

# THE DETERMINANTS OF THE REAL EXCHANGE RATE IN SIERRA LEONE

ROBERT DAUDA KORSU (Ph.D) and SAMUEL JAMIRU BRAIMA\*

(Email: [rdkorsu@yahoo.co.uk](mailto:rdkorsu@yahoo.co.uk))

(Email: [samjambra1@yahoo.com](mailto:samjambra1@yahoo.com))

## ABSTRACT

*The real exchange rate measures the competitiveness of an economy to international trade. In Sierra Leone, the nominal exchange rate has been depreciating since the early 1970s as a result of either official intervention, during the fixed exchange rate regime, or a combination of official intervention and market forces, during the managed floating exchange rate regime. This scenario has had little reflection on the real exchange rate.*

*Though both the nominal exchange rate and the price level are used to construct the real exchange rate, previous studies on the determinants of real exchange rate in developing countries captured the effects of nominal exchange rate on the real exchange rate without capturing the effects of price changes. This paper therefore investigates the determinants of the real exchange rate for Sierra Leone by controlling also for the effects of price changes, using annual aggregate data from 1970 to 2005.*

*The estimated model is based on the inter-temporal optimizing framework of Edwards (1989). Unit root and cointegration tests are carried out and an error correction model of the actual real exchange rate model is estimated in the context of Hendry's general-to-specific modeling while the equilibrium real exchange rate is estimated using the Johansen Maximum Likelihood procedure. The results show that increases in the price level, capital inflow, capital accumulation and trade restrictions appreciate the actual real exchange rate of Sierra Leone while increases in the nominal exchange rate and output depreciate it. Improvement in the terms-of-trade and an increase in capital-inflow depreciate the equilibrium real exchange rate while capital accumulation, increase in output, increase in government expenditure and trade restrictions appreciate the equilibrium real exchange rate.*

*Hence, for a real depreciation to be sustained, policy makers should strengthen efforts to control the rate of inflation and concentrate revenue from capital inflow on investment in the tradable goods sector. Moreover, increased trade liberalization and use of supply-side policies to increase output are important for realizing real depreciation of the real exchange rate of Sierra Leone.*

JEL Classification Code: F00, F31, F41

\*Robert Dauda Korsu and Samuel Jamiru Braima are lecturers at the Department of Economics, Fourah Bay College, University of Sierra Leone.

## 1. INTRODUCTION

The real exchange rate is an important player in the growth of an economy as both its level, and stability are important in driving up exports and private investment. Moreover, misalignment of the real exchange rate leads to price distortions and hence resource misallocation (between the tradable and non-tradable goods sectors). While misalignment of the real exchange rate can be an undervaluation or overvaluation, overvaluation has been the common case in developing countries. An overvalued real exchange rate reduces profit in the tradable goods sector, thereby reducing investment in this sector. This has negative implications on export and hence the trade balance. Persistence overvaluation of the real exchange rate may also lead to currency crisis (Xiaopu, 2002). The growing overvalued exchange rate that took off in sub-Saharan Africa in the early 1980s contributed to the poor performance on the current account balances in the region (Ghura and Grennes 1993).

In Sierra Leone, high rates of inflation and slow growth have not been the only macroeconomic challenges but poor external sector performance has also been persistent. Table 1.1 shows Sierra Leone's macro economy at a glance. The table shows that high rate of inflation was a common phenomenon in Sierra Leone from the mid 1970s to 2000. Slow growth was also a problem in Sierra Leone in the same period while poor external sector performance was the case even after 2000 (from the 1970s to 2005).

Table 1.1 also reveals important information about the nominal and real exchange rates of Sierra Leone. Nominal exchange rate depreciation increased from 1.4 % over the period 1970-1975 to 34 % over the period 1980-1985 while real exchange rate depreciation was negative (an appreciation) over the period 1970-1975 (-1.3%). The negative depreciation (an appreciation) of the real exchange rate increased over the period 1980-1985 (-3.0 %). Over the period 1986-1990, nominal exchange rate depreciation was 112 % while real exchange rate depreciation was only 16.0 %. Over the period 1991-1995 nominal exchange rate depreciation was 41.9 % while real exchange rate depreciation was negative (-1.7 %). Over the periods 1996-2000 and 2001-2005 nominal exchange rate depreciations were 23.8% and 6.9 % respectively, while real exchange rate depreciations were only 5.0 % and 3.0 % respectively. These figures show that nominal exchange rate in Sierra Leone has been depreciating but with only weak reflection on the real exchange rate, which is the measure of the competitiveness of the economy to international trade.

**Table 1.1: Basic Macro Economic Indicators for Sierra Leone, 1970 to 2005**

Indicator	1970-1975	1976-1979	1980-1985	1986-1990	1991-1995	1996-2000	2001-2005
Real GDP Growth (%)*	3.24	1.57	1.36	0.86	-6.1	-4.48	6.31
Inflation Rate (%)	8.43	14.41	45.81	93.12	48.12	21.37	6.53
Export (% of GDP)	23.99	20.03	13.31	18.36	14.72	2.15	8.95
Import ( % of GDP)	30.37	30.57	23.13	20.6	18.49	16.48	27.63
Export Growth (%)	3.61	19.86	28.58	123.08	22.95	18.14	80.01
Import Growth (%)	12.27	19.59	21.88	101.83	39.61	44.76	26.66
Trade Balance (% of GDP)	-6.38	-10.5	-9.82	-2.24	-3.72	-14.33	-18.69
Nominal Exchange Rate (Bilateral with U.S)	0.84	1.09	2.16	58.78	540.84	1472.4	2404.8
Nominal Exchange Rate Depreciation (%)	1.4	4.8	34.07	112.07	41.97	23.83	6.9
Real Exchange Rate Depreciation (%) (Bilateral with U.S dollar)	-1.31	4.65	-3.03	16.01	-1.66	5.00	3.02

Source: Calculated by author from International Financial Statistics CD ROM 2007

\* Calculated by author from World Development Indicators CD ROM 2007

The important question then is ‘what are the determinants of the real exchange rate of Sierra Leone?’ This paper therefore investigated the determinants of the real exchange rate of Sierra Leone, taking into consideration both the short- run (actual) and long run (equilibrium) determinants. The importance of examining both the actual and equilibrium perspectives is predicated on the fact that a combination of the two sets of determinants can bring appropriate policy response to not only depreciating the observed real exchange rate (thereby boosting investment in the tradable sector) but also to handling deviation of the actual real exchange rate from its equilibrium value (misalignment of the real exchange rate).

The rest of the paper is organized as follows. Section 2 is an overview of exchange rate policies in Sierra Leone. Section 3 is literature review. Section 4 is methodology and empirical results and Section 5 is conclusion and lessons for policy.

## **2. OVERVIEW OF EXCHANGE RATE POLICIES IN SIERRA LEONE**

As in the case of many developing countries, Sierra Leone continued the use of the fixed exchange rate regime after the collapse of the Bretton Woods System in the early 1970s. The authorities were initially reluctant to devalue the leone or adopt the (managed) flexible exchange rate regime, which had been adopted in many developed economies following the collapse of the Bretton Woods System. The reluctance to devalue the leone was based on the fear that such action would reduce the external value of the leone and increase the general price level through the exchange rate pass-through phenomenon. However, with the experience of persistent deficit in the balance of payments, series of exchange rate adjustments were adopted in the 1980s and eventually in 1990, the floating exchange rate regime (a managed type) was adopted.

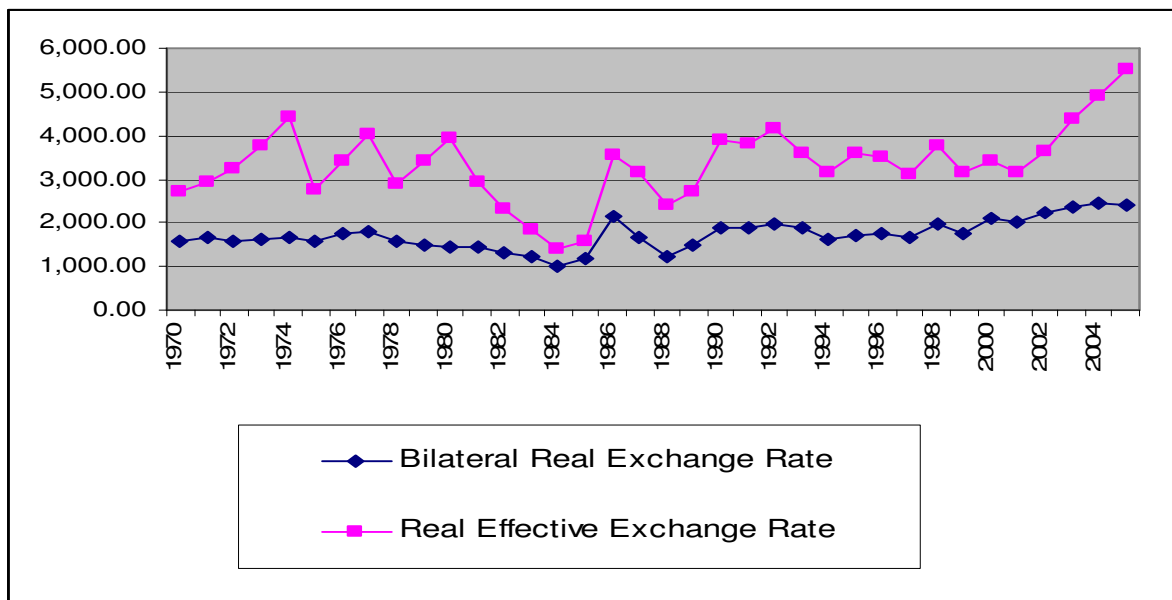
The leone was devalued for the first time in November 1967 following the devaluation of the pound sterling, by 14.3 %. The key motivation of the devaluation was to prevent capital outflow following the devaluation of the pound sterling. The leone was pegged to the British pound in 1967 until 1978, at a rate of two leones per British pound (Le 2.00 = £ 1.00), when it was de-linked from the pound and set at the rate of Le 2.25 per special drawing right (SDR).

As a result of the declining economic performance of the early 1980s, including poor external sector performance, a dual exchange rate system was introduced in December 1982, under the Modified Exchange Rate Arrangement (MERA). This involved an official exchange rate and a commercial market rate. The official exchange rate was set at Le 1.52 per U.S \$ while the commercial market rate had no definite rate. This policy did not prove to be effective since external sector performance continued to deteriorate. This was however not surprising since such a system often encourages the diversion of export earnings from the official market to the parallel market.

A unified exchange rate system was adopted in July 1986. However, fiscal deficit continued to grow and was mainly financed by borrowing from domestic banking system, especially through domestic credit to the government. Hence, money supply was difficult to control, leading to inconsistent monetary expansion with high inflation and real exchange rate appreciation as consequences. Three devaluations took place between August 1987 and January 1990.

In April 1990, the leone was floated in the context of the managed type and most current account transactions were liberalized. The main reason for the adoption of the managed floating exchange rate regime was the fact that in the fixed exchange rate regime the premium between the official and parallel market rate was getting larger. Thus, smuggling of diamond, gold and other produce was on the increase, thereby undermining the balance of payments. Over the period 1970 to 2005, the nominal exchange rate (defined as leones per U.S dollar) increased with little reflection on the real exchange rate (see Table 1.1). Figure 2.1 shows the real exchange rate over the period 1970 to 2005.

**Figure 2.1: The Real Exchange Rate in Sierra Leone**



*Source:* Calculated by author from International Financial Statistics CD-ROM 2007

### **3. LITERATURE REVIEW**

Empirical studies on the determination of real exchange rate (hence real exchange rate misalignment) have been challenging. This difficulty arises from the fact that both the actual and equilibrium real exchange rate have to be determined. Moreover, the equilibrium real exchange rate is unobservable.

A strand of the literature on real exchange rate is the case of the developed economies. This strand uses the purchasing power parity (PPP) or the macroeconomic balance approach to determine the equilibrium real exchange rate and hence the degree of real exchange rate misalignment without paying attention to the determinants of the real exchange rate. Hence, the focus of this strand is mainly the determination of the degree of misalignment of the real exchange rate rather than the determinants of the real exchange rate.

Another strand in the literature is the case of developing countries. This was pioneered by Edwards (1988, 1989) and later by Rodriguez (1989), Elbadawi (1994) and Montiel (1997). Edwards (1989) built a theoretical model for developing countries to explain the short and long run determinants of the real exchange rate. He applied the model to a panel of twelve countries observed over the period 1962 and 1985 by using fixed effect model. His sample includes Brazil, Columbia, El Salvador, Greece, India, Israel, Malaysia, Philippines, South Africa, Srilanka, Thailand and Yugoslavia. His finding is consistent with his theoretical prescription that in the short run both real and nominal variables affect the real exchange rate while in the long run only real variables affect the real exchange rate (that is, only real variables affect the equilibrium real exchange rate). His finding showed that the fundamental (long-run) determinants of the real exchange rate are the terms of trade, level and composition of government consumption, controls on capital flows, exchange and trade controls, technological progress and capital accumulation. His study revealed that in the short run both the nominal exchange rate and domestic credit as well as the real variables that determine the long run real exchange rate are the determinants of the real exchange rate. The coefficient of terms of trade was found to be negative, the coefficient of the ratio of government expenditure to GDP was found to be negative, the coefficient of exchange and trade controls (proxied by parallel market premium) was found to be negative, the coefficient of technological progress (proxied by output growth) was found to be positive (contradicting the Ricardo-Balassa hypothesis), the coefficient of capital flow (lagged) was

found to be negative and the coefficient of capital accumulation (measured as investment-GDP ratio) was found to be positive. He also found that in the short run nominal exchange rate depreciation leads to a depreciation of the real exchange rate while an increase in domestic credit leads to an appreciation of the real exchange rate.

The work of Edwards (1989) inspired many studies on the determinants of the real exchange rate as well as the determination of real exchange rate misalignment in developing countries. These studies include Ghura and Grennes (1993) for a panel of sub-Saharan African economies, Elbadawi (1994) for Chile, Ghana and India, Cottani et al (1990) for a group of developing countries, Amin and Awung (1997) for Cameroon, Congo and Gabon, Parikh (1997) for South Africa, Aron et al. (1997) for South Africa, Baye and Khan (2002) for Nigeria, Mweza (1993) for Kenya, Olopoenia (1992) for Nigeria, Obadan (1994) for Nigeria, Ogun (1998) for Nigeria, Eita and Sichei (2006) for Namibia, Baffes et. al.(1997) for Cote d'Ivoire and Burkina Faso, Hyder and Mahboob (2006) for Pakistan and Mungule (2004) for Zambia.

Owing to data problem, the numbers of real variables that have been used as explanatory variables in the determination of the real exchange rate have not been the same across empirical studies but the nominal variables used are nominal exchange rate and domestic credit (or excess domestic credit). A common observation in the studies on the determinants of the real exchange rate in the developing countries are that both the nominal exchange rate and domestic credit expansion have only short run impact on the real exchange rate while real variables have both long run and short run impact on the real exchange rate.

Single equation approach has been used to determine the impact of monetary variables on the short-run (actual) real exchange rate. This approach assumes that excess domestic credit increases the price level thereby leading to appreciation of the real exchange rate. However, though previous studies used excess domestic credit in the real exchange rate model and considered its effects on the real exchange rate to work by raising the price level, none of them has tested the direct effect of price changes on the real exchange rate.

Some studies have applied The Ordinary Least Squares (OLS) regression to investigate the determinants of the real exchange rate ( for example, Ghura and Green, 1993, Cottani et al, 1990, Sekkat and Varondakis, 1998 and Afridi, 1995) while some others have applied the technique of unit root, cointegration and equilibrium correction modeling ( for example, Elbadawi 1994, Montiel 1997, 1999, Elbadawi and Soto 1997, Gelbard and Nagayasu ,1999, Kadenge, 1998,

Baffes et al.,1999, Faruquee,1995, Feyzioglu,1997, Kemme and Roy, 2005, Hyder and Mahbood 2006, and Eita and Sichei, 2006).

Another observation in the literature is the fact that while some studies examined the determinants of the short-run real exchange rate as well as the (long-run) equilibrium real exchange rate ( and hence characterize the nature of misalignment of the real exchange rate) other studies go further to determine the effect of real exchange rate misalignment on key macroeconomic variables. Studies in the former category include: Baffes et al. (1999), Baye and Khan (2002), Kemme and Roy (2005), Eita and Sichei (2006), Hyder and Mahbood (2006). Studies that fall under the latter category include: Edwards ( 1989), who found that in his sample of twelve developing countries, those with less real exchange rate misalignment performed better ( in terms of growth of output) than those with more real exchange rate misalignment; Ghura and Grennes (1993) who found that real exchange rate misalignment negatively affects income growth, exports, imports, investment and savings; Ogun (1998), who found that real exchange rate misalignment has negative effect on non-oil exports of Nigeria, Grober (1993), who found that exchange rate misalignment had no effect on the exports of Argentina, Brazil, Colombia, Greece, Malaysia, Mexico, Philippines, South Africa, Thailand and Yugoslavia. However, Grober's result is in contrast with most of the other developing-country studies probably because his measure of misalignment was based on the black market premium while most of the other studies on developing countries used the model based approach to obtain the equilibrium real exchange rate ( and hence the real exchange rate misalignment).

The review of the empirical literature on the determinants of the real exchange rate reveals that while much has been done on developing countries, the authors are not aware of studies on Sierra Leone. Moreover, while the real exchange rate is calculated using the nominal exchange rate and the price level, the nominal exchange rate has been included in models of real exchange rate but the price level has not been included in these models. This study departs from previous studies on the determinants of the real exchange rate by accounting for the direct effects of the price level on the real exchange rate.

## 4. METHODOLOGY AND EMPIRICAL RESULTS

### 4.1 Methodology

The theoretical framework for modeling the dynamics of the real exchange rate is the intertemporal optimizing model developed by Edwards (1989). This choice draws from the fact that unlike other theoretical models that focus only on the determinants of the equilibrium real exchange rate, it distinguishes factors that determine the equilibrium real exchange rate from those that determine the short-run dynamics of the real exchange rate. Moreover, the model was developed to capture the structure of a typical developing country. This model has been used to estimate real exchange rate models in many developing countries (For example, Mungule 2004 for Zambia and Ghura and Grennes 1993 for sub Sahara Africa (SSA)).

His model takes into account the effects of nominal exchange rate depreciation/ devaluation and macroeconomic policies (monetary and fiscal policies) on the short run dynamics of the real exchange rate and controls for initial equilibrium condition (disequilibrium between the long- run equilibrium real exchange rate and the actual real exchange rate).

According to this model, the real exchange rate is determined by three forces: (i) nominal exchange rate depreciation/devaluation. That is, nominal exchange rate depreciation leads to real exchange rate depreciation in the short run (ii) the tendency for actual real exchange rate to correct existing misalignments between long run (equilibrium) real exchange rate and actual real exchange rate. This self-correcting process is considered to be higher when the reduction in price of nontradable goods is higher. (iii) macroeconomic policies. That is, unsustainable (inconsistent) macroeconomic policies appreciate the real exchange rate. This is functionally represented as follows:

$$\Delta \ln RER_t = \Psi (\ln RER_t^* - \ln RER_{t-1}) - \Omega (Z_t - Z_t^*) + \Phi (\ln e_t - \ln e_{t-1}) \quad (4.1)$$

$$0 < \Psi < 1, 0 < \Omega < 1 \text{ and } 0 < \Phi < 1$$

Where: RER = actual real exchange rate, RER\* = equilibrium real exchange rate, Z = index of macro policies, Z\* = the sustainable level of macro policies, e = nominal exchange rate, t is time subscript and  $\Delta$  is the difference operator.

The first term on the right hand side of equation (4.1) captures the autonomous tendency for the actual real exchange rate to correct existing misalignment, with  $\Psi$  being the speed at which this takes place. The second term captures the effect of unsustainable macroeconomic policies on the movement of the real exchange rate and the third term captures the effect of nominal exchange rate depreciation/devaluation on the real exchange rate movement.

A basic problem encountered in estimating equation (4.1) is that the equilibrium real exchange rate ( $RER^*$ ) is unobservable. However, it has been recognized in the literature (for example Edwards (1989) , Montiel (1999) , Dornbusch (1973) , Rodriguez (1989) and Elbadawi (1994) that the equilibrium real exchange rate is determined by real factors only. Edwards (1989) derived these factors to be the terms of trade (TOT), level and composition of government consumption as a ratio of GDP (GCN), control on capital flows (CAPCON), exchange and trade controls (EXHCON), technological progress (TECPRO) and capital accumulation as a ratio of GDP ( $I/GDP$ ). In log linear form this is given as:

$$\begin{aligned} LnRER_t^* &= v_0 + v_1 Ln(TOT)_t + v_2 Ln(GCN)_t + v_3 Ln(CAPCON)_t + \\ &\quad v_4 Ln(EXHCON)_t + v_5 Ln(TECPRO)_t + v_6 Ln(I / GDP)_t \end{aligned} \quad (4.2)$$

$v_1, v_2, v_6 > 0$  or  $< 0$  ,  $v_3, v_4, v_5 < 0$

Substituting equations (4.2) in equation (4.1) and simplifying the resulting expression gives the following equation:

$$\begin{aligned} LnRER_t &= \bar{w}_0 + \bar{w}_1 Ln(TOT)_t + \bar{w}_2 Ln(GCN)_t + \bar{w}_3 Ln(CAPCON)_t + \\ &\quad \bar{w}_4 Ln(EXHCON)_t + \bar{w}_5 Ln(TECPRO)_t + \\ &\quad \bar{w}_6 Ln(I / GDP)_t + (1 - \Psi) Ln(RER)_{t-1} - \\ &\quad \Omega(Z_t - Z_t^*) + \Phi(Lne_t - Lne_{t-1}) + U_{1t} \end{aligned} \quad (4.3)$$

$$\bar{w}_1 > / < 0, \bar{w}_2 > / < 0, \bar{w}_3 < 0, \bar{w}_4 < 0, \bar{w}_5 < 0, \bar{w}_6 > / < 0, \Omega < 0 \text{ and } \Phi > 0.$$

Where the  $\bar{w}$ 's are combinations of the  $v$ 's and  $\Psi$  and  $U_1$  is an error term assumed to be identically and independently normally distributed.

A problem faced in the estimation of equation (4.3) is the determination of the components of inconsistent macro policy ( $Z-Z^*$ ). Excess supply of domestic credit (EXCRE) measured as the rate of growth of domestic credit minus lagged rate of growth of real GDP is used by Edwards to represent inconsistent monetary policy<sup>1</sup> while he used the ratio of fiscal deficit (FD) to high powered money (H) as a proxy for inconsistent fiscal policy.

Many studies on developing countries have used only excess domestic credit in their real exchange rate models to account for inconsistent macroeconomic policies (for example, Elbadawi, (1994), Parikh (1997) and Mungule (2004)). The basis of this is that fiscal deficits are mostly financed by seigniorage (printing money) in most developing countries. This serves to control for possible multicollinearity between inconsistent fiscal policy and monetary policy variables, given that fiscal deficits are often financed by seigniorage.

However, the inclusion of inconsistent monetary policy variables to capture inconsistent macroeconomic policies in the real exchange rate model is justified in the literature (pioneered by Edwards, 1989) on the grounds that such policies lead to higher inflation, and hence, appreciating real exchange rate. Therefore, their effects on the real exchange rate is only indirect. It is therefore important to determine the effects of inflation on the real exchange rate. This is done in this study by introducing the price level, rather than measures of these inconsistent macroeconomic policies, in the real exchange rate model.

Proxies are used for most of the variables in equation (4.3) because data is not available for them. In the case of technological progress, real gross domestic product (RGDP) is the traditional variable used as proxy (Edwards 1989). This is done in order to test the Ricardo-Balassa effect<sup>2</sup>. This proxy is adopted here in an effort to test the Ricardo-Balassa effect. To the extent that it is difficult to find a proxy for government expenditure on non-tradable goods, total government expenditure as a ratio of GDP is used. Control on capital flow (CAPCON) is represented by capital flow (CAPFLO) which is net change in reserve minus trade balance scaled by GDP, as there is no data on capital control. EXCHCON is represented by the closeness of the economy to international trade (CLOSE) as there is no data on exchange and trade control. The index of closeness is GDP divided by the sum of exports and imports.

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<sup>1</sup> This measure of excess domestic credit assumes that the demand for domestic credit is unitary elastic with respect to income (Edwards 1989).

<sup>2</sup> The Ricardo-Balassa thesis states that improvement in technology appreciates the real exchange rate.

The empirical model explaining the dynamics of the short-run real exchange rate is therefore given as follows:

$$\begin{aligned} \ln RER_t = & \varpi_0 + \varpi_1 \ln(TOT)_t + \varpi_2 \ln(G / GDP)_t + \varpi_3 \ln(CAPFLO / GDP)_t + \\ & \varpi_4 \ln(CLOSE)_t + \varpi_5 \ln(Y_g)_t + \\ & \varpi_6 \ln(I / GDP)_t + (1 - \Psi) \ln(RER)_{t-1} - \\ & \Omega \ln P_t + \Phi (\ln e_t - \ln e_{t-1}) + U_{1t} \end{aligned} \quad (4.4)$$

$$\varpi_1 > / < 0, \varpi_2 > / < 0, \varpi_3 < 0, \varpi_4 < 0, \varpi_5 < 0, \varpi_6 > / < 0, \Omega < 0 \text{ and } \Phi > 0.$$

Where P is the price level, Y is real gross domestic product, the  $\varpi$ 's are combinations of the  $\nu$ 's and  $\Psi$  and  $U_1$  is an error term assumed to be identically and independently normally distributed.

The real effective exchange rate (REER) is used to estimate the real exchange rate because it is weighted by the trade shares of exporting partners (thus controlling for third country effect). Moreover, most studies that have estimated real exchange rate models have used the notion of real effective (multilateral) rather than real bilateral exchange rate. The real effective exchange rate is computed as follows:

$$REER = \sum_{i=1}^{i=4} S_i \left( \frac{e_i C P I^*_i}{C P I} \right) \quad (4.5)$$

Where:

REER = real effective exchange rate

i = major export partner of Sierra Leone. Four major export partners are considered (Belgium, Germany, U.K and U.S with trade weighed calculated from World Fact Book as 0.7, 0.15, 0.1 and 0.05 respectively.

$S_i$  = the weight of country i in the total export of Sierra Leone

$CPI^*_i$  = the consumer price index of country i

## 4.2 Empirical Results

### 4.2.1 Tests for Stationarity

The importance of tests for stationarity of variables is rooted on the fact that regression involving non-stationary variables leads to misleading inferences since the estimated coefficients would be biased and inconsistent. When all or some of the variables are not stationary, it is important therefore to carry out appropriate transformation (differencing) to make them stationary. The Dickey Fuller class of tests and the Phillips-Perron Unit root tests for stationarity were used to test for variable stationarity.. Table 4.1 shows the result of the unit root tests.

**Table 4.1: Results of the Unit Root Tests: Using Dickey- and Augmented Dickey-Fuller Tests**

VARIABLE		Dickey Fuller (DF) Test		Augmented Dickey Fuller (ADF) Test				Conclusion
				One-Lag Model		Two-Lag Model		
		With Drift	Drift and Trend	With Drift	Drift and Trend	With Drift	Drift and Trend	
Nominal Exchange Rate	Level	0.1996	-1.5600	-0.5673	-1.9847	-0.5610	-1.7293	I (2)
	ΔLevel	-2.9085	-2.8240	-2.8658	-2.7617	-1.8921	-1.7604	
	Δ <sup>2</sup> Level	-6.2721**	-6.2192**	-6.3790**	-6.3721**	-4.6108**	-4.6708	
Real Exchange Rate	Level	-2.3050	-2.5172	-2.4536	-2.6846	-1.5429	-1.7870	I (1)
	ΔLevel	-5.8330**	-5.7941**	-5.6923**	-5.7101**	-3.5917*	-3.6978*	
Price Level	Level	-0.1767	-0.9117	-0.9496	-1.5136	-1.1703	-1.8135	I(2)
	ΔLevel	-2.5222	-2.4731	-1.9397	-1.9094	-1.5708	-1.5570	
	Δ <sup>2</sup> Level	-7.4967**	-7.5036**	-5.5491**	-5.6780**	-4.4155**	-4.6408**	
Capital Flow- GDP Ratio	Level	-1.8441	-2.2079	-1.1548	-1.4452	-1.5111	-1.1747	I(1)
	ΔLevel	-8.3873**	-8.2802**	-3.9946**	-3.9328**	-3.7142**	-3.7130**	
Closeness	Level	-2.1314	-2.2855	-1.8640	-1.9382	-2.1782	-2.6160	I(1)
	ΔLevel	-6.7002**	-6.6750**	-3.7591**	-3.7821*	-3.8790**	-3.9775*	
Terms of Trade	Level	1.6517	0.1005	3.4783	1.7778	1.8788	1.3518	I(1)
	ΔLevel	-7.3815**	-10.2537**	-2.4331	-3.9649*	-1.4380	-2.9358	
Investment -GDP Ratio	Level	-2.9388	-3.1928	-1.5911	-0.9211	-1.6912	-1.6360	I(1)
	ΔLevel	-10.6514**	-10.8305**	-4.3002**	-4.3902**	-3.6240*	-3.7144**	
Government Expenditure -GDP Ratio	Level	-2.7974	-2.7655	-2.1345	-2.1152	-2.1247	-2.0873	I(1)
	ΔLevel	-7.2984**	-7.1810**	-4.4019**	-4.3258**	-4.3401**	-4.2688*	
Real Income	Level	-1.2909	-0.5432	-1.5267	-1.1549	-1.8345	-2.1468	I(1)
	ΔLevel	-4.4831**	-4.5982**	-2.6379	-2.7441	-2.7787	-2.9601	
		<b>CRITICAL VALUES</b>						
		Auxiliary Regression with Drift		1%	5%			
		Auxiliary Regression with Drift and Trend		-3.6394	-2.9511			
				-4.2436	-3.5443			


Note : \*\* and \* indicate that the variable is stationary at the 1% and 5% level of significance respectively.

**Table 4.2 Results of the Tests for Stationarity: Using Phillips-Perron Test**

VARIABLE		Phillips Perron Test Statistic		Conclusion	
		With Drift	Drift and Trend		
Nominal Exchange Rate	Level	-0.147125	-1.915323	I(2)	
	$\Delta$ Level	-2.829664	-2.736458		
	$\Delta^2$ Level	-10.39575**	-13.53827**		
Real Exchange Rate	Level	-2.304985	-2.517244	I(1)	
	$\Delta$ Level	-6.129873**	-6.508672		
Price Level	Level	-0.349862	-1.647701	I(2)	
	$\Delta$ Level	-2.427801	-2.473054		
	$\Delta^2$ Level	-8.030880**	-11.93448**		
Capital Flow-GDP Ratio	Level	-1.599487	-2.207894	I(1)	
	$\Delta$ Level	-8.335548**	-8.319022**		
Closeness	Level	-2.174088	-2.454470	I(1)	
	$\Delta$ Level	-6.813759**	-6.899971**		
Terms of Trade	Level	2.696447	0.868821	I(1)	
	$\Delta$ Level	-7.238805**	-9.558644**		
Investment –GDP Ratio	Level	-2.674635	-3.192774	I(1)	
	$\Delta$ Level	-10.55310**	-10.95700**		
Government Expenditure – GDP Ratio	Level	-2.764257	-2.729361	I(1)	
	$\Delta$ Level	-8.216906**	-7.801281**		
Real Income	Level	-1.488208	-1.089614	I(1)	
	$\Delta$ Level	-4.451951**	-4.598229**		
<b>CRITICAL VALUES</b>					
		<b>1%</b>	<b>5%</b>		
Auxiliary Regression with Drift		-3.6394	-2.9511		
Auxiliary Regression with Drift and Trend		-4.2436	-3.5443		

Note: \*\* and \* indicate that the variable is stationary at the 1% and 5% level of significance respectively.

The unit root tests show that all the variables are not stationary. While the price level and the nominal exchange rate are stationary after second differencing, all other variables are stationary after first differencing. In order to determine how to model the short-run dynamics of the real exchange rate, it is therefore important to carry out test for cointegration.

#### 4.2.2 COINTEGRATION TEST

When two or more time-series are not stationary, it is important to test whether there is a linear combination of them that is stationary. This phenomenon is referred to as test for cointegration. The existence of cointegration implies that there is a long-run relationship among the variables. Hence, the short-run dynamics can be represented by an error correction mechanism (Engle and Granger 1987). We applied both the Engle-Granger Two-Step procedure and the Johansen Maximum Likelihood Methodology for the cointegration test. Table 4.3 shows the results of the cointegration test using the Engle-Granger Two-Step procedure. The result shows that there is cointegration among the variables of the model.

**Table 4.3: Result of the Cointegration Test Using the Engle-Granger Methodology**

	Dickey Fuller	Augmented-Dickey Fuller		Phillips Perron	Conclusion
		One Lag	Two Lags		
Residual from the Static Long-run Model	-4.923030**	-5.166248**	-4.073569**	-4.799765**	There is cointegration

Note \*\* implies that the residual is stationary at the 1 % level of significance

Table 4.4 presents the results of the cointegration test, using the Johansen methodology. The results show that based on the Traced Statistic and the Maximum Eigen-value Statistic, the null hypothesis that ‘there is no cointegration among the variables’ is rejected at both the 5% and 1% levels of significance. The Trace Statistic indicates 7 and 9 cointegrating equations at the 1% and 5% levels of significance respectively, while the Maxim Eigen-value test indicates 4 cointegrating equations at both the 5 % and 1 % levels. The cointegration test results are therefore uninformative about the number of cointegrating relations among the variables. However, Pesaran and Pesaran (1997) have pointed out that both the Trace Statistic and the Maximum-Eigen value Statistic give conflicting conclusions and decision about the number of cointegrating vectors should be based on economic theory or other available information. We therefore proceeded on the basis that at least, there is cointegration and then focused on the cointegrating relation that explains the real exchange rate. This led to our normalization with

respect to the real exchange rate variable. This approach has been used by Mtonga (2006) and Pesaran et. al.(2000).

**Table 4.4: The Result of the Cointegration Test by the Johansen Methods**

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.958	386.227	202.92	215.74
At most 1 **	0.865	278.134	165.58	177.20
At most 2 **	0.854	209.940	131.70	143.09
At most 3 **	0.769	144.531	102.14	111.01
At most 4 **	0.562	94.632	76.07	84.45
At most 5 **	0.476	66.553	53.12	60.16
At most 6 **	0.450	44.572	34.91	41.07
At most 7 *	0.313	24.216	19.96	24.60
At most 8 *	0.286	11.456	9.24	12.97

\*(\*\*) denotes rejection of the hypothesis at the 5%(1%) level

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.958	108.093	57.42	63.71
At most 1 **	0.865	68.194	52.00	57.95
At most 2 **	0.854	65.408	46.45	51.91
At most 3 **	0.770	49.900	40.30	46.82
At most 4	0.562	28.079	34.40	39.79
At most 5	0.476	21.981	28.14	33.24
At most 6	0.450	20.355	22.00	26.81
At most 7	0.313	12.761	15.67	20.20
At most 8	0.286	11.456	9.24	12.97

\*(\*\*) denotes rejection of the hypothesis at the 5%(1%) level

### 4.2.3 The Short-run Dynamics of the Real Exchange Rate

To the extent that the real exchange rate and the regressors of the model are not stationary and cointegration is established, the appropriate mechanism for modeling the short run real exchange rate for Sierra Leone is an error correction mechanism (ECM). We therefore estimated an error correction model of the real exchange rate. In the error correction model, the second differences of the nominal exchange rate and the price level were used while the first differences of all the other variables were used. This is because the former variables are integrated of order two while the latter are integrated of order one.

Table 4.5 shows the result of the parsimonious error correction model. In this model, while most of the variables are significant at the 1 % or 5 % level of significance, two of them (the previous value of the price level and the error correction term) are significant at the 10 % level. We deleted the least statistically significant variable (the previous price level) from this model to obtain a model in which all the variables are significant at the 1 % or 5 % level. However, investment, real GDP and capital flow became insignificant. Moreover, the log-likelihood and the Akaike Information Criterion suggest that the deletion of these variables is not useful though the Schwarz Criterion suggests that the deletion is useful. We therefore maintained the model in which the previous price level and the error correction term are significant at the 10 % level. Appendix Table 1 shows the result of the model obtained by considering critical values of the t-statistics at only the 1 % and 5 % levels of significance.

The result of the error correction model shows that nominal exchange rate depreciation leads to a depreciation of the real exchange rate of Sierra Leone and this effect holds both in the contemporaneous sense and after a year and the contemporaneous effect is higher than the effect after a year. The price level has negative effect on the real exchange rate of Sierra Leone. This implies that as the price level increases, the real exchange rate of Sierra Leone appreciates. This effect also holds after a year, though it decreases in magnitude. The one period lag of capital flow has negative effect on the real exchange rate though the contemporaneous value is insignificant in the model, implying that increase in capital flow to Sierra Leone in a particular year, appreciates the real exchange rate in the following year. This means that the Dutch Disease syndrome holds in Sierra Leone with a lag effect. The one period lag of closeness of Sierra Leone to international trade has a negative effect on the real exchange rate. Hence, commercial policies that encourage trade liberalisation in Sierra Leone depreciate the real exchange rate. The

lag value of investment-GDP ratio has a negative effect on the real exchange rate. Investment is expected to have a positive effect on the real exchange rate when investment takes place more in the tradable goods sector than the non-tradable goods sector; otherwise it is expected to have a negative effect on the real exchange rate. This sign implies that in Sierra Leone, investment takes place more in the non-tradable goods sector. Real GDP has a positive effect on the real exchange rate. This is in contrast to the prediction of the Ricardo-Balassa thesis. This result implies that in the short run, real GDP growth comes from the nontradable goods sector of Sierra Leone. The ratio of government expenditure to GDP is insignificant in the model. This insignificance could be as a result of the fact that the investment variable has both private- and government- sector components; government expenditure is made up of consumption and investment; and investment is significant in the model. This reflects the fact that over the period 1970 to 2005, government investment was higher than private investment in Sierra Leone. The terms of trade is also found to be insignificant in the real exchange rate model. The insignificance of the terms of trade implies that terms of trade as an external factors have not been a player in the determination of the competitiveness of Sierra Leone to international trade.

Various diagnostic tests were carried out in order to determine the robustness of the real exchange rate model. Appendix Table 2 shows the results of the residual diagnostic tests while Appendix Table 3 shows the results of the model stability test. The results show that the residuals of the model are normal, there is no autocorrelation problem, there is no heteroscedasticity problem and there is no auto regressive conditional heteroscedasticity.

**Table 4.5: The Parsimonious Error Correction Model of Real Exchange Rate**

	<b>Coefficient</b>	<b>Standard Error</b>	<b>t-Statistics</b>	<b>Prob</b>
Constant	0.030934	0.025798	1.199108	0.2427
$\Delta^2 \text{LnP}$	-1.150627	0.237587	-4.842966	0.0001
$\Delta^2 \text{Lne}$	0.842099	0.131167	6.420033	0.0000
$\Delta^2 \text{LnP}(-1)$	-0.473327	0.259940	-1.820909	0.0817
$\Delta^2 \text{Lne}(-1)$	0.678120	0.210024	3.228776	0.0037
$\Delta \left( \frac{\text{Capflo}}{\text{GDP}} \right) (-1)$	-1.680184	0.777228	-2.161764	0.0413
$\Delta \text{LnCLOSE}$	-0.328350	0.146334	-2.243835	0.0348
$\Delta \left( \frac{I}{\text{GDP}} \right) (-1)$	-0.219519	0.082190	-2.670886	0.0136
$\Delta \text{LnRGDP}$	0.721902	0.297296	2.428225	0.0234
ecm	-0.435559	0.237001	-1.837800	0.0790
R-squared	0.744356			
Adjusted R-squared	0.644322			
Akaike info criterion	-0.778083			
Schwarz criterion	-0.324596			
Log likelihood	22.83837			
F-statistic	9.263309			
Prob(F-statistic)	0.00005			

### 4.2.3: The Equilibrium Real Exchange Rate Model

The equilibrium real exchange rate model is estimated based on Elbadawi (1994), Rodriquez (1989) and Dornbusch (1973). The central idea here is that the equilibrium (long run) real exchange rate is a function of only real variables. Hence, the price level and nominal exchange rate were eliminated from the model. The Johansen Maximum Likelihood was applied in order to get the determinants of the long run real exchange rate. The choice draws from the fact that the static long run model, which is obtained by the ordinary least squares, leads to biased and inconsistent estimates of the long run parameters. Table 4.6 shows the normalized cointegrating coefficients for the equilibrium real exchange rate model and equation (4.6) shows the result of the equilibrium real exchange rate model.

**Table 4.6: Normalised Cointegrating Coefficients for the Equilibrium RER Model**

Normalized cointegrating coefficients (std.err. in parentheses)							
LnREER	Ln(I/GDP)	LnRGDP	Ln(G/GDP)	LnCLOSE	LnTOT	(CAPFLO/GDP)	C
1.0000	0.971088 (0.11758)	0.391988 (0.15667)	0.505255 (0.13727)	1.791473 (0.15977)	-0.336516 (0.06945)	-3.691915 (0.77170)	-9.038544 (1.86767)

$$\text{LnREER} = 9.0385 - 0.9711\text{Ln}(I/\text{GDP}) - 0.3920\text{LnRGDP} - 0.5053\text{Ln}(G/\text{GDP}) - 1.7915\text{LnCLOSE} + 0.3365\text{LnTOT} + 3.6919(\text{CAPFLO}/\text{GDP}) \text{-----} \quad (4.6)$$

The equilibrium real exchange rate model shows that the equilibrium real exchange rate of Sierra Leone appreciates with increase in investment, implying that in Sierra Leone investment takes place more in the nontradable goods sector than the tradable goods sector. The equilibrium real exchange rate appreciates with increase in real GDP. This implies that in the long-run the Ricardo-Balassa effect holds in Sierra Leone. Hence, in the long run, productivity growth takes place in the tradable goods sector of Sierra Leone. The equilibrium real exchange rate appreciates also with increase in government expenditure and commercial policies that reduce trade liberalisation. However, the equilibrium real exchange rate depreciates with increase in the terms of trade and capital inflow. The sign of the coefficient of terms of trade implies that the substitution effect of an improvement in the terms of trade of Sierra Leone outweighs the income effect. The sign of the coefficient of capital flow shows that in the long run, increase in capital

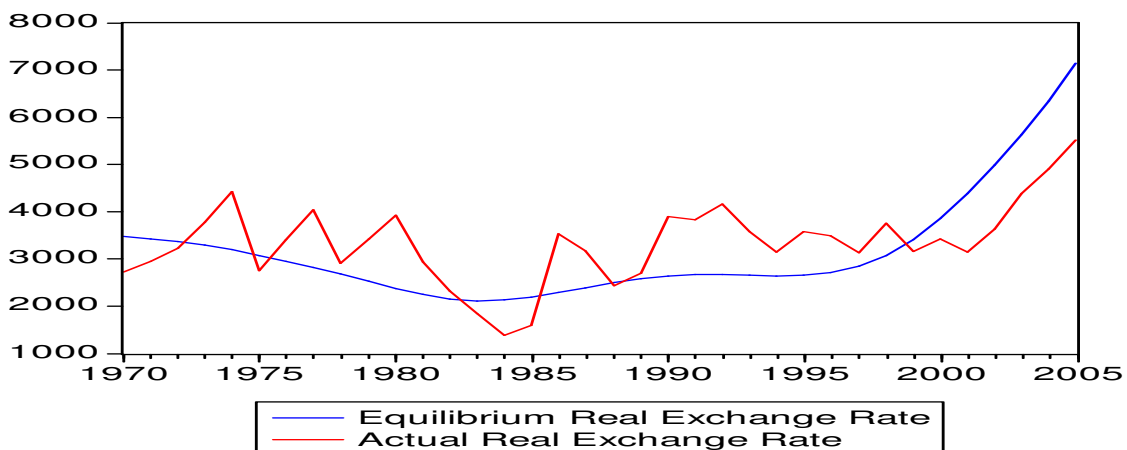
inflow to Sierra Leone depreciates the real exchange rate, which implies that the Dutch Disease syndrome does not hold in the long run in Sierra Leone. This makes sense because in the long run, the increase in government expenditure on nontradable goods increases output despite its short-run inflationary effect. This increase in output has a disinflationary effect, with depreciation of the real exchange rate as a consequence.

#### 4.2.4 The Real Exchange Rate Misalignment

The Equilibrium real exchange rate was obtained by first decomposing the fundamentals of the equilibrium real exchange rate into their permanent and cyclical components. This is because the equilibrium real exchange rate requires the fundamentals to be at their sustainable values. To do this we used the Hodrick-Prescott Filter. The permanent components were then substituted into the equilibrium real exchange rate model, in equation (4.6), to obtain the equilibrium real exchange rate. Figure 4.1 shows the graphs of the equilibrium and actual real exchange rates.

Figure 4.1 shows that the real exchange rate of Sierra Leone was overvalued<sup>3</sup> for most of the period between 1972 and 1998. It was undervalued over the periods 1970-1972 and 1999-2005. The period of consistent undervaluation of the real exchange rate is the post-war period (2000- 2005). This was a period of increased trade liberation and capital inflow.

**Figure 4.1: The Equilibrium and Actual Real Exchange Rates**



<sup>3</sup> Real exchange rate misalignment is calculated as the percentage deviation of equilibrium real exchange rate from the actual real exchange rate.

## **5. Conclusion and Lessons for Policy**

### **5.1 Conclusion**

The real exchange rate is a measure of the competitiveness of an economy to international trade and an overvalued real exchange rate increases the price of domestic goods abroad, leading to lower demand for exports. This deteriorates the trade balance. In Sierra Leone, the nominal exchange rate increased in the 1970s, 1980s, 1990s and the 2000s by either government action (in the fixed exchange rate regime) or a combination of government intervention and market forces (in the managed floating exchange rate regime which took off in 1990). However, the real exchange rate, which is very important in bolstering the external sector, did not follow the trend of the nominal exchange rate. We therefore investigated the determinants of the real exchange rate of Sierra Leone and constructed a model based real exchange rate misalignment index for Sierra Leone using aggregate annual data from 1970 to 2005. The approach involved testing the variables for unit root and cointegration and then estimating a short run real exchange rate model in the error correction context using the Hendry's general to specific modeling. The long-run (equilibrium) real exchange rate model was estimated using the Johansen Maximum Likelihood procedure.

The results of the error correction model shows that increase in the price level, capital inflow, capital accumulation and trade restrictions appreciate the actual real exchange rate of Sierra Leone while increase in the nominal exchange rate and output depreciate it. The equilibrium real exchange rate model shows that improvement in the terms-of-trade and an increase in capital-inflow depreciates the equilibrium real exchange rate. Capital accumulation, increase in output, increase in government expenditure and trade restrictions appreciate the equilibrium real exchange rate.

The real exchange rate misalignment index shows that while the real exchange rate was undervalued over the period 1999 to 2005 it was overvalued most of the time between 1972 and 1998.

## **5.2 Lessons for Policy**

These empirical findings have implications for measures to bolster the competitiveness of Sierra Leone to international trade. First, increase domestic policies that ameliorate inflation are imperative since increase in domestic price level appreciates the real exchange rate. Second, to the extent that capital accumulation appreciates the real exchange rate, there is need for the creation of an enabling environment that encourages investment in the tradable goods sector, rather than the non-tradable goods sector. This can be done by reforming the agricultural and industrial sectors of Sierra Leone so that they will attract investment for export purpose and reforming the mining sector for increased investment. Third, given the fact that trade restrictions appreciate the real exchange rate, there is need to encourage Sierra Leone's integration with other economies in the West African sub-region as well as out of the sub-region. Fourth, since real output has positive impact on the real exchange rate, to obtain a sustained real exchange rate depreciation, supply side policies that increase productivity are useful in Sierra Leone. These include improvement in the educational system, infrastructure and health facility.

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## APPENDIX

**Appendix Table 1: Result of the Error Correction Model Based on 5 % Level of Significance**

	<b>Coefficient</b>	<b>Standard Error</b>	<b>t-Statistics</b>	<b>Prob</b>
Constant	0.017668	0.029116	0.606805	0.5487
$\Delta^2 \text{LnP}$	-0.634216	0.208360	-3.043846	0.0049
$\Delta^2 \text{Lne}$	0.749220	0.145574	5.146675	0.0000
$\Delta \text{LnCLOSE} (-1)$	-0.283995	0.117119	-2.424835	0.0218
ECM	-0.801399	0.232617	-3.445141	0.0018
R-squared	0.560960			
Adjusted R-squared	0.500403			
Akaike info criterion	-0.576196			
Schwarz criterion	-0.351731			
Log likelihood	14.79532			
F-statistic	9.263309			

## Appendix Table 2: Results of Model-Residual Diagnostic Tests

### Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.026353	Probability	0.156794
Obs*R-squared	5.338317	Probability	0.069311

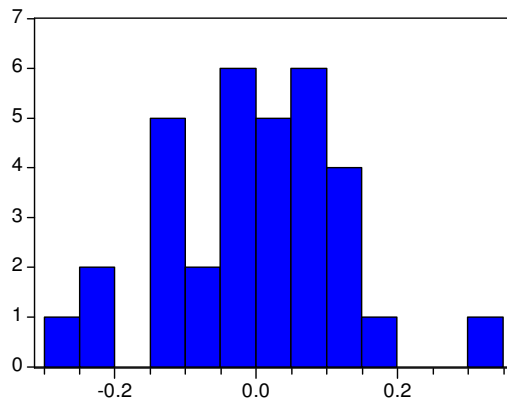
### White Heteroskedasticity Test:

F-statistic	0.910428	Probability	0.581139
Obs*R-squared	17.79649	Probability	0.469133

### ARCH Test:

F-statistic	0.133007	Probability	0.717893
Obs*R-squared	0.141248	Probability	0.707043

### Normality Test



Series: Residuals	
Sample 1973 2005	
Observations 33	
Mean	1.43E-17
Median	0.008968
Maximum	0.322836
Minimum	-0.254744
Std. Dev.	0.122993
Skewness	0.049009
Kurtosis	3.236678
Jarque-Bera	0.090233
Probability	0.955886

**Appendix Table 3: Results of the Model Stability Test**

