in Appendix C corroborates our findings in the VAR estimations. Broadly, we found that decomposition of the capital inflows was not trivial and that in the same direction, the extent of appreciation of the real exchange rate as a result of increased capital inflows was slightly greater in the "permanent" inflows model (0.7) than in the "non-permanent" inflow model (0.2), while the magnitude of appreciation for the official inflows scenario (i.e aid made up of both "permanent" and "non-permanent" inflows) was 0.5. In relation to other fundamentals, they all had similar impact on real exchange rate in the long-run as reported under the VAR estimations, indicating that our estimations are robust[17].

Short-run analysis

We use the residual covariance matrix to identify the short-run structure. If the identified structure represents the dynamics in the data, the residual covariance matrix should not be highly correlated. An identified short run structure from the system is presented below for the scenario when aid is used as a measure of capital inflows. Similar models are reported in the appendix when the other remaining two measures of capital inflows are used, that is, "permanent" and "non-permanent"). The findings should be interpreted cautiously as we have relatively short time series.

Table 4 presents the parsimonious short run model for the "aid model". With a high *p*-value of about 0.95 (bottom of Table 4), we could not reject the null hypothesis of the 19 over-identifying zero restrictions imposed on the variables found to be insignificant in the initial estimation. The only variable that appears to have a significant effect on the equilibrium exchange rate in the short run is the trade volume, which depreciates the equilibrium exchange rate in the short run, thus causing misalignments. The error correction term is also significant, as is the effect of liberalisation or reforms (that is, the shift dummy). An interpretation is that short-run movements are driven by trade (exports)[18] and the REER takes a relatively long time to restore equilibrium.

This finding was also corroborated when we identified the short-run model using CAPF2 (see Appendix). Like the aid inflows model, we found that only the trade volume measure was significant in causing short-run deviations in the REER in addition to liberalisation (or

[16] This measure is a little under two years when the "permanent" inflow measure is used and about 5 years when the "non-permanent" inflow measure is used.
[17] See Appendix C for full details of the single equation results.

adjustment which was captured with a shift dummy variable treated as a weakly exogenous variable). On the other hand, when we used CAPF1 (non-permanent inflows), short run adjustments in the real exchange rate was found to be a response of adjustment effects (or effects of liberalisation). Both capital inflows and trade volume measures were found to be insignificant (see Appendix for details of the short-run parsimonious model).

We also noted that the extent of depreciation due to trade volume changes was higher in the "permanent" capital inflow model than in the official inflow model. The error correction terms in all estimations were also significant, as is the effect of SAP and liberalisation or reforms (that is, the shift dummy) in all models. It is obvious that, in all cases, short-run deviations in real effective exchange rate in Ghana (irrespective of the type of inflows) are driven by trade, and equilibrium is restored after a relatively long period.

Its own lagged value is the only variable that influenced capital inflow in the short-run. In the short-run, trade volume (open) is influenced by both the previous level of real effective exchange rate and its own lagged level. The most significant finding is that capital inflow does not have any significant influence on real effective exchange rate in the short run in spite of its significant impact in the long-run. We can conclude by saying that misalignments in the equilibrium real exchange rate, measured as short-term deviations from the equilibrium, are mainly driven by trade volumes. A possible explanation could be short-term increases in import bills in excess of sustainable foreign exchange receipts.

[18] As imports are seen to be more stable.

Table 4: Parsimonious Short-run Model[19]

	$\Delta LREER$	$\Delta LOPEN1$	$\Delta LAID$
$\Delta LREERtcpi$	1	0	0
$\Delta LOPEN1$	0	1	0
$\Delta LAID$	0	0	1
$\Delta LREER_{t-1}$		**0.238** (3.32)	
$\Delta LOPEN1_{t-1}$	**0.597** (2.24)	**-0.295** (-2.38)	
$\Delta LAID_{t-1}$			**-0.571** (-6.36)
$\Delta LTOT$			
$\Delta LTOT_{t-1}$			
$\Delta DTFP$			
$\Delta DTFP_{t-1}$			
$dt74$			**-0.929** (-7.11)
$\Delta ds83$	**-0.989** (-2.90)	**-0.493** (-2.83)	**-0.294** (-1.43)
$\Delta ds83_{t-1}$	**-0.943** (-1.93)	**-1.220** (-5.19)	**-0.735** (-2.95)
ECT_{t-1}	**-0.240** (-3.99)	**-0.153** (-5.31)	**-0.145** (-4.52)
$\varepsilon_{\Delta LREERtcpi}$	1	0.389	-0.242
$\varepsilon_{\Delta LOPEN1}$	0.389	1	-0.498
$\varepsilon_{\Delta LAID}$	-0.242	-0.498	1

***LR test of over-identifying restrictions:** $\chi^2(19) = 10.304[0.945]$

6. Impulse Response Analysis and Misalignment

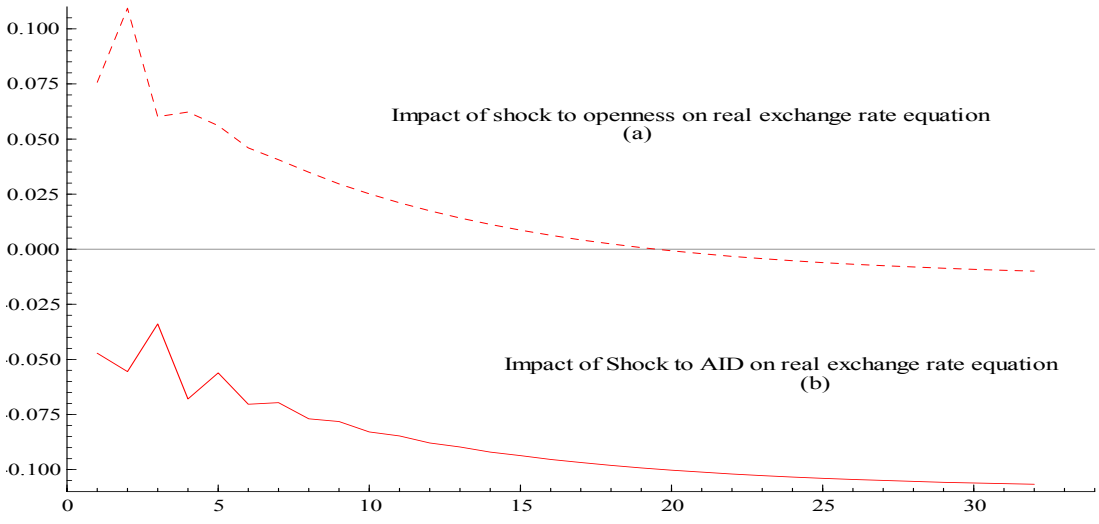
Given that we identified only one cointegrating relation in our estimation, and the fact that we had three endogenous variables, it implies we have two possible stochastic trends driving the long-run equilibrium real exchange rate model. In addition, since we assumed prior to our estimations that we have two weakly exogenous variables that is, *TOT* and *TFP,* we will in all have a total of four driving trends in our model of five variables with one co-integration relation. This leaves the possibility for many types of impulse response analysis (see Juselius, 2003 and Favero, 2001). We computed the orthogonal impulse response functions for the equilibrium relation to changes in only two of the driving trends, *AID* and trade volume (Open), given our objective to capture how real exchange rate responds to capital inflows. The results shown in Figure 7 clearly support our earlier finding about the effect of these two variables in the long-run relation.

[19] Short run model was identified using the full information maximum likelihood (FIML) estimation technique as in PcGive 10.3.

It is clear from the plot of the function (panel b) that aid inflows[20] have a long run permanent appreciating effect on ERER which appreciates gradually for a few years and then settles at the new long-run equilibrium (with an impact of roughly 12%). Similarly, we found an initial depreciating effect of a change in the degree of openness (trade) on ERER but this trend decays after about 19 years. We can say that positive changes in trade[21] (especially, expansion in exports) have a medium term depreciating impact on equilibrium real exchange rate, whereas aid has a long run permanent appreciating impact.

A major shortcoming of the impulse response analysis arises from the high correlation in the residual covariance matrix, which is used in this case to represent the structural shock in the impulse response analysis. If the high correlation is due to omitted variables, it is very difficult to interpret the residuals as a possible measure of autonomous errors (structural shocks). A large residual correlation coefficient does not necessarily imply a structural simultaneous effect nor does it imply incorrectly specified expectations (Juselius, 2003).

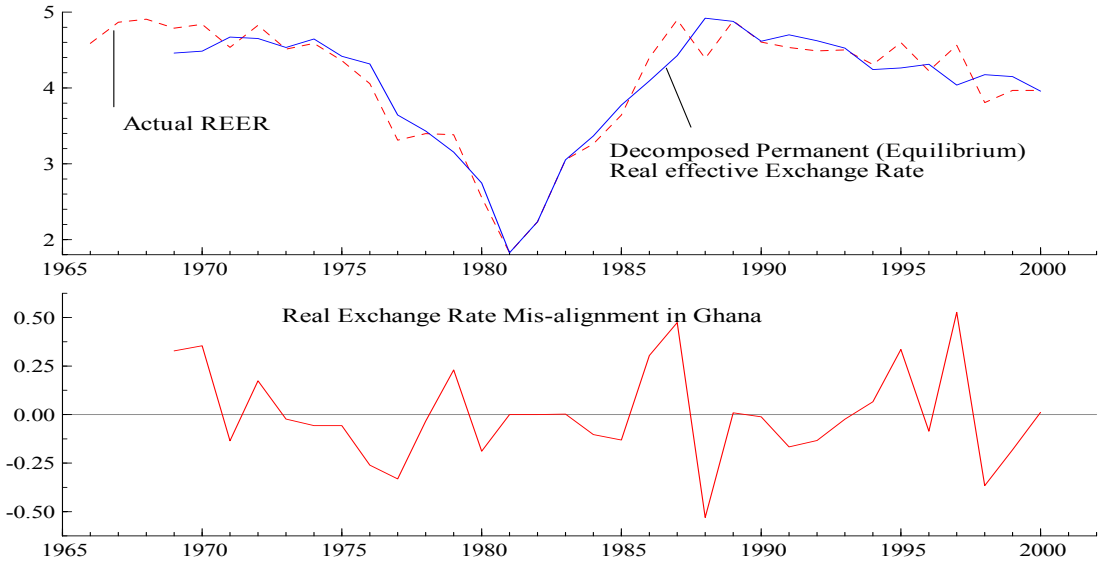
Figure 7: Impulse Response Functions for shocks to AID and OPEN (on LREER Equation)



[20] We used the aid equation in the impulse response analysis and derivation of ERER and misalignment so that we could compare our results with other studies. Using CAPF1 and CAPF2 does not change the trends.

Finally, we can estimate the equilibrium real effective exchange rate using the multivariate orthogonal decomposition technique (Gonzalo and Granger, 1995). See appendix for an outline of this procedure. This allows only the innovations from the permanent component of the fundamentals to affect the long-run forecast of the real effective exchange rate. The results show that the REER in Ghana has persistently been mis-aligned[22] (see Figure 8, full details in the Appendix). The extent of misalignment was quite small prior to the mid-1980s, but there were large misalignments around 1987/88 and 1997/98. This supports the claim by Edwards (1988) that real exchange rates in developing countries are persistently misaligned, and that this poses a major problem for exchange rate management. In the years when Ghana introduced economic reform (1974, 1983 and 1987) the currency tends to be undervalued, perhaps because macroeconomic instability prompts reform. Otherwise, the currency tends to be over-valued in real terms.

Figure 8: Equilibrium Real Effective Exchange Rate and Misalignment



[21] One may wonder why imports (demand for foreign exchange) and exports (supply of foreign exchange) would have the same effect. However, as indicated above, trade volume is driven by changes in exports given relatively stable imports.

[22] [22] Misalignment is defined as:

$$RER_{mis} = \frac{RER - ERER}{ERER}$$

where, RER_{mis} is real exchange rate misalignment, RER is the observed real exchange rate, and $ERER$ represents the permanent movement in the fitted equilibrium real exchange rate after decomposing the original fitted values into permanent and temporary movements. The vertical scale of the lower panel of figure 7.3 measures the percentage misalignment while the horizontal scale measures the period.

7 Conclusions and Implications

This paper examines the real effects of aid inflows on the Ghanaian economy by looking at how real effective exchange rate responds to changes in its fundamentals, particularly the effect of changes in Aid. Our model drew on Dutch Disease theory and the theory of long-run determinants of equilibrium real exchange rates. We used annual data over the period 1966-2000. *A priori* expectation based on theory is that in the long-run excessive inflows would lead to overheating in the economy and consequently lead to increase in the demand for non-tradables causing increase in price of non-tradables, and finally leading to a fall in the REER (that is real appreciation). We tested this hypothesis for Ghana.

This paper contributes to the empirical literature in the following way:

- The use of VARs to properly model the data and test theoretical hypothesis against empirical analysis. This approach addresses problems of endogeneity and exogeneity, and of interaction and interdependence of the fundamentals in determining their impact on REER. This allows us to capture some of the dynamics within these models by using linear combinations of the common stochastic trends to generate impulse response analysis.
- We have been able to use the multivariate orthogonal decomposition methodology to estimate the equilibrium real exchange rate (in Ghana) and its misalignment. In comparison to the use of fitted values, we notice that fitted values includes both the transitory and permanent components of the innovations in the fundamentals and thus does not measure the true equilibrium values. By using the multivariate orthogonal decomposition methodology our study has treated equilibrium as a steady state relation rather than a static equilibrium (which has been the case in most studies). Thus, the approach offers improved measures of equilibrium REER and misalignment.
- The novelty of this study is that by decomposing the capital inflows (official, "permanent" and "non-permanent"), we have been able to establish the magnitude and direction of their impact on real exchange rate in both the long and short run. This is vital for policy purposes in developing countries. We show that different types of capital inflows have different implications on REER in the long and short run.

In summary, our study has been able to establish the following:

- there is a long run relationship between REER and its fundamentals (co-integration relation) with all the variables being significant in the co-integrating space including the shift dummy (a measure of SAP and liberalisation).
- Neither "permanent" (FDI, remittances and grants) nor "non-permanent" (loans, equities, portfolio investments) capital inflows[23] have a short run effect on the real exchange rate in Ghana. Short-run deviations from the long-run (mis-alignments) are driven by changes in trade volume (changes in exports mainly). This is particularly important for policy in managing exchange rate misalignments in Ghana.
- Capital inflows (all measures) had a strong and significant appreciation effect on the real exchange rate in the long-run, confirming the Dutch Disease hypothesis in Ghana. The extent of appreciation in the long-run was slightly greater for the "permanent" inflows than for the "non-permanent" inflows.
- The study also establishes that the direction of misalignment of the cedi has moved in tandem with identifiable policy changes (showing a history of persistent misalignments). The implication of this is that one can identify regime effects in the pattern of misalignment in Ghana. Anytime Ghana introduced some kind of adjustment (1974, 1983 and 1987), the cedi tends to be undervalued. This is mainly due to the significant depreciation of the exchange rate associated with these reforms. However, as the gains from the reforms dissipate over time, the cedi begins to over-value. Other than these periods, the currency has mainly been over-valued in real terms. Significant among these periods were 1987 when the financial sector reforms were introduced in Ghana and the exchange rate system was gradually liberalised to reflect market conditions.
- Finally, this paper contributes to the debate in policy circles on "what constitutes the equilibrium real exchange rate" in terms of the fundamental determinants. The estimated model will allow Ghanaian policy makers to assess how fundamentals contribute to overvaluation or undervaluation. This provides direction to policy decisions in an attempt to correct the misalignment and manage the exchange rate.

[23] The same interpretation applies to official inflows measured as aid.

References

Baffes, J., Elbadawi, A., and O'Connell, A. (1999). 'Single Equation Estimation of the Equilibrium Real Exchange Rate' in Hinkle, L and Montiel, P, J (eds), *Exchange Rate Misalignment, Concepts and Measurements for Developing Countries*, A World Bank Research Publication, Oxford University Press.

Banerjee, A., Dolado,J.J., Galbraith, J.W. and Hendry, D.F. (1993), *Co-Integration, Error-Correction, and the Econometric Analysis of Non-Stationary Data*, Advanced Texts in Econometrics, Oxford University Press.

Bank of Ghana Annual Reports and Economic Bulletins (Various Editions), Information, Documentation and Publication Department (IDPS), Bank of Ghana.

Brown, T.M (1972) "Macroeconomic Data for Ghana", *Economic Bulletin of Ghana*, Vol. 2, nos. 1 and 2.

Edwards, S (1989). *Real Exchange Rates, Devaluation, and Adjustment*. Cambridge, Mass: MIT Press.

Edwards, S (1988). 'Real and Monetary Determinants of Real Exchange Rate Behaviour, Theory and Evidence from Developing Countries', *Journal of Developing Economies* **29:**311-41

Edwards, S (1994) 'Real and Monetary Determinants of Real Exchange Rate Behaviour: Theory and Evidence from Developing Countries', in Williamson, J (eds) *Estimating Equilibrium Exchange Rates*, Institute for International Economics.

Elbadawi, I. (1994) 'Estimating Long-Run Equilibrium Real Exchange Rates', in Williamson, J (eds) *Estimating Equilibrium Exchange Rates*, Institute for International Economics.

Elbadawi, I and Soto, R (1997). 'Real Exchange Rates and Macroeconomic Adjustment in Sub-Saharan Africa and Other Developing Countries', *Journal of African Economies,* **6***(3):74-120*.

Favero, C.A (2001). *Applied Macroeconometrics*, Oxford: Oxford University Press.

Ghana Economic Surveys , published by Statistical Service of Ghana.

Ghura, D and Grennes, T. (1993) "The Real Exchange Rate and Macroeconomic Performance in Sub-Saharan Africa". Journal of Development Economics **42**, 155-74.

Gonzalo, J and Granger, C. (1995), 'Estimation of Common Long Memory Components in Co-integrated Systems', *Journal of Business and Economic Statistics*, **13**, 27-36.

Granger, C.W.J and Newbold, P (1977), *Forecasting Economic Time Series*, Academic Press, New York, NY.

Harris, R.I.D (1995), *Using Co-integration Analysis in Econometric Modelling*, Prentice Hall.

Hamilton, J. (1994). *Time Series Analysis*. Princeton: Princeton University Press.

Hinkle, L. E. and Montiel, P.J (1999) (eds), *Exchange Rate Misalingment*, Oxford University Press/World Bank.

International Financial Statistics (various Editions), Publication of the International Monetary Fund (IMF).

Johansen, S. (1988). 'Statistical Analysis of Co-integration Vectors', *Journal of Economic Dynamics and Control* **12**, 231-254.

Johansen, S. (1989), 'Likelihood Based Inferences on Co-integration. Theory and Applications', Cento Interuniversitario di Econometria (CIDE), Bologna.

Johansen, S. (1995), *Likelihood Based Inference in Co-integrated Vector Autoregressive Models*, Oxford University Press, Oxford.

Johansen, S (1996) 'Likelihood Based Inference for Cointegration of Non-Stationary Time Series'. In: D.R. Cox., D. Hinkley, and O.E. Barndorff-Nielsen (eds.), *Likelihood, Time Series with Econometric and other Applications*. Chapmann and Hall.

Johansen, S. and Juselius, K (1990), 'Maximum Likelihood estimation and inference on Co-integration-with applications to the demand for money', *Oxford Bulletin of Economics and Statistics* **52**, 169-210.

Juselius, K. (2003).*The Co-integrated VAR Model: Econometric Methodology and Macroeconomic Applications* (forthcoming).

Leith, J.C (2000) 'Ghana: Long Term Growth, Atrophy and Recovery: A Report for the OECD Development Centre Project, Paris: OECD.

Montiel, P. J. (1999). 'Determinants of the Long-Run Equilibrium Real Exchange Rate: An Analytical Model' in Hinkle, L and Montel, P, J (eds) *Exchange Rate Misalignment, Concepts and Measurements for Developing Countries*, A World Bank Research Publication, Oxford University Press.

Olofsgard, A. and Olausson, M (1993) 'Development Assistance and Dutch Disease Evidence from Kenya', Stockholm: Stockholm University.

Opoku-Afari, M. (1996), "Interest Rate Determination in Ghana:1960-1994", MPhil Thesis at the Department of Economics, University of Ghana, Legon. Ghana (unpublished).

Reinold, H and Til van (1994) 'Recent Experiences with Floating Exchange Rates in Developing Countries: Case Study of Ghana', in R. C. Barth and W. Chorng-Huey (eds) *Approaches to Exchange Rate Policy: Choices for Developing Economies*, IMF Institute, Washington.

Sackey, A (2001). 'External Aid and Real Exchange Rates in Ghana', AERC, Nairobi, Kenya.

Sims, C.A (1980). 'Macroeconomics and Reality', *Econometrica*, **48**:1-48.

Stein, J. L. (1992) 'Fundamental Determinants of Exchange Rates', Journal of International and Comparative Economics, **1** (2).

Van Wijnbergen, S and Edwards, S (1989) 'Disequilibrium and Structural Adjustment', in Chenery, H. and Srinivasan, T.N. (eds) *Handbook of Development Economics* **2**: 1481-1533

White, H. and Wignaraja, G (1992) 'Exchange Rates, Trade Liberalisation and Aid: The Sri Lankan Experience', *World Development*, **20** (10):1471-1480

Williamson, J (1994). *Estimating Equilibrium Exchange Rates*. Washington, D.C: Institute for International Economics.

Younger S.D (1992) 'Aid and the Dutch Disease: Macroeconomic Management When Everybody Loves You', *World Development* **20** (11) 1587-1597.

APPENDIX A: Data Sources and Definitions

Terms of Trade (*TOT*) are from the World Bank African Development Indicators (2002 CD ROM) and are defined as relative prices of exports to imports with $1995 = 100$.

Openness (*Open*) is measured as exports plus imports as a ratio of GDP, with data from the World Bank African Development Indicators (2002 CD ROM).

Technological Change (*TFP*) is estimated from a simple Cobb-Douglas production function involving only two factors (capital and labour) by assuming constant returns to scale. The labour share is defined as the average labour income as a ratio of GDP and the capital coefficient is defined by factor shares. We assumed a labour share of 0.77, implying a capital coefficient of 0.23, following Brown (1972) and Leigh (2000). The rather low level of the capital coefficient may be explained by excess capacity in state owned enterprises and mining facilities. Figure B1 panel 5(a) plots total factor productivity (TFP), the residual from the growth accounting equation. Data for the estimation were drawn from the World Bank Development Indicators 2002.

Capital inflows as defined in three different versions in the paper was based on data from the *Geographical Distribution of Financial Flows to Aid Recipients* (OECD/DAC, CD ROM)

Real Effective Exchange Rate (*REER*) was measured as nominal effective exchange rate multiplied by the ratio of a trade-weighted wholesale price index of Ghana's trading partners and the consumer price index in Ghana. The data are from the *Direction of Trade Yearbook* (various editions) and the IMF *International Financial Statistics* (various editions).