Optimal level of reserve holding: an empirical investigation in the case of Albania

Shijaku, Gerti

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OPTIMAL LEVEL OF RESERVE HOLDINGS: AN EMPIRICAL INVESTIGATION IN THE CASE OF ALBANIA

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Gerti Shijaku*

BANK OF ALBANIA

*Gerti Shijaku, Research Department, Bank of Albania,
e-mail: gshijaku@bankofalbania.org

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CONTENTS

ABSTRACT

This discussion material analyses the change in international reserve holdings and their determinants, and evaluates their optimal level from a cost opportunity perspective. The material is based on the Buffer Stock model. This model assumes that reserve holdings are affected by changes of payments and receipts in the balance of payments. Reserves serve as a buffer stock to accommodate fluctuations of external transactions. The focus of the model is to estimate the optimal level of reserves against possible exogenous shocks or a crisis, particularly fluctuations of foreign capital inflows, mainly remittances. The volatility of reserve holdings is generated by Autoregressive Conditional Heteroskedasticity (ARCH) estimation, while the Buffer Stock model is estimated with an ARDL approach. Results indicate a negative relationship of reserve holdings with opportunity cost, volatility and deviation of exchange rate from the trend and positive relationship with imports. The approach estimation suggests that the level of optimal reserve holdings is more sensitive to precautionary rather than mercantilist motives.

Keywords: International Reserve Holdings, Buffer Stock Model, EGARCH(p,q)-AR(q), ARDL Approach.

JEL Classification: E11, E52, E58, E59, F31, F41

1. INTRODUCTION

The stock of reserve holdings of a country is the set of all liquid assets in foreign currency held by central banks as a guarantee to ensure the payment of obligations that may arise in the context of trade and financial transactions obligations. It is a public asset that could and should be used to guarantee the continuation of economic activity and financial stability in case of crises. Thus, reserves are a tool in the form of guarantee to the economy, but used only in extreme cases. Generally, reserve holdings (held in the form of hard currencies or metals in a monetary or monetarised form) have the ability to generate profits when used in the money and capital markets. But, by definition, it can be understood that the security motive predominates income motive and, therefore, reserve assets are invested in safer investments with a low rate of return. Consequently, raising the level of reserve holdings has a high opportunity cost.

However, the overall definition fits and varies depending on the choices that countries make in terms of the economic model and degree of openness, external sector characteristics and the exchange rate regime. In general, reserve holdings would play a more active role in countries with fixed exchange rate regime or in economies that use this mechanism as a tool to maintain comparative advantages in exporting industries, or to accommodate the negative effects of unstable foreign capital inflows as in the case of remittances and portfolio investments. In such cases, reserve holdings may serve first, as a mean to achieve monetary policy in terms of restrictions on capital mobility; second, to support external trade policy and to avoid any difficulties in international transactions as a result of lack of liquidity in foreign currency; third, to be self-insured against the fluctuations of foreign capital inflows, mainly remittances and foreign direct investment, and to accommodate the negative seasonality effects, speculative shocks and current account deficit effects caused by both public and private sector.

Generally speaking, globalization has brought some new tendencies relating to the stock of reserve holdings. Beyond fixed exchange rate regime policy, the rapid expansion of globalisation process originally appeared through the reallocation of production to developing and transition countries. This promoted substantial foreign investment inflows and was followed by the growth of trade from developing countries to developed ones. These phenomena led to a substantial raise of trade surpluses and reserve holdings of the developing countries. Reserve holdings also increased in transition economies, which have experienced high current account deficits driven by higher foreign direct investment inflows. These tendencies are also noted in the small economies in South-Eastern Europe, which have accumulated large reserve stocks compared to the relative size of their economy. In contrast to these countries, Albania has accumulated reserves at a lower speed. These reserves are accumulated in a framework of a floating exchange rate regime and a capital account virtually liberalised and persistent current account deficit compared to the region.

Albania started the economic transition process with a very low level of reserve holdings of only about USD 2 million. The socialist state used reserves to provide the means of consumption in the presence of collapsing planned economy. The accumulation of reserves has been an integral part of the monetary programme carried out in light of the IMF agreements, specified in the monetary programme as a bottom level sufficient to cover up four months of imports. This level is achieved almost throughout the programme enforcement period and remains so today.

However, the concept of determining reserve holdings outlined above faces two main challenges. First, in the recent years, monetary policy, meaning design and implementation, has gone through significant changes. It moved from monetary targeting forms towards inflation targeting regime [Fullani, (2009)]. Second, referring to the monetary policy strategy of the Bank of Albania, as in the case of the European Central Bank (ECB), money will continue to play an important indicative role on monetary policy in the long run but inflation forecasting and expectation have already the leading role in setting policy in the short and medium run. Lastly, the operational policy has recently moved from targeting money circulation in targeting the short-term interest rates.

On the other hand, unlike different successful transition economies, Albania has not received high foreign investment inflows similar to the ratios observed in Central European economies. Still, Albania offers great potentials in certain areas like tourism, infrastructure, energy, agribusiness, etc., which, for capital markets, make it a good opportunity to invest. The entry of one or more major projects, comparable to those of Central Europe, comprises a significant amount of foreign currency for the small Albanian economy. In terms of floating exchange rate policy, such investment could cause a significant appreciation of domestic currency and hence a loss of competitiveness. The question is how should Bank of Albania operate in such an environment?

The Bank of Albania will have to manage these development influxes and their effects on the economy in two different approaches. First, from the macroeconomic perspective: mainly focusing on inflation and less production. Second, from the financial stability perspective: mainly in current account deficits, under a floating exchange rate regime and inflation targeting regime and capital account fully liberalised. So the question is whether to intervene in order to increase the level of reserve holdings? Or to what extent should reserve holdings increase without dictating the exchange rate?

From another perspective, the rapid growth of fiscal deficit in the last three years has increased the public debt of the Albanian economy and has boosted the cost of borrowing. Consequently, reserves holdings should also consider the external borrowing costs.

This discussion paper attempts to apply an empirical approach in evaluating the optimal level of reserve holdings in the case of Albania. At the same time, efforts are made to better understand the nature of the link between the dynamics of developments in the current and capital accounts, expressed through the volatility of international transactions, and financial costs of reserve holdings. The first aim is to examine the impact of international transaction dynamics on reserve holdings and the second is to assess the optimal level in terms of opportunity cost.

The material is organised as follows: section 2 explains the Buffer Stock model for assessing reserve holdings. Section 3 analyses the results in the case of Albania. The material concludes with some recommendations and conclusions.

2. MODELLING INTERNATIONAL RESERVE HOLDINGS

Reserve holdings are an important macroeconomic indicator. They are necessary as a guarantee to balance external sector shocks. The higher the reserve stock level, the more protected the economy is. On the other hand, reserve holdings have a financial and economic cost expressed as forgone earnings from investment and in the growth of the external government debt. Thus, it is necessary to evaluate the optimal level of reserve that satisfies both outlined criteria. Estimating the optimal level is a task faced by the monetary authority of a country. Frenkel and Jovanovic (1981) developed a theoretical Buffer Stock model of the demand for reserve. This model describes reserves as a continuous exogenous Wiener process of the following form:

$$dIR(t) = -\mu dt + \sigma dW(t) \quad (1)$$

Where, IR(t) is the level of reserves at time t and W(t) is a standard Wiener process, based on a simple random walk, with mean μ and with variance σ. The change in the level of reserves in a small time interval dt is a normal distribution variety. At each point in time, the distribution of reserve holdings IR(t) is characterised by:

$$IR(t) = IR^* - \mu t + \sigma W(t) \quad (2)$$

Where, IR* is the optimal level of reserves, μ denotes the deterministic part of the instantaneous change in reserves and σ represents the standard deviation of the change in reserves that comes from the Wiener process.

In this model, reserves are a stochastic process governing the inflows of payments and receipts in the balance of payments. Thus, changes in reserves are a normal variety process with mean $-\mu\Delta t$ and variance $\sigma\Delta W(t)$. The actual stock of reserves IR(t), in time t, is a random variable characterized by:

$$IR(t) = IR0 - \mu t + \sigma W(t) \quad (3)$$

And

$$IR(t) \sim N\,(IR0 - \mu t; + \sigma 2(t) \quad (4)$$

In the above case, according to Frenkel and Jovanovic (1981), IR_0 is the initial stock of reserve (assumed to be the optimal level). If we also assume that overall reserves are at their optimum level, in other words on average each year stocks are close to the optimal level, the displacement constant μ is zero and thus the product μ is zero. So the stochastic process that governs changes in reserves is without a drift. For developing economies, μ is a conditional variable, which requires further discussion. It is, however, worth noting that many authors, who have been basing on this model, have adjusted this assumption as described below.

Under the above assumption, Frenkel and Jovanovic (1981) assume that the optimal level is the stock of reserves that minimises the cost of adjustment (which itself means a cost that can be derived by adjusting the current level of reserves to the optimal level and the opportunity cost of holding reserves). In the case of the first cost, it can be considered as the level of money that should be withdrawn from the economy so as to yield the desired balance of payments surplus that is necessary to accumulate reserves. Thus, this cost measures the cost of pursuing reserves in the case when it is below the optimal level (in other words the cost of real adjustment necessary to enable a positive balance of the foreign payments). The second cost represents the opportunity cost (forgone earnings) of reserve holdings. So, it is the amount of forgone earnings from not investing the reserves, or the amount of forgone earnings lost in the form of interest in case of borrowing. It measures the cost for the society whenever the level of reserves is above the optimal level and should be adjusted down. The optimal stock serves to simultaneously minimise both costs, so that it minimises the loss function.

Using a second order approximation suggested by Taylor (2002) and then the log linearization of the obtained expression; the optimal stock of reserves can be expressed by:

$$\log(IR_t) = b_0 + b_1 \log(\sigma_t) + b_2 \log(r_t) + \upsilon_t \quad (5)$$

Where, r is the opportunity cost of reserve holdings. Frenkel and Jovanovic (1981) evaluated equation (5) in order to calculate the corresponding value of the coefficients, which later can be used to estimate the optimal level of reserve holdings. The priorities of the Buffer Stock model relate to the appearance as a time continuous approach and to the possibility to evaluate easily generated variables. I will try to evaluate the same equation, in order to find the approximate values of the respective coefficients. Thus, variables included in equation (5) are expressed in nominal value.

3. APPLYING BUFFER STOCK MODEL: THE CASE OF ALBANIA

Most studies on the subject have assumed that the optimal level of reserve holdings is a stable function of a small number of variables [Prabheesh (2009), Ramachandran (2006) Edwards (1985)]. Hence, in order to evaluate the Buffer Stock model from the financial cost concept and given that in the case of Albania reserves are held in terms of months of imports covered, I found it more appropriate to estimate reserve holdings by the following equation presented by Frenkel and Jovanovic (1981):

$$\log(IR_t) = b_0 + b_1 \log(\sigma_t) + b_2 \log(r_t) + b_3 \log(IM_t) + u_t \qquad (6)$$

Where, IMt is the monthly import volume of goods and services of a given country. The use of imports is also justified because imports are a factor of pressure of the balance of payments and it serves as a scale factor for a country [Silva and Silva (2004)]. So equation (6) is the starting point of reserve holdings estimation in the case of Albania empirically. Initially, it was assessed the volatility of payments and receipts in the balance of payments based on equation (5); then, the Buffer Stock model was evaluated by the ARDL approach. Lastly, you will find the analyses and the interpretation of empirical results.

A. ESTIMATING THE VOLATILITY OF RESERVE HOLDINGS AND NOMINAL AND REAL EXCHANGE RATE, OPPORTUNITY COST AND THE DINAMICS OF CURRENT ACCOUNT

The precautionary approach assumes that financial integration of the developing countries increases exposure to volatile capital flows or hot money, which are subject to sudden stop and reversal [Aizenman and Marion, (2002) and [Calvo (1998)]. On the other hand, mercantilist approach argues that reserve holdings may serve to promote exports and channel domestic and foreign direct investment to the export industries [Aizenman and Lee (2005)].

According to Vika (2008), on short-run basis, Bank of Albania has been generally intervening in the foreign exchange market to reduce high market volatility or put a stop to exchange rate overshooting, but not to influence the exchange rate trend on the long-run. Thus, this study makes an attempt to test the precautionary and mercantilist motives through the assessment of the volatility of payments and receipts in the balance of payments in terms of the volatility of the change in reserve holdings[1] and the Nominal and Real Effective Exchange Rate (REER and NEER), as well as the assessment of the deviation of the exchange rate from the long-term trend.

The time series on (IR_t) represents the stock of reserve holdings and is the sum of gold, foreign currency tranches and stock Special Drawing Rights and are in millions of Euro. The exchange rate is expressed as the national currency per unit of foreign currency. A rise in the exchange rate indicates the appreciation, and a decline indicates the depreciation of the Albanian Lek (ALL). The volatility of these variables covers the period 1996M1–2010M12. The data on stock of reserve holdings and exchange rate are taken from Bank of Albania.

The modelling of the volatility dynamics of IR_t, $REER_t$ and $NEER_t$ is estimated through the Autoregressive Conditional Heteroskedasticity approach (ARCH estimation) because the diagnostic ARCH-LM test indicates that the time series suffer from the ARCH effects. In this case, in order to generate a suitable variable to measure the volatility of payments and receipts in the balance of payments, different specifications of ARCH, GARCH, EGARCH, TGARCH, PARCH and C-ARCH have been tested. The estimates were based

[1] Generally, the volatility of payments and receipts in the balance of payments is measured by the standard deviation from the long-term tendency of changes in the stock of reserve holdings for a given period of time [see Prabheesha, et al., (2009), Ramachandran (2006), Ford and Huang (1994), Landell-Mills (1989), Frenkel and Jovanovic, (1981)]. The disadvantage of this method is that it produces greater (increasing) biased estimation due to the re-accumulation of reserves, and lower (decreasing) estimation due to the rapid decline of reserve holdings during financial crises [Flood and Marion, (2002)]. To avoid this, the change in the stock of reserve holdings [Silva and Silva, (2004)] and the average change in the real and/or nominal effective exchange rate (REER and NEER) [(Ramachandran, (2006)] are adapted as proxies for the volatility of payments and receipts in the balance of payments.

on the specification used by Ramachandran (2006) and Silva and Silva (2004), mathematically expressed as:

$$\Delta IR_t = \delta_{0\,(reserves)} + \sqrt{h}_{t\,(reserves)} * \upsilon_{(reserves)} \qquad (7)$$

$$\Delta REER_t = \delta_{0(REER)} + \sqrt{h}_{t(REER)} * \upsilon_{(REER)} \qquad (8)$$

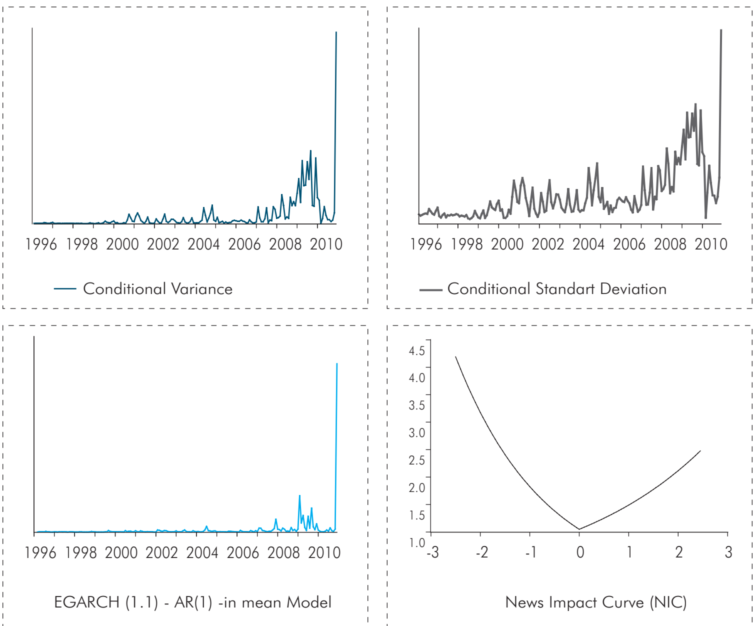
$$\Delta NEER_t = \delta_{0(NEER)} + \sqrt{h}_{t(NEER)} * \upsilon_{(NEER)} \qquad (9)$$

Where, δ_0 is a constant; h_t is the conditional variance of the respective variable and v_t The usage of alternative ARCH approach aims to explain the volatility of reserve holdings especially during the period of economic crisis that swept Albania in the late 2008 and early 2009.

The best suitable model, among the specifications outlined above, is selected based on the Akaike Info Criterion (AIC) and on the diagnostic test of Q-statistic and ARCH LM-test. Thus, EGARCH(1,1)-AR(1)-in-mean model specification is selected as the best arrangement to measure the volatility of changes in reserve holdings. The model diagnostics do not indicate problems with serial correlation in the standardized squared residuals or ARCH effect on residuals. EGARCH models are best suited to capture the volatility of financial data [Brooks (2008) and Enders (2010)]. Moreover, the indicator of measuring the changes in the balance of payment transactions (σ) on one hand reflects the volume of foreign capital inflows and on the other hand, appears as a characteristic of the possibility of free capital mobility in a country [Flood and Nancy (2002)]. Hence, since the EGARCH approach imposes no restrictions on the sign of the coefficients, the model appears to be satisfactory and overall the EGARCH(1,1)-AR(1)-in-mean model add some vital information (Table 4a).

The conditional standard deviation is significant at conventional significance levels, implying that it affects the volatility of reserve (Table 4a). The AR(1) is significant and improves the Q-square statistics test. The coefficient of the conditional shock c(5) is statistically significant and positive. This implies that the conditional shock raises the conditional volatility of the reserve holdings. The coefficient c(6) has a negative sign even though it is statistically insignificant. This indicates that shocks have asymmetric effects on the volatility of reserve holdings. The magnitude of the coefficient, albeit statistically insignificant, confirms that positive shocks react positively by reducing volatility, while volatility increases more in response to a negative shock rather than a positive shock, which is reconfirmed by the News Impact Curve (Chart 1). The magnitude and significance of the coefficient c(7) reveal that the degree of persistence of the shocks is high. Such an effect was conducted throughout the whole estimated ARCH type models, indicating that the impact of shocks on reserve holdings does not die out and has long-lasting effects.

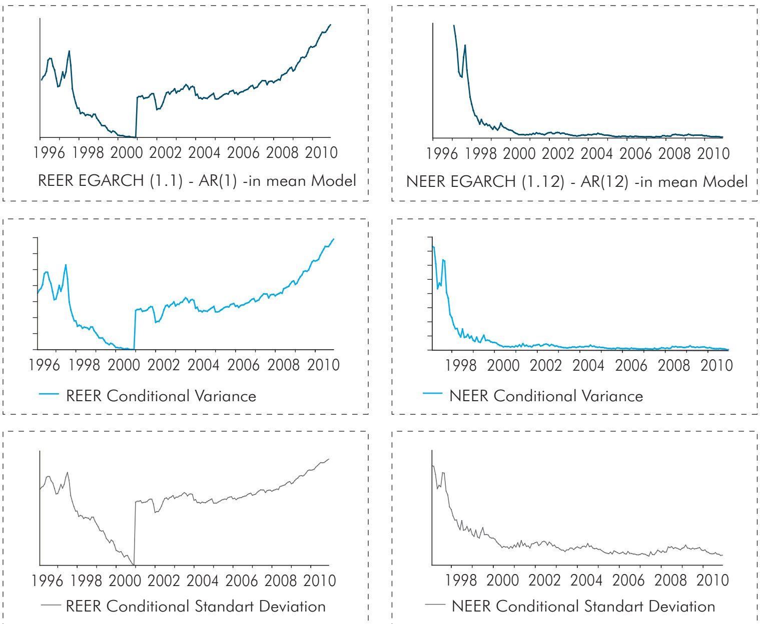
Chart 1 Volatility of reserve holdings based on EGARCH(1,1)-AR(1)-in-mean model



Source: Author’s calculations

In addition, the estimated results (Chart 2) indicate that the volatility of changes in reserve holdings is higher during the period 2008M01-2010M02 and again at the end of 2010. The higher volatility level corresponds to the economic crisis that swept Albania due to the global financial crisis. In this aspect, volatility is affected by the fall of domestic demand during this period and the management of reserve holdings to cover a certain number of imports. Second, the level of reserve holdings, consequently to volatility, is affected by the intervention of the Bank of Albania to stabilise the domestic currency price (Lek) in the short-run and interventions for the payment of public debt. In addition, the higher level of volatility at the end of 2010 is due to the disbursement of external borrowing from the Ministry of Finance.

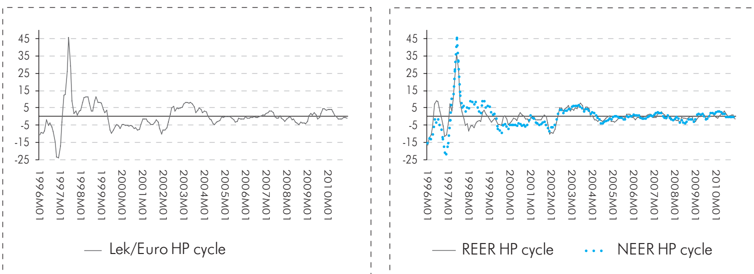
Chart 2 Volatility of REER and NEER based on EGARCH-in-mean Model



Source: Author's calculations

Results in Tables 4b and 4c show that the conditional standard deviation is statistically significant for REER. The coefficient of the conditional shock c(5) is statistically significant, and for the REER (NEER) it is negative (positive). This implies that the conditional shock decreases (raises) the conditional volatility of the REER (NEER). The coefficient c(5) (Table 4b) has a positive sign, while the coefficient c(7) (Table 4c) has a negative sign. This suggests that shocks have asymmetric effects on the volatility of NEER and not on REER, albeit statistically insignificant. The magnitude and sign of the coefficient indicate that the volatility of REER (NEER) increases more in response to positive (negative) shocks. The models show that the degree of shocks is high and persistent, even though it is insignificant on NEER. Furthermore, the estimated results (see Chart 2) show that the volatility of changes in NEER is higher during the period 1997-1998, and normalizing thereafter. In the meantime, the volatility of changes in REER is higher during the period 1997-1998 and is again rising since 2001, reflecting more the changes in relative prices.

Chart 3 Deviation of REER, NEER and Lek/Euro from the HP filter trend



Source: Author's calculations

The measure of the undervalued exchange rate to capture the mercantilist motive is contrasted using the HP filter method based on REER, NEER and Lek/Euro[2] The deviation of REER, NEER and

[2] EU countries are Albania's main trading partners. Hence, a large portion of foreign exchange transactions are carried out between the Albanian Lek and the Euro. This analysis, therefore, includes also the deviation of Lek/Euro nominal exchange rate.

Lek/Euro from the HP filter trend (Chart 3) shows positive and negative values, indicating that throughout the sample analysis, the exchange rate has gone though a pattern of appreciation and depreciation against other currencies.

Other estimates of reserve modelling[3], have also shown that the opportunity cost of reserve holdings plays an important role in the level of reserves. Overall, this economic variable is defined as the difference between the highest potential forgone marginal productivity from an alternative investment of fixed assets and the yield (income) from the reserve holdings in foreign currencies [Ben-Bassat and Gottlieb (1992)]. This indicator can be defined as the difference between the yields (interest) paid on public debt and the rate of return from investing the reserve holdings [Edwards (1985)]. For developing countries, opportunity cost must present a combination of internal and external costs because these costs differ greatly from investment return rate of reserves [Silva and Silva (2004)]. The estimated variable of opportunity cost[4] expresses the difference between the 3, 6 and 12-month weighted average bill rates and 10-year Eurobonds monthly rate of return to the yield of investing reserves measured by 1-3 year German emissions index. Data on Eurobonds are taken from the official website of the European Central Bank (ECB). Data on treasury bills rate, the German index and those on imports are taken from Bank of Albania. Data on imports express the monthly value of the volume of imports of goods and services in million Euros. The estimated coefficients present the elasticities of the affecting dynamics of explanatory variables on the dependent variable.

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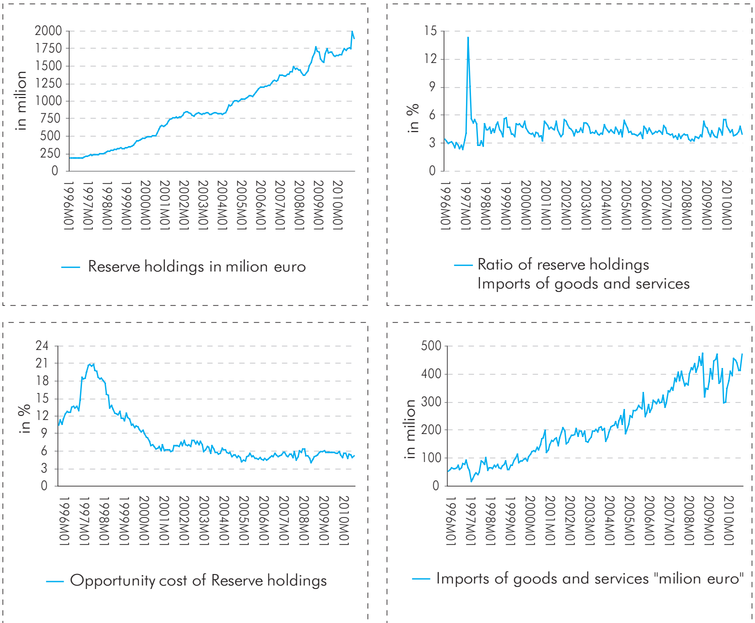
3 See: Heller (1996); Clark (1970); Frenkel and Jovanovic (1981); Edwards (1983, 1984, 1985); Ben-Bassat and Gottlieb (1992); Wijnholds and Kaptyn (2001); Silva and Silva (2004); Ramachandran (2004); Jeanne and Ranciere (2006) and Jeanne and Ranciere (2009)].

4 Albania, like most developing countries, borrows in international financial markets on regular basis, which in turn brings in foreign capital inflows. Meanwhile, the cost of borrowing varies extremely as a result of borrowing capacities, type and the duration of loan maturity. Conversely, reserves are invested by the Bank of Albania at a lower rate than the yield paid on debt services because the objective of the bank is to invest in safe investment instruments. Thus, the estimation of the opportunity cost variable aims at generating an indicator that optimises the characteristics of Albania and satisfies the theoretical definition.

Countries are often exposed to the difficulties of controlling capital movement over the crisis period, mainly due to the development of modern technology, new financial instruments and the lack of controlling mechanism. Therefore, higher reserve volatility means that reserves hit their lower bound more frequently. The central bank should be willing to hold a larger stock of reserves and tolerate greater opportunity costs in order to incur the cost of restocking less frequently [Flood and Nancy (2002)]. Moreover, according to Elbadawi (1990), volatility term (b1) is viewed as a proxy for the theoretical concept of risk and uncertainty. Besides, a positive value of REER_hp_cycle, NEER_hp_cycle and Lek/Euro_hp_cycle would indicate an undervalued nominal and real exchange rate of Albanian Lek (ALL) against other foreign currencies and accordingly it would increase reserve holdings [Prabheesh (2009)]. Thus, it is assumed that in the long-run, reserve holdings depend positively on the magnitude of the volatility of balance of payments transactions ($b_1>0$). Furthermore, reserves generally are exposed to opportunity costs, expressed through forgone earnings. So, the lower the alternative opportunity cost, the higher will be the level of reserve holdings ($b_2<0$), as alternative investment will be less attractive.

Finally, the impact of the volume of imports of goods and services, *IM*, is undetermined [Elbadawi (1990)]. On the one hand, a Keynesian model that emphasizes output adjustment will call for a negative impact between the reserve holdings and the volume of imports; however, an alternative theory of adjustment mechanism emphasizing the role of relative prices and the price level would call for a positive impact. Hence, although this issue is an empirical question, referring to the strategy of managing reserve holdings followed by Bank of Albania and the tendency to gradually move towards full capital mobility liberalisation, I assumed that the developments in current and capital account play an important role in reserve holdings in the case of Albania. Hence, the higher the changes in foreign transaction payments, the higher will be the level of reserve holdings and, for this reason, I assume that the greater is the volume of imports in monetary value, the higher will be the level of reserve holdings ($b_3>0$).

Chart 4 Reserve Holdings and explanatory variables



Source: Bank of Albania and ECB

B. THE BUFFER STOCK MODEL THROUGH THE ARDL APPROACH

In the case of Albania, the Buffer Stock model was evaluated through the ARDL approach developed by Pesaran et al (2001). First, as the sample period is relatively short, the pursuit of this methodology appears to be more efficient and appropriate. Second, this approach allows, through the specification of the model, a long-run cointegration relationship. Third, the method assumes that included variables of interest can be cointegrated in long-run period, even though they might have different order of integration I(0) or I(1). In addition, the approach to a single equation provides more degrees of freedom compared to the Vector Autoregressive

(VAR) and Vector Error Correction Mechanism (VECM) approach developed by Johansen and Jeselius (1990). Hence, the estimated regression can be specified by:

$$\Delta \log IR_t = \alpha_0 + \beta_1 \log IR_{t-1} + \beta_2 \log \sigma_{t-1} + \beta_3 \log r_{t-1} + \beta_4 \log IM_{t-1} + \sum_{i=1}^{p} \delta_{1i} \Delta \log IR_{t-i} + \sum_{i=0}^{q} \delta_i \Delta \log \sigma_{t-i} + \sum_{i=0}^{q} \delta_i \Delta \log r_{t-i} + \sum_{i=0}^{q} \delta_i \Delta \log IM_{t-i} + \delta_i T_t + \varepsilon_t \quad (10)$$

Where, $\log IR_t$ is the logarithm of reserve holdings; $\log\sigma_t$[5] is the logarithm of the volatility of the stock of reserve; logrt is the logarithm of the opportunity cost; $\log IM_t$ is the logarithm of imports of goods and services in million Euros; β_i is the long-run coefficient; α_i is the constant or the drift coefficient; Δ is difference operator; T_t is the time trend.

Three main steps were considered in our application of the ARDL model. Initially, the Buffer Stock model was estimated by ordinary least square (OLS) technique. Then, the presence of long-run linear relationship is traced by conducting an F-test (Wald test) for the joint significance of the coefficients of the lagged levels of the variables. Second, the long-run relationship between reserve and other explanatory variables is evaluated as follows:

$$\Delta \log IR_t = \alpha_0 + \sum_{i=1}^{p} \delta_{1i} \Delta \log IR_{t-i} + \sum_{i=0}^{q} \delta_2 \Delta \log \sigma_{t-i} + \sum_{i=0}^{q} \delta_3 \Delta \log r_{t-i} + \sum_{i=0}^{q} \delta_4 \Delta \log IM_{t-i} + \lambda_i ECM_{t-1} + \varepsilon_t \quad (11)$$

Where, all variables are as previously defined. The lag length in the ARDL model is selected based on the AIC criterion[6]. Third, the short-run dynamic elasticities were obtained by estimating an error correction model convergence to long-run equilibrium. This is specified as follows:

$$\log IR_t = c_0 + \sum_{i=1}^{p} \beta_1 \log IR_{t-i} + \sum_{i=0}^{q=1} \beta_2 \log n\sigma_{t-i} + \sum_{i=0}^{q=2} \beta_3 \log r_{t-i} + \sum_{i=0}^{q=3} \beta_4 \log IM_{t-i} \quad (12)$$
$$\beta_{5i} T_t + \varepsilon_t$$

[5] In other models, $\log\sigma_t$ is represented by logREER, logNEER, which express the volatility of REER and NEER, and by REER_hp_cycle, NEER_hp_cycle and Lek/Euro_hp_cycle, which represent the deviation of the exchange rate from HP filter trend.

[6] AIC is known for selecting the respective maximum lags. In econometric models of monthly data, the optimal lag is 12-24 [Pesaran et al (2001)], although the results of the F-test depend on the number of lags imposed [Bahmani-Oskooee and Rehman (2005)].

Where, λ is the speed of adjustment towards equilibrium; δ_{1234} are the short-run dynamic elasticities of adjustment; ECMt-1 is the lagged error correction term estimated from equation (10):

$$ECM_t = \log IR_t - \alpha_0 - \sum_{i=1}^{p} \beta_1 \log IR_{t-i} + \sum_{i=0}^{q=1} \beta_2 \log \sigma_{t-i} + \sum_{i=0}^{q=2} \beta_3 \log r_{t-i} + \sum_{i=0}^{q=3} \beta_4 \log IM_{t-i} \quad (13)$$

The coefficient and the statistical significance (t-Statistic) of the error correction term are presented as an alternative option for evaluating the long-run cointegration relationship. The negative magnitude and the statistical significance of the lagged error correction term (ECM_{t-1}) is a good way to show that there is a long-run cointegration relationship between dependent and independent variables [Kremers, et al (1992)].

C. EMPIRICAL RESULTS AND DISCUSSION

The assessment of the long-run cointegration relationship, through the ARDL approach, provides an analytical and statistical framework, which is based on the assumption that variables might be integrated of order I(0) or I(1). However, implementing the unit root test is necessary to understand first, their characteristics and second, to make sure that the ARDL approach is an appropriate method. The unit root test is based on Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) diagnostic tests. The results of these tests (Table 5) suggest that some variables are stationary in first difference I(1) and some are stationary at I(0). This indicates that applying the ARDL approach is suitable, while in the estimated equation a constant and a time trend have been included.

In addition, equation (10) is estimated by OLS technique. However, to fulfil the endogeneity condition, each variable is estimated as a dependent variable on the left-hand side (LHS) of equation (10)[7]. The critical values of F-test are shown in Table 4[8]. The optimal lag that maximises the AIC criterion and meets the endogeneity condition is 12 when variables to capture the precautionary motives are used and 8 when the empirical model

[7] See: Pesaran et al (2001) for further information on the ARDL bounds test approach.

[8] The approximate critical values of F-test were obtained from Narayan (2004), which has re-estimated the lower I(0) and upper I(1) bound critical values, in order to estimate the adequate coefficients with a low number of observations.

contented a mixture of variables on precautionary and mercantilist motives. The computed critical values of F-statistics from the Wald tests for restrictions imposed on the parameters are reported in Table 6a-to-f. The results suggest that in the case of Albania, there is a unique cointegration relationship between reserve holdings and its determinants. The empirical analysis based on the ARDL approach proved that there is a linear relationship between reserve holdings and other explanatory variables in the long-run.

Having established that reserve holdings have a long-run linear relationship with other determinant variables, following the ARDL approach, equation (11) is estimated for the long-run elasticities. The optimum ARDL lag order suggested by AIC and the estimated long-run elasticity coefficients of the ARDL models suggested by AIC are reported in Table 7a-to-b. The results obtained from the estimation of the Buffer Stock model have been quite satisfactory. The long-run coefficients indicate that *logKOSTO* and *lnIMP* exhibit the theoretically expected sign and are statistically significant at conventional level, meanwhile apart from being statistically insignificant only *logREER* has the positive expected sign.

The elasticity of logKOSTO has a negative sign and it shows that the increase in financial and economic costs will generate the need to reduce the stock of reserves. The magnitude and statistical significance of the coefficient reconfirm the conclusions of Edwards (1985) and Ben-Bassat and Gottlieb (1992) that the methodology used to estimate the opportunity cost is accurate, generating a theoretically expected coefficient. The results show that the elasticity of imports of goods and services is significantly positive. The level of reserve holdings will respectively change by around -0.30 to -0.38 percent in response to a 1 percent change in the opportunity cost. The level of reserve holdings will respectively change by around 0.30 to 0.54 percent in response to a 1 percent change in the volume of imports. This suggests that, in the case of Albania, expenditure-reducing policies[9], are being pursued, meaning that any attempt to improve the current account deficit is done through expenditure-reducing policies. The positive sign of imports coefficient confirms, according to Clark (1970), that the accumulation and management of reserves holding is

[9] See: Edwards (1985)

dictated by the philosophy of the Anglo-American doctrine, while the increasing level has served as a self-insurance instrument to avoid costly liquidation of long-term projects when the economy is susceptible to sudden stops of capital inflows and to support trade and monetary policies.

The magnitude of the coefficient associated with the precautionary and mercantilist concerns, apart from the volatility of logREER, indicate that in the case of Albania there exists a negative relationship on reserve holdings. In light of the high level of reserve holdings, a negative relationship is due to the tendency to offset and reduce absorption in the volatility of transactions payments through reserves usage [Aizenman and Sun (2009)].

However, even though it might bring the exhaustion of reserve, the magnitude and the significance of the coefficient imply that such policy action is relatively small and insignificant. First, under a floating exchange rate mechanism, this is due to the objective of the Bank of Albania to intervene in the foreign exchange market to reduce the high volatility or curb the depreciation and appreciation of the exchange rate in the short-run. Second, Bank of Albania targets and considers information neither on the real or nominal exchange rate nor on the REER, NEER and the volatility in the transaction of payments and receipts when considering the level of reserve holdings.

The coefficient of time trend is statistically significant and has the expected positive sign. This is evidence that in time, further improvement of managerial and investment skills will eventually lead to the raise of reserve holdings by the Bank of Albania.

Furthermore, the estimated elasticities of the long-run coefficients with respect to the volatility suggest that in the long-run reserve holdings are very sensitive to developments in the current account. This implies that the strategy on the management of reserve holdings by the Bank of Albania is mainly based on the information on the monetary volume of imports of goods and services. This indicates the precautionary motives of holding reserves against the persistent current account deficit in Albania during the sample period. The elasticity magnitude and the statistical significance suggest that in the case of Albania, reserve holdings are less sensitive to the variables associated with the mercantilist concerns and the precautionary motives associated with volatility. This provides a hint on the ground that Bank of Albania does use reserve holdings neither as a tool to maintain comparative advantages in exporting industries nor to accommodate the negative effects of unstable foreign capital inflows as in the case of remittances and portfolio investment. Thus, the estimation of Buffer Stock model through the ARDL approach and the results obtained in the case of Albania appear to be consistent with other empirical estimates for transition and developing economies, where current account dynamics are the main affecting force on the movements and accumulation of reserve holdings[10].

In addition, equation (12) is estimated using the lags determined in the evaluation of the long-run coefficients, while the short-run coefficients estimated by the ARDL approach are used to form the error correction term (returning to equilibrium). Tables 8a-to-8f report the results of the short-run error correction model along with a set of diagnostic tests conducted on the short-run model with respect to regression determination coefficient (R2), model functional formulation Ramsey RESET test, normality (Jacque-Bera), serial correlation and heteroskedasticity in the error term and stability of the coefficient estimated using the cumulative sum (CUSSUM) and cumulative sum of squares (CUSSUMSQ) test[11].

The preliminary analysis indicates that the short-run coefficients are quite different from the long-run. From the magnitude viewpoint, some of the short-run elasticities do not have the expected sign, while some of them are statistically insignificant. Overall, although partly statistically significant, the short-run elasticity coefficients have the expected sign. In the short-run, reserve correction and readjustment dynamics have the greatest impact. This effect is followed, in terms of the coefficient size, by the impact of the opportunity cost, imports and volatility. Still the impact of volatility on reserve holdings is the smallest. However, in the short-run, the analysis of one lagged coefficients suggests that the variables have the expected sign and the optimal level of reserve holdings is more affected by current account dynamics.

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[10] See Prabheesh (2007), Silva and Silva (2004) and Frenkel and Jovanovic (1981).

[11] Indicator (S) indicates that the regression is stable and (U) stands for unstable.

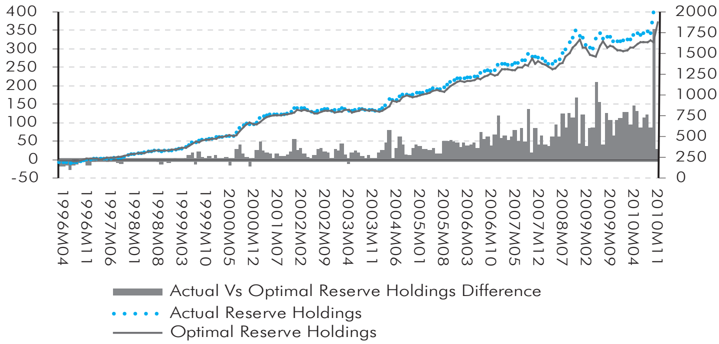
Moreover, the negative sign and the statistical significance of the error term at the 1 percent significance level is another indication that confirms that in the long-run reserve holdings are cointegrated with other explanatory variables. This confirms the theoretical approach introduced by Frenkel and Jovanovic (1981) in the case of Albania. Second, there is a causality effect in at least one direction [Granger (1986)]; and third, there is an error correction mechanism, which brings reserves back into equilibrium. Therefore, the long-run equilibrium is achievable. Meanwhile, overall the value of the magnitude of the error mechanism might be slow. This indicates that any deviation from equilibrium is eliminated within one month on a slow basis process. The low speed of adjustment might give a hint toward a less active reserve management, in the case of Albania. This might be the case given the availability of data on real time, the floating exchange rate mechanism and the strategy of the Bank of Albania to spread the target level of reserve to import ratio throughout the year and not on a single moment, such that it would not affect the exchange rate. In addition, the low readjustment coefficient, along with the increasing level of reserve holdings, provides evidence that the return to equilibrium will require the use of a large amount of reserves to finance the balance of payments needs [Prabheesh (2007)].

Furthermore, the analysis on the gap between actual and the estimated optimum level of reserve holdings is relatively small[12]. which justifies the low speed of adjustment. This conclusion is confirmed in Chart 5. The relatively small difference indicates that Bank of Albania has a sufficient level of reserve holdings to fulfil the minimum requirements and hence it stands in a somewhat comfortable zone with the existing stock of reserves. This proves that the composition and implementation of the strategy on the management of reserve holdings has been consistent and a function of objectives set under the Monetary Approach to Balance of Payments. In addition, this recommends that the increasing level of reserves has been necessary and close to the optimal level. Accordingly, in the case of Albania, the low and increasing level of reserve holdings since the early 1990s is explained, on the one hand, by the high but decreasing rate of the opportunity cost and, on the other, by the low but increasing level of public debt

[12] See: Clark (1970)

and imports. Moreover, besides the possibility of rapid growth of reserve holdings, this development relates to the improvement of management and investment capacities by the Bank of Albania. Although, the analysis of the gap level recommends that overall in the last decade the actual level of reserve holdings is higher than the optimal level estimated by the model. This result can be explained through the tendency to be self-insured against fluctuations in the foreign capital inflows, fiscal dominance, growing public debt (especially foreign borrowing) and short-run risks in the exchange rate and the objectives to cover a certain number of monthly imports as an indicator of macroeconomic stability.

Chart 5 Actual Vs optimal level of reserve holdings based on the logVAR model



Source: Author's calculations

The critical value of the regression determination coefficient (R2), throughout the whole models, might be considered as low, while a set of diagnostic tests conducted on the short- and long-run model revealed no problem with respect to the functional formulation and misspecification, serial correlation and heteroskedasticity in the error term. Moreover, the diagnostics of the cumulative sum (CUSUM) and cumulative sum off squares (CUSUMSQ) plots (Diagram 1a-to-1f) suggest that the residual variance is somewhat stable within the 5 percent bounds level of significance. This suggests that in the case of Albania, the optimal demand level has been somewhat stable across time, even though evidence seems to illustrate that global financial and economic crises had an impact on the stock of reserve holdings.

IV. CONCLUSIONS

This discussion paper empirically evaluates a stochastic model for determining the optimal reserve holdings in the case of Albania according to the Buffer Stock model developed by Frenkel and Jovanovic (1981). The theoretical approach allows modelling the indicator of volatility by ARCH estimation, while in the future the model may be used to assess the need of holding reserves in agreement with the IMF. The optimal reserve holdings were determined as a function of precautionary and mercantilist motives of holding reserves and developments. It was assumed that, on average, the net payments equal zero. The empirical model was evaluated through the ARDL approach developed by Pesaran et al (2001).

The estimated results confirm the theoretical approach in the case of Albania that, in the long-run, there is a cointegration relationship between the level of foreign reserve and considered explanatory variables. The results show that the developments in current account are important in determining the level of reserves and their management follows the Anglo-American approach and the need to be self-insured against fluctuations and uncertainties in foreign capital inflows and to support the trade and monetary policies. In addition, results suggest that reserve holdings are affected neither by precautionary motives related to capital flow volatility nor by mercantilist motives related to export promoting policies.

The analysis on the gap between actual and the estimated optimum level of reserve holdings is relatively small, which justifies the low speed of adjustment found on the estimated models. The relatively small difference indicates that the Bank of Albania has a sufficient level of reserve holdings to fulfil the minimum requirements and hence it stands in a somewhat comfortable zone with the existing stock of reserves. This proves that the composition and implementation of the strategy on the management of reserve holdings has been consistent and a function of the objectives set under the Monetary Approach to Balance of Payments. In addition, this recommends that increasing the level of reserves reflects necessarily and is close to the optimal level.

However, the model is based on past developments approach, while reserve is a macroeconomic indicator, which is better determined by the macroeconomic variables in a country (such as public debt, economic growth, foreign capital inflows, interest rates on debt services, remittances etc) in the future. Traditionally, the level of foreign reserves held by the central bank is explained by two approaches. On the one hand, demand for reserve holdings is a function of mismatches between the desired and actual level; and on the other hand, based on the Monetary Approach to Balance of Payments However, the changes in reserve holdings relate to excess demand or/and supply for money. Demand for foreign reserve will in the future be estimated empirically based on other determinants, including monetary variables. This, among others, allows us to understand the role and effect of money and how reserve holdings relate to large foreign inflows.

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APPENDIX

Table 1a Estimation results of the random walk model for dIR

Dependent Variable: dIR				
Method: Least Squares				
Sample (adjusted): 1996M02 2010M12				
Included observations: 179 after adjustments				
	Coefficient	Std. Error	t-Statistic	Prob.
C	9.584981	2.364425	4.053831	0.0001
R-squared	0.000000	Mean dependent var		9.584981
Adjusted R-squared	0.000000	S.D. dependent var		31.63385
S.E. of regression	31.63385	Akaike info criterion		9.751904
Sum squared resid	178124.7	Schwarz criterion		9.769710
Log likelihood	-871.7954	Hannan-Quinn criter		9.759124
Durbin-Watson stat	1.980567			

Table 2a Testing for ARCH residual effects on dIR

Heteroskedasticity Test: ARCH				
F-statistic	5.753021	Prob. F(1,176)		0.0175
Obs*R-squared	5.634226	Prob. Chi-Square(1)		0.0176
Test Equation:				
Dependent Variable: RESID^2				
Method: Least Squares				
Sample (adjusted): 1996M03 2010M12				
Included observations: 178 after adjustments				
Newey-West HAC Standard Errors & Covariance (lag truncation=4)				
	Coefficient	Std. Error	t-Statistic	Prob.
C	830.6951	352.8121	2.354497	0.0197
RESID^2(-1)	0.179986	0.016769	10.73320	0.0000
R-squared	0.031653	Mean dependent var		1000.663
Adjusted R-squared	0.026151	S.D. dependent var		4474.149
S.E. of regression	4415.260	Akaike info criterion		19.63469
Sum squared resid	3.43E+09	Schwarz criterion		19.67044
Log likelihood	-1745.488	Hannan-Quinn criter.		19.64919
F-statistic	5.753021	Durbin-Watson stat		2.012034
Prob(F-statistic)	0.017505			

Table 1b Estimation results of the random walk model for dlog(REER)

Dependent Variable: DLOG(REER)				
Method: Least Squares				
Sample (adjusted): 1996M03 2010M12				
Included observations: 178 after adjustments				
Convergence achieved after 3 iterations				
Newey-West HAC Standard Errors & Covariance (lag truncation=4)				
	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.002036	0.002307	-0.882528	0.3787
AR(1)	0.363966	0.081135	4.485912	0.0000
R-squared	0.132767	Mean dependent var		-0.001917
Adjusted R-squared	0.127840	S.D. dependent var		0.022539
S.E. of regression	0.021049	Akaike info criterion		-4.872785
Sum squared resid	0.077976	Schwarz criterion		-4.837034
Log likelihood	435.6778	Hannan-Quinn criter.		-4.858287
F-statistic	26.94439	Durbin-Watson stat		1.901971
Prob(F-statistic)	0.000001			
Inverted AR Roots	.36			

Table 2b Testing for ARCH residual effects on dlog(REER)

Heteroskedasticity Test: ARCH				
F-statistic	6.587108	Prob. F(1,176)		0.0111
Obs*R-squared	6.421621	Prob. Chi-Square(1)		0.0113
Test Equation:				
Dependent Variable: RESID^2				
Method: Least Squares				
Sample: 1996M03 2010M12				
Included observations: 178				
Newey-West HAC Standard Errors & Covariance (lag truncation=4)				
	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000382	8.88E-05	4.304668	0.0000
RESID^2(-1)	0.100278	0.110535	0.907206	0.3655
R-squared	0.036077	Mean dependent var		0.000438
Adjusted R-squared	0.030600	S.D. dependent var		0.000975
S.E. of regression	0.000960	Akaike info criterion		-11.04746
Sum squared resid	0.000162	Schwarz criterion		-11.01171
Log likelihood	985.2240	Hannan-Quinn criter.		-11.03296
F-statistic	6.587108	Durbin-Watson stat		1.355460
Prob(F-statistic)	0.011104			

Table 1c Estimation results of the random walk model for dlog(NEER)

Dependent Variable: DLOG(NEER)				
Method: Least Squares				
Sample (adjusted): 1996M08 2010M12				
Included observations: 173 after adjustments				
Convergence achieved after 69 iterations				
Newey-West HAC Standard Errors & Covariance (lag truncation=4)				
MA Backcast: 1996M07				
	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000980	0.001893	-0.517814	0.6053
AR(1)	0.309366	0.181323	1.706155	0.0898
AR(2)	-0.122889	0.151968	-0.808654	0.4199
AR(6)	-0.220872	0.136389	-1.619426	0.1072
MA(1)	0.246505	0.206168	1.195656	0.2335
R-squared	0.319743	Mean dependent var		-0.001124
Adjusted R-squared	0.303546	S.D. dependent var		0.023042
S.E. of regression	0.019229	Akaike info criterion		-5.036314
Sum squared resid	0.062119	Schwarz criterion		-4.945179
Log likelihood	440.6412	Hannan-Quinn criter.		-4.999341
F-statistic	19.74137	Durbin-Watson stat		1.984593
Prob(F-statistic)	0.000000			
Inverted AR Roots	.71-.40i	.71+.40i	.06+.80i	.06-.80i
	-.61-.39i		-.61+.39i	
Inverted MA Roots		-.25		

Table 2c Testing for ARCH residual effects on dlog(NEER)

Heteroskedasticity Test: ARCH				
F-statistic	38.47587	Prob. F(1,170)	0.0000	
Obs*R-squared	31.74396	Prob. Chi-Square(1)	0.0000	
Test Equation:				
Dependent Variable: RESID^2				
Method: Least Squares				
Sample (adjusted): 1996M09 2010M12				
Included observations: 172 after adjustments				
Newey-West HAC Standard Errors & Covariance (lag truncation=4)				
	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000204	7.01E-05	2.913029	0.0041
RESID^2(-1)	0.429764	0.088754	4.842177	0.0000
R-squared	0.184558	Mean dependent var		0.000360
Adjusted R-squared	0.179761	S.D. dependent var		0.000975
S.E. of regression	0.000883	Akaike info criterion		-11.21434
Sum squared resid	0.000133	Schwarz criterion		-11.17774
Log likelihood	966.4333	Hannan-Quinn criter.		-11.19949
F-statistic	38.47587	Durbin-Watson stat		2.252111
Prob(F-statistic)	0.000000			

Table 3 Information criteria of the estimated models (errors follow normal distribution)

Model	AIC	SIC	HQ	Serial Corelation Effects	Negative Coeffience in the Variance Equation	ARCH Effects
ARCH (11)	9.275463	9.346690	9.304345	No	No	[0.5625]
GARCH (11)	8.860027	8.949061	8.896130	Yes	No	[0.0112]
GARCH (11) - AR(1)	8.944731	9.054564	9.054564	No	No	[0.7190]
TGARCH (11)	8.869650	8.976490	8.912973	Yes	Yes	[0.0203]
TGARCH (11) - AR(1)	8.935122	9.060248	8.985864	No	No	[0.4375]
EGARCH (11)	9.092575	9.199414	9.135897	No	No	[0.6058]
EGARCH (11) - AR(1)	8.987551	9.112877	9.038495	No	Yes	[0.9179]

Table 4a EGARCH (11) – AR(1)-in-mean model for dIR (errors follow normal distribution)

Dependent Variable: *dIR*
Method: ML - ARCH (Marquardt) - Normal distribution
Sample (adjusted): 1996M03 2010M12
Included observations: 178 after adjustments
Convergence achieved after 112 iterations
Presample variance: backcast (parameter = 0.7)

LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)
*RESID(-1)/@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	0.179143	0.087136	2.055907	0.0398
C	7.751772	1.630941	4.752943	0.0000
AR(1)	0.452236	0.057105	7.919381	0.0000
Variance Equation				
C(4)	-0.101686	0.411550	-0.247082	0.8048
C(5)	1.554286	0.435741	3.566996	0.0004
C(6)	-0.312856	0.209856	-1.490815	0.1360
C(7)	0.849841	0.090535	9.386923	0.0000

R-squared	-0.469417	Mean dependent var	9.599526
Adjusted R-squared	-0.520976	S.D. dependent var	31.72249
S.E. of regression	39.12266	Akaike info criterion	8.987751
Sum squared resid	261729.6	Schwarz criterion	9.112877
Log likelihood	-792.9098	Hannan-Quinn criter.	9.038493
Durbin-Watson stat	2.370426		
Inverted AR Roots	.45		

Table 4b EGARCH (11)-in-mean model for dlog(REER) (errors follow normal distribution)

Dependent Variable: DLOG(REER)				
Method: ML - ARCH				
Sample (adjusted): 1996M02 2010M12				
Included observations: 179 after adjustments				
Convergence achieved after 22 iterations				
Presample variance: backcast (parameter = 0.7)				
LOG(GARCH) = C(3) + C(4)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(5) *RESID(-1)/@SQRT(GARCH(-1)) + C(6)*LOG(GARCH(-1))				
	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	-0.743097	0.090018	-8.254986	0.0000
C	0.011058	0.001447	7.641938	0.0000
	Variance Equation			
C(3)	-0.095318	8.44E-05	-1129.304	0.0000
C(4)	-0.029071	2.64E-09	-11014674	0.0000
C(5)	0.083754	0.021803	3.841314	0.0001
C(6)	0.987315	1.03E-07	9627658.	0.0000
R-squared	0.008603	Mean dependent var		-0.001798
Adjusted R-squared	-0.020050	S.D. dependent var		0.022531
S.E. of regression	0.022756	Akaike info criterion		-5.171984
Sum squared resid	0.089586	Schwarz criterion		-5.065144
Log likelihood	468.8925	Hannan-Quinn criter.		-5.128661
F-statistic	0.300237	Durbin-Watson stat		1.240005
Prob(F-statistic)	0.912189			

Table 4c EGARCH (1,2)-AR(12)-in-mean model for dlog(NEER) (errors follow normal distribution)

Dependent Variable: DLOG(NEER)
Method: ML - ARCH
Sample (adjusted): 1997M02 2010M12
Included observations: 167 after adjustments
Convergence achieved after 24 iterations
Presample variance: backcast (parameter = 0.7)

LOG(GARCH) = C(5) + C(6)*ABS(RESID(-1)/@SQRT(GARCH(-1)))
+ C(7) *RESID(-1)/@SQRT(GARCH(-1)) + C(8)*LOG(GARCH(-1))
+ C(9)*LOG(GARCH(-2))

	Coefficient	Std. Error	z-Statistic	Prob.
@SQRT(GARCH)	-0.258491	0.249465	-1.036183	0.3001
C	0.000675	0.001777	0.379808	0.7041
AR(1)	0.236256	0.069688	3.390192	0.0007
AR(12)	0.183470	0.062415	2.939497	0.0033
Variance Equation				
C(5)	-0.737533	0.376449	-1.959183	0.0501
C(6)	0.318137	0.154865	2.054278	0.0399
C(7)	-0.094910	0.090280	-1.051290	0.2931
C(8)	0.569088	0.637559	0.892603	0.3721
C(9)	0.380631	0.615127	0.618784	0.5361

R-squared	0.157560	Mean dependent var	-0.000822
Adjusted R-squared	0.114905	S.D. dependent var	0.022439
S.E. of regression	0.021110	Akaike info criterion	-5.813511
Sum squared resid	0.070412	Schwarz criterion	-5.645475
Log likelihood	494.4282	Hannan-Quinn criter.	-5.745309
F-statistic	3.693799	Durbin-Watson stat	1.374214
Prob(F-statistic)	0.000558		

Inverted AR Roots	.89	.77+.43i	.77-.43i	.45-.75i
	.45+.75i	.02+.87i	.02-.87i	-.42-.75i
	-.42+.75i	-.73+.43i	-.73-.43i	-.85

Table 5 Unit root test analysis

	ADF test result				Phillips-Perron test result			
	Null Hypothesis: Unit Root				Null Hypothesis: Unit Root			
	Level		First Difference		Level		First Difference	
Variablat	[Prob.]	Lag[a]	[Prob.]	Lag[a]	[Prob.]	Lag[b]	[Prob.]	Lag[b]
Intercept								
log(*IR*)	[.2673]	4	[.0000]	5	[.1841]	4	[.0000]	5
log(*r*)	[.7539]	3	[.0000]	0	[.7411]	3	[.0000]	0
log(*IM*)	[.5153]	20	[.0000]	25	[.6159]	20	[.0000]	25
log(σ)	[.0004]	0	[.0000]	3	[.0004]	8	[.0000]	119
log(*REER*)	[.0007]	0	[.0000]	1	[.0019]	3	[.0000]	30
log(*NEER*)	[.0265]	0	[.0000]	0	[.0250]	2	[.0000]	3
REER_HP_Cycle	[.0000]	4	[.0000]	5	[.0000]	2	[.0000]	10
NEER_HP_Cycle	[.0000]	3	[.0000]	6	[.0035]	0	[.0000]	4
Lek/Euro_HP_Cycle	[.0000]	3	[.0000]	6	[.0007]	1	[.0000]	5
Intercept and Trend								
log(*IR*)	[.8915]	4	[.0000]	8	[.8846]	4	[.0000]	8
log(*r*)	[.7274]	2	[.0000]	0	[.5968]	2	[.0000]	0
log(*IM*)	[.0000]	1	[.0003]	25	[.0000]	1	[.0000]	25
log(σ)	[.0000]	0	[.0000]	3	[.0000]	8	[.0001]	111
log(*REER*)	[.0011]	0	[.0000]	1	[.0023]	2	[.0000]	31
log(*NEER*)	[.1322]	0	[.0000]	0	[.1326]	3	[.0000]	2
REER_HP_Cycle	[.0000]	4	[.0000]	5	[.0000]	2	[.0000]	10
NEER_HP_Cycle	[.0000]	3	[.0000]	6	[.0189]	0	[.0000]	4
Lek/Euro_HP_Cycle	[.0000]	3	[.0000]	6	[.0048]	1	[.0000]	5
None								
log(*IR*)	[1.000]	1	[.0000]	4	[1.000]	1	[.0000]	4
log(*r*)	[.2382]	5	[.0000]	1	[.2849]	5	[.0000]	1
log(*IM*)	[.8924]	36	[.0000]	21	[.9973]	36	[.0000]	21
log(σ)	[.7951]	4	[.0000]	3	[.8065]	111	[.0000]	133
log(*REER*)	[.4616]	20	[.0000]	1	[.5047]	33	[.0000]	30
log(*NEER*)	[.9868]	0	[.0000]	0	[.9845]	4	[.0000]	5
REER_HP_Cycle	[.0000]	4	[.0000]	5	[.0000]	2	[.0000]	10
NEER_HP_Cycle	[.0000]	3	[.0000]	6	[.0002]	0	[.0000]	4
Lek/Euro_HP_Cycle	[.0000]	3	[.0000]	6	[.0000]	1	[.0000]	5

[a] automatic lag selection based on SC criteria
[b] based on New-West Bandwidth selection through using the Bartlett Kernel

Table 6a ARDL bound test for cointegration analysis for equation (7) (logVAR)

Dependant Variable[1]	AIC-SC lags	F-statistic	df	[Prob.]	Results***
F_{logR}(log*I*R | logVAR,logKOSTO,logIM)	12	4.60293	(4,108)	[.0018]	Cointegration
F_{logVAR}(logVAR | log*I*R,logKOSTO,logIM)	12	4.16239	(4,108)	[.0036]	No conclusive
$Flog_{KOSTO}$(logKOSTO | logVAR,log*I*R,logIM)	12	1.41890	(4,108)	[.2326]	No cointegration
F_{logIM}(logIM | logVAR,logKOSTO,log*I*R)	12	2.71188	(4,108)	[.0334]	No cointegration

*** Based on the critical value suggested by Narayan (2004), for an equation with intercept and time trend, where k = 3 and n = 165

- (1 %) : lower bound I(0) = 4.568 and upper bound I(1) = 5.960
- (5 %) : lower bound I(0) = 3.363 and upper bound I(1) = 4.515
- (10 %): lower bound I(0) = 2.823 and upper bound I(1) = 3.885

Table 6b ARDL bound test for cointegration analysis for equation (7) (logREER)

Dependant Variable[1]	AIC-SC lags	F-statistic	df	[Prob.]	Results***
F_{logR}(log*I*R | logREER,logKOSTO,logIM)	12	4.443	(4,109)	[.0023]	Cointegration
F_{logVAR}(logREER | log*I*R,logKOSTO,logIM)	12	0.966	(4,109)	[.4289]	No cointegration
$Flog_{KOSTO}$(logKOSTO | logREER,log*I*R,logIM)	12	1.740	(4,109)	[.1464]	No cointegration
F_{logIM}(logIM | logREER,logKOSTO,log*I*R)	12	2.136	(4,109)	[.0812]	No cointegration

*** Based on the critical value suggested by Narayan (2004), for an equation with intercept and time trend, where k = 3 and n = 165

- (1 %) : lower bound I(0) = 4.568 and upper bound I(1) = 5.960
- (5 %) : lower bound I(0) = 3.363 and upper bound I(1) = 4.515
- (10 %): lower bound I(0) = 2.823 and upper bound I(1) = 3.885

Table 6c ARDL bound test for cointegration analysis for equation (7) (logNEER)

Dependant Variable[1]	AIC-SC lags	F-statistic	df	[Prob.]	Results***
F_{logR}(log*I*R | logNEER,logKOSTO,logIM)	12	5.317	(4,97)	[.0006]	Cointegration
F_{logVAR}(logNEER | log*I*R,logKOSTO,logIM)	12	4.398	(4,97)	[.0026]	No conclusive
$Flog_{KOSTO}$(logKOSTO | logNEER,log*I*R,logIM)	12	2.597	(4,97)	[.0409]	No cointegration
F_{logIM}(logIM | logNEER,logKOSTO,log*I*R)	12	2.854	(4,97)	[.0277]	No cointegration

*** Based on the critical value suggested by Narayan (2004), for an equation with intercept and time trend, where k = 3 and n = 165

- (1 %) : lower bound I(0) = 4.568 and upper bound I(1) = 5.960
- (5 %) : lower bound I(0) = 3.363 and upper bound I(1) = 4.515
- (10 %): lower bound I(0) = 2.823 and upper bound I(1) = 3.885

Table 6d ARDL bound test for cointegration analysis for equation (7) (REER_HP_cycle)

Dependant Variable[(1)]	AIC-SC lags	F-statistic	df	[Prob.]	Results***
F_{logR}(logIR | REER_hp,logKOSTO,logIM)	8	5.440	(4,131)	[.0004]	Cointegration
F_{REER_hp}(REER_hp | logIR,logKOSTO,logIM)	8	3.284	(4,131)	[.0133]	No cointegration
$Flog_{KOSTO}$(logKOSTO | REER_hp,logIR,logIM)	8	2.351	(4,131)	[.0574]	No cointegration
F_{logIM}(logIM | REER_hp,logKOSTO,logIR)	8	4.025	(4,131)	[.0041]	No conclusive

*** Based on the critical value suggested by Narayan (2004), for an equation with intercept, where k=3 and n=165

- (1 %) : lower bound I(0) = 3.908 and upper bound I(1) = 5.004
- (5 %) : lower bound I(0) = 2.920 and upper bound I(1) = 3.838
- (10 %): lower bound I(0) = 2.747 and upper bound I(1) = 3.312

Table 6e ARDL bound test for cointegration analysis for equation (7) (NEER_HP_cycle)

Dependant Variable[(1)]	AIC-SCl ags	F-statistic	df	[Prob.]	Results***
F_{logR}(logIR | NEER_hp,logKOSTO,logIM)	8	5.427	(4,131)	[.0004]	Cointegration
F_{NEER_hp}(NEER_hp | logIR,logKOSTO,logIM)	8	3.090	(4,131)	[.0181]	No cointegration
$Flog_{KOSTO}$(logKOSTO | NEER_hp,logIR,logIM)	8	2.558	(4,131)	[.0416]	No cointegration
F_{logIM}(logIM | NEER_hp,logKOSTO,logIR)	8	4.022	(4,131)	[.0029]	No conclusive

*** Based on the critical value suggested by Narayan (2004), for an equation with intercept, where k=3 and n=165

- (1 %) : lower bound I(0) = 3.908 and upper bound I(1) = 5.004
- (5 %) : lower bound I(0) = 2.920 and upper bound I(1) = 3.838
- (10 %): lower bound I(0) = 2.747 and upper bound I(1) = 3.312

Table 6f ARDL bound test for cointegration analysis for equation (7) (Lek/Euro_HP_cycle)

Dependant Variable[(1)]	AIC-SC lags	F-statistic	df	[Prob.]	Results***
F_{logR}(logIR | Lek/Euro_hp,logKOSTO,logIM)	8	4.507	(4,131)	[.0019]	Cointegration
F_{NEER_hp}(Lek/Euro_hp | logIR,logKOSTO,logIM)	8	3.087	(4,131)	[.0182]	No conclusion
$F_{logKOSTO}$(logKOSTO | Lek/Euro_hp ,logIR,logIM)	8	2.779	(4,131)	[.0295]	No conclusion
F_{logIM}(logIM | Lek/Euro_hp ,logKOSTO,logIR)	8	3.697	(4,131)	[.0069]	No conclusion

*** Based on the critical value suggested by Narayan (2004), for an equation with intercept, where k=3 and n=165

- (1 %) : lower bound I(0) = 3.908 and upper bound I(1) = 5.004
- (5 %) : lower bound I(0) = 2.920 and upper bound I(1) = 3.838
- (10 %): lower bound I(0) = 2.747 and upper bound I(1) = 3.312

Table 7a Estimating long-run elasticities of reserve using ARDL approach (logVAR)

ARDL (2, 0, 0, 2) selected based on Akaike Information Criteria (AIC) criterion. Dependant Variable is ΔlogIRt. 166 observations used for estimation from 1997M03 – 2010M12				
Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	5.0910	.547340	9.3013	[.000]
$logVAR_t$	-.012387	.014851	-.83408	[.406]
$logKOSTO_t$	-.33464	.080688	-4.1473	[.000]
$logIM_t$	.38683	.099299	3.8956	[.000]
trend	.0042028	.0010529	3.9918	[.000]

Table 7b Estimating long-run elasticities of reserve using ARDL approach (logREER)

ARDL (2, 0, 0, 1) selected based on Akaike Information Criteria (AIC) criterion. Dependant Variable is $\Delta logIR_t$. 155 observations used for estimation from 1998M02 – 2010M12				
Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	5.1150	.81154	6.3028	[.000]
$logREER_t$	.013781	.043224	.31883	[.750]
$logKOSTO_t$	-.33508	.11145	-3.0065	[.003]
$logIM_t$	.39219	.11567	3.3905	[.001]
trend	.0040815	.0011771	3.4673	[.001]

Table 7c Estimating long-run elasticities of reserve using ARDL approach (logNEER)

ARDL (2, 3, 0, 2) selected based on Akaike Information Criteria (AIC) criterion. Dependant Variable is $\Delta logIR_t$. 167 observations used for estimation from 1997M02 – 2010M12				
Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	4.8412	.5470	8.8553	[.000]
$logNEER_t$	-.014343	.013596	-1.0549	[.293]
$logKOSTO_t$	-.30218	.079623	-3.7951	[.000]
$logIM_t$	.38009	.093862	4.0494	[.000]
trend	.004805	.0010872	4.1210	[.000]

Table 7d Estimating long-run elasticities of reserve using ARDL approach (REER_HP_cycle)

ARDL (2, 0, 0, 0) selected based on Akaike Information Criteria (AIC) criterion. Dependant Variable is $\Delta logIR_t$. 172 observations used for estimation from 1996M09 – 2010M12				
Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	4.7009	1.2754	3.6857	[.000]
$REER\_HP\_cycle_t$	-.12475	.011720	-1.0644	[.289]
$logKOSTO_t$	-30299	.25993	-1.1656	[.245]
$logIM_t$	.54936	.15888	3.4578	[.001]

Table 7e Estimating long-run elasticities of reserve using ARDL approach (NEER_HP_cycle)

ARDL (2, 0, 0, 0) selected based on Akaike Information Criteria (AIC) criterion. Dependant Variable is $\Delta logIR_t$. 172 observations used for estimation from 1996M09 – 2010M12				
Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	4.8289	1.1230	4.3001	[.000]
$NEER\_HP\_cycle_t$	-.010710	.0097008	-1.1040	[.271]
$logKOSTO_t$	-.38040	.21417	-1.7762	[.078]
$logIM_t$	.54604	.13951	3.9139	[.000]

Table 7f Estimating long-run elasticities of reserve using ARDL approach (Lek/Euro_HP_cycle)

ARDL (2, 1, 0, 0) selected based on Akaike Information Criteria (AIC) criterion. Dependant Variable is $\Delta logIR_t$. 172 observations used for estimation from 1996M09 – 2010M12				
Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	5.3316	1.6502	3.2309	[.001]
$Lek/Euro\_HP\_cycle_t$	-.016975	.015907	-1.0672	[.287]
$logKOSTO_t$	-34738	.31647	-1.0977	[.274]
$logIM_t$	.46019	.2139	2.1770	[.031]

Table 8a Error correction for the selected ARDL model (logVAR)

ARDL (2, 0, 0, 2) selected based on Akaike Information Criteria (AIC) criterion. Dependant Variable is $\Delta logIR_t$. 166 observations used for estimation from 1997M03 – 2010M012				
Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	.6565E-3	.0055531	.11823	[.906]
ΔlogIR(-1)	.16650	.073302	2.2714	[.024]
ΔlogVAR	-.0012266	.0017594	-.69715	[.487]
ΔlogKOSTO	-.048079	.022605	-2.1269	[.035]
ΔlogIM	.022953	.011452	2.0043	[.047]
ΔlogIM(-1)	-.019263	.011435	-1.6846	[.094]
trend	-.6639E-6	.4151E-4	-.015993	[.987]
ECM(-1)	-.12784	.25665	-4.9811	[.000]
Diagnostic indicator				
R^2	.20698	-	180.9241	[.000]
Adj R^2	.17185	$X^2_{Re\ set}$	.26892	[.604]
F-stat (7, 158)	5.8914[.000]	X^2_{Auto}	6.0127	[.915]
S. E. R.	.023543	X^2_{white}	0.92047	[.762]
AIC	382.8776	Cusum	S	
SIC	370.4297	Csumsq	S	
$ecm_t = InRt + 0.012387*InVARt + 0.33464*InKOSTO_t - 0.38683*InIMP_t - 0.0042028 *Trend_t - 5.0910$				

Table 8b Error correction for the selected ARDL model (logREER)

ARDL (2, 0, 0, 1) selected based on Akaike Information Criteria (AIC) criterion. Dependant Variable is $\Delta logIR_t$. 155 observations used for estimation from 1998M02 – 2010M012				
Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	.4549E-3	.0063990	.071091	[.990]
ΔlogIR(-1)	.17337	.076072	2.2790	[.024]
ΔlogREER	.4132E-3	.012471	.033134	[.974]
ΔlogKOSTO	-.046921	.023792	-1.9721	[.050]
ΔlogIM	.025358	.016573	1.5301	[.128]
trend	.6027E-6	.4722E-4	.012764	[.990]
ECM(-1)	-.13806	.029424	-4.6922	[.000]
Diagnostic indicator				
R^2	.19349	-	183.8179	[.000]
Adj R^2	.16080	$X^2_{Re\ set}$	1.2226	[.269]
F-stat (6, 148)	5.9179[.000]	X^2_{Auto}	7.3188	[.836]
S. E. R.	.024003	X^2_{white}	.26102	[.609]
AIC	354.7307	Cusum	S	
SIC	344.0787	Csumsq	S	
$ecm_t = lnR_t$ -.013781*$lnREER_t$ +.33508*$lnKOSTO_t$ – -.39219*$lnIMP_t$ – .0040815 *$Trend_t$ – 5.1150				

Table 8c Error correction for the selected ARDL model (logNEER)

ARDL (2, 3, 0, 2) selected based on Akaike Information Criteria (AIC) criterion. Dependant Variable is $\Delta logIR_t$. 167 observations used for estimation from 1997M02 – 2010M012				
Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	.6913E-3	.0053826	.12844	[.898]
ΔlogIR(-1)	.15918	.072681	2.1901	[.030]
ΔlogNEER	.6018E-3	.0020418	.29474	[.769]
ΔlogNEER(-1)	.0042615	.0020466	2.0822	[.039]
ΔlogNEER(-2)	.0057184	.0020032	2.8547	[.005]
ΔlogKOSTO	-.043189	.022066	-1.9573	[.052]
ΔlogIM	.021844	.011429	1.9113	[.058]
ΔlogIM(-1)	-0.16361	.010996	-1.4880	[.139]
trend	-.4376E-6	.4061E-4	-.010775	[.991]
ECM(-1)	-.13149	. 024011	-5.4760	[.000]
Diagnostic indicator				
R^2	.24804	-	212.8935	[.000]
Adj R^2	.20493	$X^2_{Re\ set}$	.32884	[.566]
F-stat (9, 157)	5.7542[.000]	X^2_{Auto}	9.7988	[.634]
S. E. R.	.083589	X^2_{white}	.9070E-3	[.976]
AIC	387.6235	Cusum	S	
SIC	372.0335	Csumsq	S	
$ecm_t = lnR_t$ + .014343*$lnNEER_t$ + .30218*$lnKOSTO_t$ – .38009*$lnIMP_t$ – .0044805 *$Trend_t$ – 4.8412				

Table 8d Error correction for the selected ARDL model (REER_HP_cycle)

ARDL (2, 0, 0, 0) selected based on Akaike Information Criteria (AIC) criterion.
Dependant Variable is $\Delta logIR_t$. 172 observations used for estimation from 1996M09 – 2010M012

Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	.4975E-3	.0030241	.16453	[.870]
ΔlogIR(-1)	.13204	.074226	1.7789	[.077]
ΔREER_HP_cycle	-.0011093	.5499E-3	-2.0171	[.045]
ΔlogKOSTO	-.036333	.022598	-1.6078	[.110]
ΔlogIM	.010218	.010940	.93398	[.352]
ECM(-1)	-.037263	.0083631	-4.4556	[.000]
Diagnostic indicator				
R^2	.18299	-	201.8255	[.000]
Adj R^2	.15838	$X^2_{Re\ set}$	.0025163	[.960]
F-stat (5, 166)	7.4357[.000]	X^2_{Auto}	9.6619	[.634]
S. E. R.	.095135	X^2_{white}	.036742	[.848]
AIC	394.9388	Cusum	S	
SIC	385.4963	Csumsq	S	

$ecm_t = lnR_t + .012475*REER\_HP\_Cycle_t + .30299*lnKOSTO_t - .5436*lnIMP_t - 4.7009$

Table 8e Error correction for the selected ARDL model (NEER_HP_cycle)

ARDL (2, 0, 0, 0) selected based on Akaike Information Criteria (AIC) criterion.
Dependant Variable is $\Delta logIR_t$. 172 observations used for estimation from 1996M09 – 2010M012

Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	.2550E-3	.0030604	.083321	[.934]
ΔlogIR(-1)	.13508	.074381	1.8160	[.071]
ΔNEER_HP_cycle	-.8267e-3	.6076E-3	-1.3606	[.175]
ΔlogKOSTO	-.039276	.022690	-1.7310	[.085]
ΔlogIM	.016030	.010862	.1.4758	[.142]
ECM(-1)	-.043573	.0097797	-4.4555	[.000]
Diagnostic indicator				
R^2	.17498	-	217.0102	[.000]
Adj R^2	.15013	$X^2_{Re\ set}$	.090594	[.763]
F-stat (5, 166)	7.0416[.000]	X^2_{Auto}	8.4992	[.745]
S. E. R.	.096066	X^2_{white}	.0037382	[.951]
AIC	394.1006	Cusum	S	
SIC	384.6581	Csumsq	S	

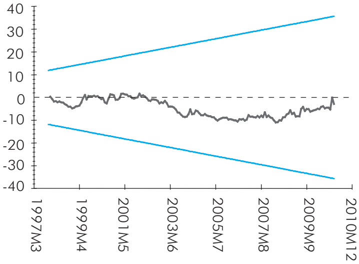
$ecm_t = lnR_t + .010710*NEER\_HP\_Cycle_t + .38040*lnKOSTO_t - .54604*lnIMP_t - 4.8289$

Table 8f Error correction for the selected ARDL model (Lek/Euro_HP_cycle)

ARDL (2, 1, 0, 0) selected based on Akaike Information Criteria (AIC) criterion. Dependant Variable is $\Delta logIR_t$. 172 observations used for estimation from 1996M09 – 2010M012				
Regressors	Coefficients	Standart error	t-statistic	[Prob.]
Constant	.9289E-3	.0032489	.28592	[.775]
ΔlogIR(-1)	.12121	.076612	1.5821	[.116]
ΔLek/Euro_HP_cycle(-1)	.4699E-3	5419E-3	-.86705	[.387]
ΔlogKOSTO	-0.37064	.023015	-1.6104	[.109]
ΔlogIM	.0088082	.011252	.78284	[.435]
ECM(-1)	.02870	.0073098	-3.9358	[.000]
Diagnostic indicator				
R^2	.16098	-	174.4001	[.000]
Adj R^2	.13571	$X^2_{Re\ set}$	.0023948	[.961]
F-stat (5, 166)	6.3701[.000]	X^2_{Auto}	9.9255	[.622]
S. E. R.	.07697	X^2_{white}	.30342	[.582]
AIC	392.6533	Cusum	S	
SIC	383.2108	Csumsq	S	
ecmt = lnRt + .016975*Lek/Euro_HP_cyclet + .34738*lnKOSTOt – .46019*lnIMPt – 5.3316				

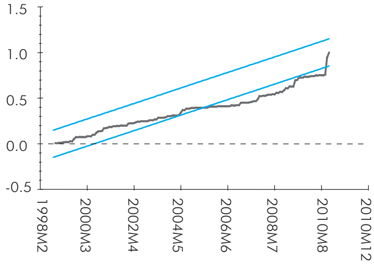
Diagram 1a Stability test analysis based on CUSUM and CUSUMSQ (logVAR)

Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

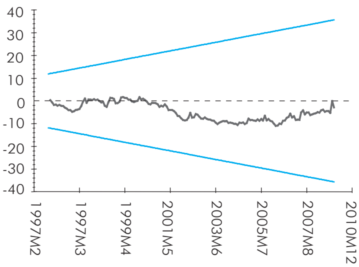
Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

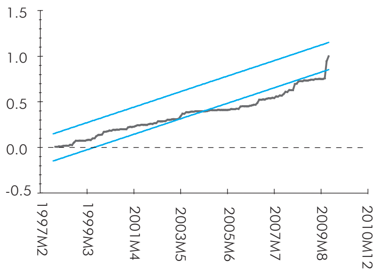
Diagram 1b Stability test analysis based on CUSUM and CUSUMSQ (logVAR)

Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

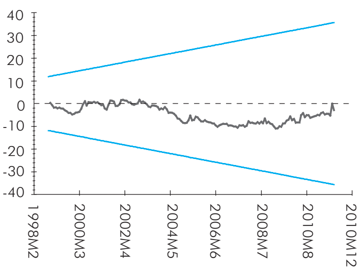
Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

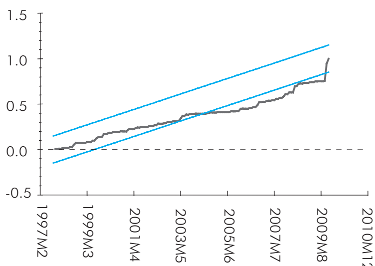
Diagram 1c Stability test analysis based on CUSUM and CUSUMSQ (logNEER)

Plot of Cumulative Sum of Recursive Residuals



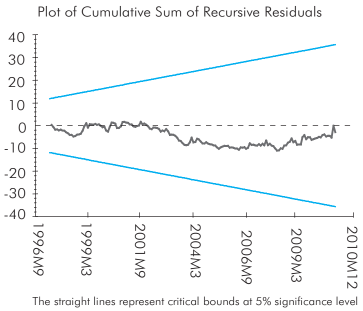
The straight lines represent critical bounds at 5% significance level

Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Diagram 1d Stability test analysis based on CUSUM and CUSUMSQ (REER_HP_cycle)



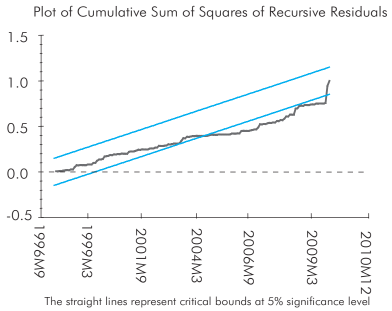
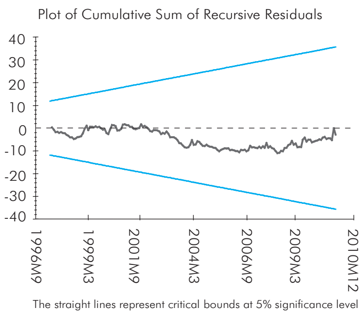


Diagram 1e Stability test analysis based on CUSUM and CUSUMSQ (NEER_HP_cycle)



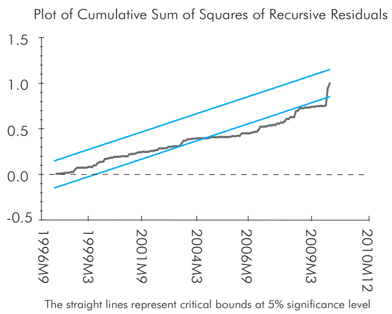
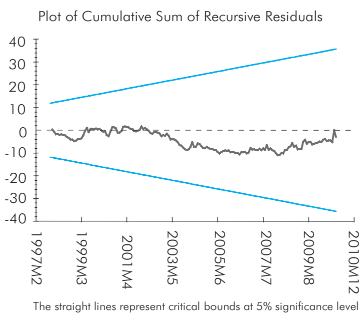
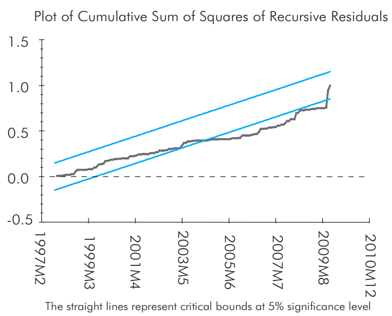


Diagram 1f Stability test analysis based on CUSUM and CUSUMSQ (Lek/Euro_HP_cycle)





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