Liberalization, monetary policy and demand for money

in Rwanda (1980-2005)

by

Musoni J. Rutayisire
Director of Research
National Bank of Rwanda

Presented at the CSAE Conference on "Economic Development in Africa"
University of Oxford
16-18 march 2008

ABSTRACT

The objective of this paper was to estimate a long and short run demand for money in Rwanda. Using the Johansen (1988) procedure, it was established that there was a stable long run relationship between the demand for money and its determinants, which are income, rate of return on foreign financial assets (Libor) and expected depreciation of the domestic currency (Rwanda franc or Rwf).These findings imply that the economic reforms implemented in Rwanda during the period covered by this study did not fundamentally alter the stability of the relationship between the demand for money and its determinants; this suggests that monetary targeting for macroeconomic stabilization purposes in Rwanda is appropriate.

The magnitude of the income elasticity coefficient (significantly higher than unity) in the demand for money in Rwanda is an indication , as is the case in many developing countries , of the importance of the transactions motive in the absence of financial assets ; it also reflects the rapid monetization of the rwandese economy and the preference for liquidity.

The significance of the rate of return on foreign financial assets and the expected depreciation of domestic currency (Rwf), have shown the importance of the external determinants of the demand for money in Rwanda ; it follows that in this context , a monetary policy favoring stability of exchange rate and real positive interest rates price is appropriate.

The different interest rates were not significant in the estimated demand for money function in Rwanda; this was not surprising, since during most of the period covered by this research, the interest rates were administratively controlled and were not determined by market forces; moreover in recent years the interest rate was made ineffective, due to persistent excess liquidity in the economy.

In the short term perspective, the dynamic model also showed that there was a stable relationship between the demand for money and its determinants in the short run. Lastly,

another important finding in this research is the speed of adjustment of the demand for money to its long run equilibrium position after short run deviations due to external shocks. As it was shown by the short run model, this adjustment period is approximately three years, pointing to persistence of monetary disequilibrium in Rwanda.

I. INTRODUCTION

A good understanding of the determinants of real demand for money in the economy through a study of the demand for money function is essential to the formulation of an effective monetary policy. The identification of a stable relationship between demand for money and its determinant variables provides an empirical proof that the monetary targeting policy is appropriate and thus confers on the monetary aggregate adopted the status of a control variable in its role as an intermediate target that would allow for the stabilization of prices and income.

We have noted that, until now, the monetary authority in charge of the design and implementation of the country's monetary policy has never refered to such a function. Yet, the National Bank of Rwanda (BNR) has always relied on monetary targeting in the sense that, in order to attain the ultimate objectives of macroeconomic policy, i.e. the stability of the national currency, prices, income and the balance of payments, it has sought to control changes in an intermediate monetary target, namely the broad money aggregate , M_2.

Between 1980 and 1989, direct credit control measures and the setting of interest rates ensured regulation of the money supply, while between 1990 and 2005, a period marked by the implementation of economic stabilization programs carried out with the support of the Bretton Woods Institutions, the regulation of the money supply was gradually achieved through indirect control instruments, i.e. the reserve requirement ratio, the National Bank discount rate and intervention on the money market.

In these programmes, monetary policy is an essential component of financial programming since monetary aggregates and credit play a key role in the determination of the level of inflation, balance of payments and output. These programs, which rely on the quantity theory of money, consider that the money is a reliable predictor of changes in these macroeconomic variables and that it can also influence their behavior. However, to be effective, this policy implicitly assumes the existence of a stable relationship between money and these variables through the demand for money function.

Important economic reforms in Rwanda were implemented during the period covered by this study, notably the liberalization of the financial sector undertaken since early 1990s and pursued in the 2000s. Since such liberalization is regarded as a potential source of instability in the demand for money, one objective of this research is to ascertain whether these reforms affected significantly the stability of the demand for money function in Rwanda.

In this research, we used the econometric technique of multivariate cointegration approach and error-correction mechanism developed by Johansen (1988) and Johansen and Juselius (1990) to establish a long run relationship between the demand for money and its determinants and we also estimated an error correction model (Engle et Granger, 1987) to analyze the short run dynamics of the demand for money in Rwanda.

Three studies on demand for money in Rwanda have been recently carried out; the first one by Kigabo (2001), the second by Nachega (1999) and the third one by David Hauner and Gabriel Di Bella (2005). In Kigabo's study, that covers the period 1975-1998, annual data on income, price and official exchange rate have been used to estimate a demand for nominal balances in Rwanda with M1 and M2 aggregates. A cointegration relationship was established between these varaibles with Johansen's (1998) procedure and an error – correction model was also estimated. The results of the study showed that the interest rate and the exchange rate of the Rwf were not significant variables in the demand for money function in Rwanda.

It was also shown that the income elasticity was significantly less than unity , while the adjustment coefficient in the short run model was equal respectively to –0,24 and –0,17 for M1 and M2 aggregates.

The study by Nachega used quarterly data for the period 1980-1998 .The author established a cointegration relationship with Johansen procedure between income, change of exchange rate, deposit interest rate and nominal balances of M2 aggregate. The demand for nominal balances with M2 was positively affected by income and interest rate, while the effect of the variation of the exchange rate was negative. Moreover, the study showed that the income elasticity was not significantly different from unity.

In the research by David Hauner and Gabriel Di Bella , the authors were particularly concerned with the usefulness of econometric modeling in low-income countries due to the unavailability and quality of data and the government's interventions in these countries.In the case of Rwanda , the authors examined first the behavior of the money multiplier and further established by the cointegration technique a long run relationship between income , exchange rate and M1 monetary aggregate ; a short run model was also estimated.The results of this study have shown that , inspite of the volatility of its determinants , the money multiplier was predictable and the application of the Chow stability tests did not reject the hypothesis of its stability.In the demand for money function , the income affected positively the demand for real balances while the effect of the exchange rate was negative . A particularly interesting finding in this study was that, despite political instability and economic reforms that occurred in the sample period (1980-2003), the results of the study were consistent with economic theory and contained useful information for policy purposes.

The objective of this paper is to empirically estimate a long and short run demand for money in Rwanda and test its stability for the period 1980-2005. With regard to Kigabo's and Nachega's works , this paper spans a longer period and uses real balances ; as to Hauner's and Di Bella's paper , it considered M1 aggregate while this research deals with M2 aggregate that is used by the National Bank of Rwanda too conduct monetary policy .

This paper is organized as follows.Section 2 describes the institutional framework and the macroeconomic developments in the period 1980-2005. Section 3 presents the theoretical framework of the study, while section 4 examines the methodological aspects of the research; section 5 presents the results of the estimations and their interpretation. Section 6 presents the conclusion of the study and the political implications of its findings.

II. INSTITUTIONAL ENVIRONMENT AND MACROECONOMIC DEVELOPMENTS

2.1. Institutional environment

The period covered by this study was characterized by Rwanda's transition from a highly controled economy (1980-1989) to a market-based economy (1990-2005). Until the late 1980s, not only the Government owned a large economic portfolio but it also set the price of goods and services and the money and financial market was heavily regulated.

From a monetary and financial standpoint, a complex quantitative and qualitative control mechanism governed the distribution of credit. The BNR determined the overall volume of credit and its breakdown by bank and sector. Certain financing was subject to a prior authorization from BNR under a provision allowing the authorized credit limits to be exceeded for individual applications and the amounts granted in this framework varied according to whether the applicant was an individual , a Rwandese citizen or a foreign resident.

The BNR set interest rates, which did not change for long periods. From Rwanda's independence in 1962 to the late 1980s, the rates were only reviewed three times, in 1967, 1979 and 1987. They subsequently remained fixed in certain sectors while they were negotiable between each bank and its customers in others.

The prevailing exchange rate system between 1980 and 1989 was also regulated and characterized by the BNR's control over all exchange operations. All import operations were subject to a license authorizing foreign currency payments. Similarly, all exports were subject to a prerequisite declaration that implied for exporters the obligation to repatriate their exports proceeds and this amount was transferred to BNR .The same controls were applied to capital movements and BNR had to ensure that the operations were in line with the exchange policy regulations. The President of the Republic had the authority to set the

exchange rate of the domestic currency and a legislation adopted in February 1981 established the fixed exchange rate system.

The period 1990-2005 was first marked by a four-year war (1990-1994), then by the genocide and the collapse of the Rwandese economy. It also witnessed deep economic reforms that allowed Rwanda to shift gradually from a regulated to a market based economy.

These reforms were carried out within successive economic stabilization programs, i.e. the SAP (1990) and the ESAF-PRGF (1998) that Rwanda implemented with the support of the international community.

The Rwandese government opted to steer the country's economy toward market based management , and this option was implemented through various measures. Price controls were removed in 1991, the privatization process of public enterprises began in 1996 and most of them were sold by the end of 2005.

From a monetary and exchange rare policy standpoint, direct control measures were gradually relaxed and gave way to mechanisms that relied more extensively on market forces to regulate the economy.

In the monetary field, direct credit restrictions were removed in 1992. To carry out its monetary policy, the BNR adopted indirect control mechanisms, i.e. the reserve ratio requirement, the discount rate and the interventions on the money market. Interest rates were completely liberalized in 1996, as lending and borrowing rates became freely negotiable between banks and their customers; the money market came into effect in 1997 and the Central Bank leading rate was introduced in 2005.

The reform of the exchange rate system began with the structural adjustment program in 1990, when residents were authorized to own foreign currency accounts in domestic commercial banks. In 1995, the flexible exchange rate system was introduced, along with new exchange policy regulations. The key innovations in the new exchange regulations were the liberalization of current account operations, market-driven exchange rates, the establishment of foreign exchange bureaus, the authorization of direct investments in Rwanda, and the transfer abroad of income generated by such investments.

Other measures were adopted subsequently to complement the regulation of exchange rate policy, in particular the right granted to exporters to dispose of foreign exchange in respect with current account operations and the authorization granted for residents to make withdrawals without supporting documents from their foreign currency accounts. However, the BNR's prior consent was maintained with regard to certain invisible transactions such as medical care, tourist trips, and so on, for which the purchase of foreign exchange is subject to ceilings as well as transfers abroad of capital not related to current account operations.

2.2. Macroeconomic developments

Macroeconomic developments during the period covered by this study were strongly influenced by unfavorable external shocks, in particular the rising price of petroleum products (the oil shock in 1979) and the drop in the value of Rwanda's principal exported goods. As Table 1 shows, in the late 1980s, the current account balance deteriorated markedly because of a drop in coffee and tea prices and a decline in net transfers to Rwanda. This imbalance persisted until 1993, mainly due to the increase in imports to meet post-war reconstruction needs. Between 1994 and 1996, the current account balance recorded large surpluses resulting from substantial flows of humanitarian aid but deteriorated again between 1997 and 2002 despite extensive external transfer flows. In 2003-2005, Rwanda experienced a substantial increase of foreign aid, but the current account deficit widened further due to the increase in imports of intermediary goods and equipments to back up economic growth, on the one hand, and of consumption goods to fill the gap in food needs, on the other hand.

At the domestic level , production was particularly affected by natural factors such as recurring drought in certain regions of the country and climatic disturbances caused by El Nino in the 1990s. In particular, these factors affected agricultural output, whose contribution to gross domestic product is estimated around 40%. It should also be noted that in the first half of the 1990s the destruction of infrastructure and population shifts resulting from the war considerably disrupted production facilities.

Table 1: External account: data in percentage of GDP

Year	1980	1985	1990	1995	2000	2005
Trade balance	-5.35	-5.18	-4.86	-8.6	-8.68	-9.58
Current account balance	-2.24	-2.6	-3.32	4.22	-6.3	-2.4
Net transfers	8.97	7.65	5.62	27.27	11.98	15.16
Overall balance (BOP)	-2.52	0.84	-2.18	5.19	0.26	4.99

Source: The Ministry of Finance and Economic Planning and the National Bank of Rwanda

The average growth rate of real GDP in the 1980s was approximately 3%, but this rate was insufficient to ensure an improvement in per capita income as the population was growing at an average annual rate of 3.5%. During the 1990s, two remarkable achievements occurred despite a highly unfavorable context. If the year 1994, during which real GDP declined by nearly 50%, is excluded, the average growth rate of real GDP stood at 7% during this period. Moreover, at the end of 2000, real GDP regained its 1990 level and the average growth rate was maintained at 5 % during the 2000s.

The changes that occurred in the institutional environment following various structural reforms and economic stabilization programs, and the international community's active support contributed significantly to the recovery of the Rwandese economy, particularly during the second half of the 1990s.

On the monetary side, the developments of the M2 aggregate increased by 7.9 % during the the 1980s and by 15.3% in the 1990s; the increase in this last period reflected higher credit to Government by the banking system in the 2000s. An important feature to be highlighted in

the period covered by this study is the improvement in the level of monetization of the rwandese economy (see Table 2). This level captured by the M2/GDP ratio increased from

Table 2: Other economic indicators

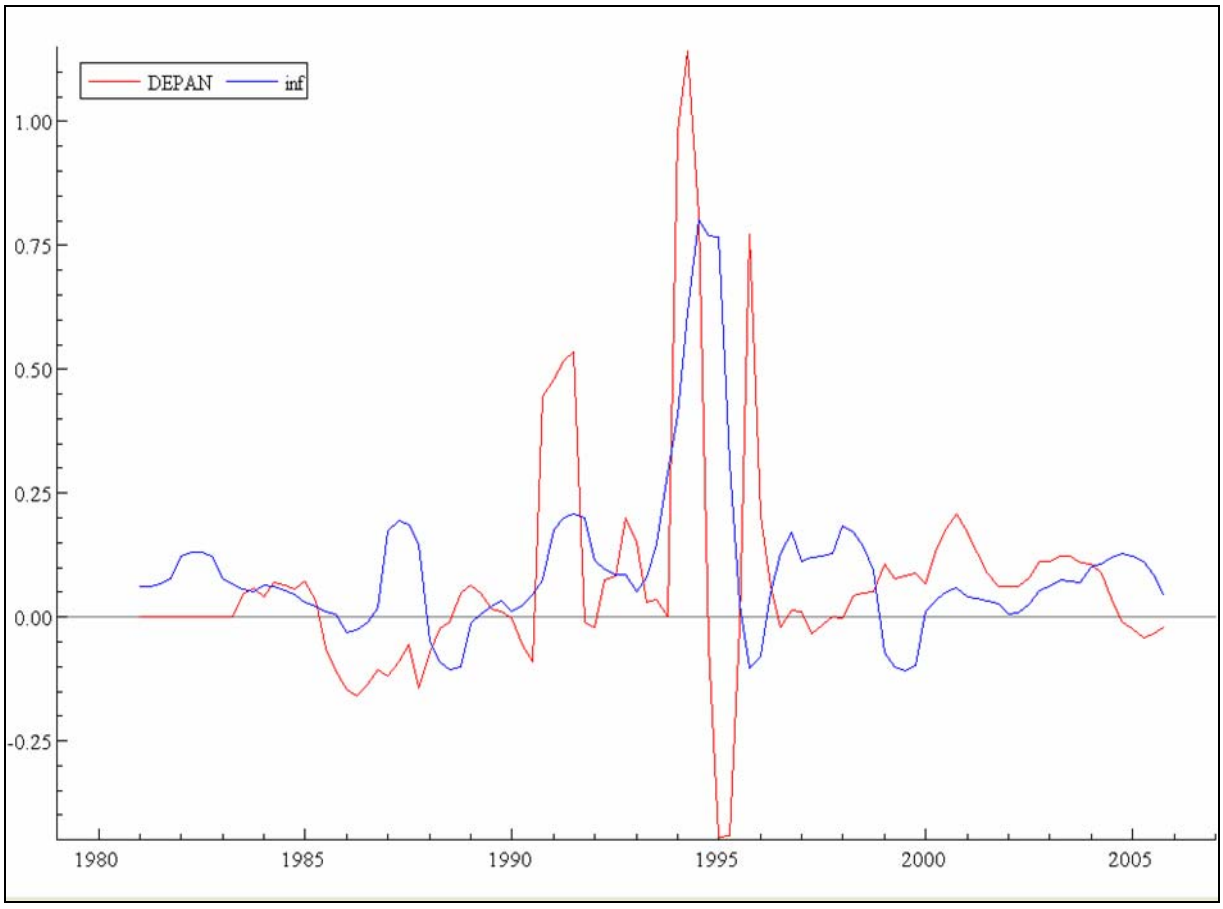
	1980	1985	1990	1995	2000	2005
GDP (real growth rate)	4.3	7.2	7.3	32.2	6.8	6.6
Inflation	7.1	1.9	4.2	21.3	3.9	9.1
Change in M_2	7.7	17.5	6.1	94,4	21.8	16.6
Real interest rate (deposit trate)	0.11	5.37	5.8	-9.1	6.2	-1.09
M2/PIB	13.1	13.4	15.0	18.6	16.8	16.4
QM/M2	23.0	37.0	45.0	36.0	42.0	39.2

Source**:** The Ministry of Finance and Economic Planning and the National Bank of Rwanda.

13.1% to 16.4% between 1980 and 2005. This increase reflected growth in income, the strengthening of the financial system following the establishment of new financial institutions such as banks and micro finance institutions and the improvements of financial conditions (positive real interest rates) that helped to channel a larger portion of national savings into the financial system. The same factors explain the change in the structure of the money supply in which, as Table 2 indicates, the share of quasi-money gradually increased from 23% to 39.2% of the money supply between 1980 and 2005.

Inflation was kept low during the 1980s, at an average rate of 4.7%, by means of direct credit restrictions and price controls. Between 1990 and 1994, the war led to the destruction of infrastructure and human resources, the breakdown of services and a reduction in output. Under these circumstances, inflation increased dramatically and reached 64% in 1994. The gradual restoration of institutions and security throughout the country, control over public spending and monetary policy made it possible between 1996 and 2000 to limit inflation to an average rate of 5.4% and during the period 2001-2005 inflation was maintained at an average of 6.7%.

Figure 1: Changes of exchange rate and inflation



Changes in the exchange rate as indicated in Figure 1 displays some stability attributable to the fixed exchange rate system and a fairly stable volume of external resources during the 1980s but also the overvaluation of the Rwanda franc in 1980-1983 and 1985-1987 inasmuch as price fluctuations during the period were not entirely reflected in the fluctuations of the nominal exchange rate.

The Rwf exchange rate was more volatile during the 1990s and 2000s insofar as the control of exchange rates was relaxed and the exchange rate was determined by market forces. Furthermore, the significant macroeconomic imbalances that appeared in the late 1980s, i.e. the deterioration of external accounts, the increase in the budget deficit and the reduction in foreign exchange reserves, which worsened during the war years, exerted so much pressure on the national currency that monetary authorities had to adjust the exchange rate of the Rwf through successive devaluations of 40% in 1990 and 15% in 1992. The Rwf was once again overvalued between 1992 and 1994 but in the wake of the liberalization of the foreign exchange policy in 1995, the domestic currency underwent a *de facto* depreciation of 45.6%. The fluctuations observed in subsequent years reflected changes due to the interactions of market forces and the interventions of the Central bank to stabilize the domestic currency.

III. THEORETICAL FRAMEWORK OF THE STUDY

3.1. Specification of demand for money

The theoretical foundations of the demand function are well established in economic literature and demand for money is widely acknowledged to be demand for real balances. Economic agents hold money balances for at least three reasons identified by Keynes: transaction, precautionary and specuclative motives. In more recent researches, theoretical analyses have focused either on the transaction motive (Baumol ,1952 ;Tobin ,1956) or on the portfolio motive (Friedman , 1956 ; Tobin ,1958). However, a broad consensus has emerged to adopt a long-term specification that establishes that demand for money is a function of a measure of real transactions, identified as the scale variable, and a variable representing the opportunity cost of holding money.

This specification, which has been adopted in empirical research, is expressed as follows (Ericsson, 1998):

(1) $M^d/P = f(Y, R)$

where M^d represents the desired long-term nominal quantity of money balances, Y the scale variable, R the vector of variables representing the opportunity cost of holding money and P the consumer price index. The function f increases in Y and decreases in relation to R.The formulation in terms of desired real balances in equation (1) implicitly hypothesizes the homogeneity of nominal balances with respect to prices, which excludes the money illusion, but this hypothesis can be empirically tested.

3.2. Choice of variables

The problems usually encountered in the construction of the demand for money function concern, in particular, the choice of variables to be adopted in this function and the question arises both for the endogenous variable and for the independent variables.

As regards the endogenous variable representing the money supply, empirical research has used several aggregates. Some researchers have adopted the monetary aggregate M1 (the money supply representing currency in circulation held by the public plus demand deposits in banks), others have used the aggregate M2 (which includes in its definition M1 plus term deposits) and still others have preferred a broader aggregate, M3, which incorporates certificates of deposit and other securities representative of national saving (Laidler, 1993). It has sometimes been suggested that the appropriate aggregate would be the one over which monetary authorities exert the greatest control and which would have a predictable impact on macroeconomic variables (Sriram, 1999). However, the observation shows that narrow aggregates, while easier to control, proved to be of little usefulness in the conduct of monetary policy since their relationship to income was highly volatile. On the other hand, broad aggregates appeared more stable in relation to money income but less controllable (Ericsson and Sharma, 1996). Recent research has favored the broad monetary aggregate

since it was considered as more appropriate to take into account financial innovations in the financial sector and their impact on monetary policy (Hafer and Jansen, 1991). For the latter reasons, broader monetary ggregate M_2 has been adopted in this study. My choice also stems from the fact that, this monetary aggregate is used by the Central bank as the intermediate target to conduct monetary policy.

As for the exogenous variables, the scale variable and the variable representing the opportunity cost of holding money balances must be determined.
According to the authors, the scale variable was represented by current income, permanent income, wealth, industrial production or consumption expenditure (Sriram, 1999). Researches on developing countries has generally current income represented by GDP, a choice justified by the low level and essentially agricultural nature of income and the predominance of the transaction motive in the economies of the developing countries (Adenkule, 1968; Laumas and Laumas, 1976). In this study, current income measured by GDP has been used as it was considered as the most appropriate scale variable for Rwanda given that other sources of wealth (financial assets) are still negligible in the Rwandese economy.

As for the opportunity cost of holding money, a distinction is made between the rates of return on the elements included in the monetary aggregate M_2 (own return rate) and the rates of return on alternative financial assets. The own return rate on money is an important variable as it takes into consideration financial innovations in the economy (Ericsson, 1998). The choice of return rate of alternative assets depends on the researchers' perspective. Those who emphasize the transaction motive would use the short-term interest rate, while those who focus on the portfolio motive wooujld prefer to use the long-term interest rate (Sriram, 1999). Some research works have also shown that real assets could be close substitutes to the money and hence include the anticipated inflation in the demand for money function (Friedman, 1956 and 1969). Studies by Adenkule (1968), Shahi (1977) and Crockett (1980), among others, have shown that, in the developing countries, the interest rate was not a significant variable in the demand for money function for the following reasons: since the

financial markets are not developed or non-existent and as interest rates are not determined by market forces, it is hard to capture the possible impact of the interest rate on demand for money. On the other hand, other studies have confirmed the importance of the anticipated inflation rate in the demand for money (Aghevli and Khan, 1978; Aghevli, Khan *et al.*, 1979; Khan, 1980). These findings have reinforced the opinion that in light of the scarcity of financial assets, individuals could only invest their savings in property such as land, buildings, livestock and so on, which, in addition to the resources they generated could also be good subtitutes to money balances for speculation and precautionary motives (Randa, 1999). However, it must be noted that some recent works have shown that, following the economic reforms that occurred the developing countries and led to the liberalization of the financial sector, the interest rate could be a significant variable in the demand for money (Rother, 1999; Nachega, 2001). In Rwanda, interest rates were fixed for many years but were totally liberalized in 1996. For this reason, it was useful to asssess to what extent demand for money was sensitive to this variable and the interest rate was included in the demand for money in Rwanda.

Moreover, empirical research has revealed that in the developing countries which experienced high inflation rates and large parallel markets, money substitution was observed where foreign currency replaced domestic currency in the portfolios of economic agents (Adam, 1992; Bahmani and Pourheydarian, 1990). So, this research has established that the currency depreciation leads to a reduction in demand for money balances in domestic cuirrency in favor of foreign currecy. It has also been observed that the depreciation of the domestic currency increases the value of assets held in foreign currenciy by residents. If the residents perceive this increase as an increase in their wealth, their demand for money will rise due to this real balance effect (Arango and Nadiri, 1981) ; as a consequence , two other opportunity costs of holding money balances have emerged, i.e. the anticipated depreciation rate of the domestic currency in relation to the foreign currency and the rate of return on foreign financial assets. Domovitz and Elbadawi (1987) have established that where foreign currency substitution for the domestic currency exists, the omission of the variable measuring the depreciation of the domestic currency in the demand for money function would bias the

results of estimations of demand for money models by overestimating the influence of inflation. In Rwanda, the exchange rate, like interest rates, was also fixed during the 1980s but was gradually liberalized during the 1990s. As a consequence of this liberalization , deposits in foreign currencies increased in commercial banks as exchange rate control was relaxed. Moreover, the gradual liberalization of the capital account afforded residents an opportunity to invest their assets abroad, which implies that demand for money in Rwanda could be sensitive to the rate of return on foreign financial assets.

As in many developing countries, the parallel exchange market is a common feature, the question has been raised as to which rate between the official and the parallel exchange rate should enter into the formulation of the demand for money in these countries. These two rates have been used in the literature. Randa (1999) and Adam (1999) have used the parallel exchange rate in their studies on Tanzania and Zambia, while Jenkins (1999) used both rates which proved to be significant in his research on Zimbabwe. In a recent study on 25 developing countries including 8 African countries, Bahmani-Oskooee, M. and Tanku, A . (2006) tried to determine if they could generalize the conclusion that the black market rate and not the official rate belongs to the demand for money in developing countries; their results showed that , while in some countries in the sample, the black market rate or the black market premium entered significantly in the demand for money, in some others, the official rate was the appropriate determinant ; for these authors it appeared that including either exchange rate (official or black market) or the premium was country specific . In our paper, as the data on the parallel exchange rate for $/Rwf were incomplete , we adopted the official exchange rate, as in fact have done the other authors mentioned above in their research on the demand for money in Rwanda[1].

In fact, the choice of the variables to be included in the demand for money function requires a sound knowledge of the characteristics and the financial structure of the economy considered.

IV. METHODOLOGICAL APPROACH

This section devoted to the study's methodological aspects first presents the basic money demand model adopted in this research and the statistical characteristics of the data used. The choice to use the cointegration techniques and the error-correction mechanism to estimate the demand for money function in Rwanda is also explained.

4.1. Demand for money in Rwanda

Official statistics indicate that 90% of Rwandese citizens earn their income from agriculture, which accounts for over 40% of the country's gross domestic product. Salaries paid by private-sector businesses and the government and income derived from the informal sector are the other main sources of income; income from investments in financial assets is still negligible. Rwanda's financial system is not developed and private-sector firms have no other recourse but bank credit to cover their financing needs. Six commercial banks, a development bank and savings and credit cooperatives are the key players in the Rwandese financial sector. It should be noted that only three commercial banks were in operation prior to 1995. The financial assets available on the market include interest-bearing time deposits, development bonds and treasury bills. Until 2005, the volume of the latter two assets was limited and their acquisition was predominantly reserved for commercial banks, financial institutions and a number of public enterprises.

It thus appears that, aside from real assets and foreign currency, substitutes for domestic currency are limited in the Rwandese economy and changes in the composition of the portfolios of the Rwandese are all the more limited as average income is very low.

Given these specific features of the economy, the basic model adopted to estimate the demand for money function in Rwanda is as follows:

(2) $LM2R = b_o + b_1 Lyr + b_2 REF + b_3 Lib + b_4 DEPAN + u_t$

where

LM2R = long-term real demand for money in M_2;

Lyr = real income (GDP);

REF = the central bank's discount rate or refinancing rate;

DEPAN = change in the anticipated exchange rate of the Rwf or depreciation rate;

Lib = London interbank offered rate (Libor) representing return on foreign financial assets;

u_t = the error term;

b_0, b_1, b_2, b_3, and b_4 are the parameters to be estimated.

Equation (2) is specified in logarithm except for the interest rate, Libor and the depreciation rate; the parameters will thus be interpreted as elasticity for income and semi-elasticities for the other right hand side variables. The expected signs of the model's parameters are:

-$b_1 > 0$, income affects positively the demand for money;

-$b_2 0 < 0$, the sign of this coefficient is negative since the increase in the central bank's refinancing rate is supposed to increase the cost of money and negatively affect the volume of credit and hence money supply in general;

-$b_3 < 0$**,** the sign of this coefficient is negative because Libor represents the rate of return on foreign financial assets, its increase leads to a higher demand for foreign financial assets to the detriment of the demand for domestic currency;

-b_4, the sign of this coefficient is indeterminate since the reaction of the demand for money with respect to depreciation of the domestic currency is subject to two opposite effects, i.e. the positive real balance effect (Arango and Nadiri, 1981) and the negative substitution effect (Adam, 1992; Bahmani and Pourheydarin, 1990); its sign will ultimately be determined by the dominant effect.

In addition to the determinant variables defined above, two dummy variables have been integrated to the model. The first one, Dummy1, is intended to take into account the permanent impact of the economic reforms introduced in Rwanda, notably in the financial sector (liberalization of credit and interest rates, introduction of flexible exchange rates …)

since early 1990s[2]; Dummy1 will take the value 0 for the period 1980(I)-1992(II) and 1 elsewhere. The second one , Dummy2 , has been added to the model to capture the effects of the war , especially in 1994 ; it will take the value 1 for the period (1994,I , II and III) and 0 elsewhere ; the seasonal dummies have also been included in the model.

4.2. Data used

We have used quarterly data drawn from various documents published by the National Bank of Rwanda (Satistical bulletins, Reports on Rwanda's Economic and Financial Developments, and etc…) and by the International Monetary Fund (International Financial Statistics and World Economic Outlook). The monetary aggregate adopted is M_2, which includes currency in ciculation held by the public, demand deposits, term deposits and foreign currency deposits in commercial banks. The interest rate used, REF, is the National Bank of Rwanda's discount rate. The price level, P_t, using 1990 as the base year, is represented by the consumer price index (CPI) since it is the only one that is published regularly. The annualized change of the Rwf/USD exchange rate has been used as a proxy for the anticipated depreciation of the domestic currency , $DEPAN_t$,and was calculated from the official exchange rate series , E_t , such that $DEPAN_t = (E_t-E_{t-4})/E_{t-4}$. It should be noted that the exchange rate series of the parallel market would probably have been a better estimator of the market price of the currency, but as this was incomplete , the official exchange rate has been used. The series on Lib (London Interbank Offered Rate or Libor) has been drawn from International Monetary Fund publications.

GDP data are from the World Economic Outlook data base. Since these data are only available on annual basis, the interpolation technique proposed by Gandolfo (1981)[3] has been used to generate quarterly data.

The nominal values of the monetary aggregates and GDP have been deflated by the consumer price index to get the real values.

4.3. Statistical properties of the variables

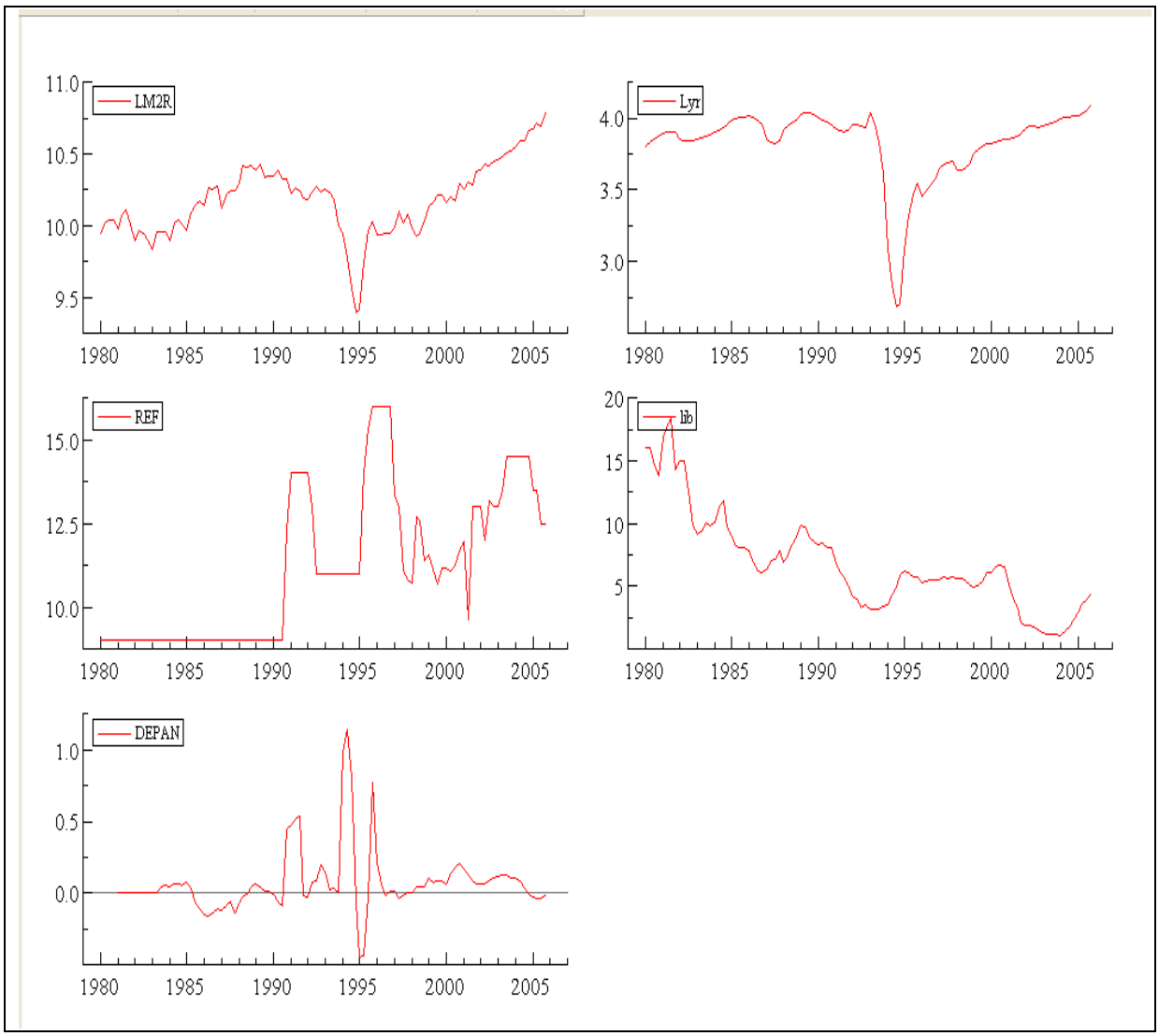
Before proceeding to the estimation of the demand for money function as specified in equation (2), the statistical properties of the variables must be investigated to ensure that they are stationary or not. The standard statistical inference is indeed valid only if, the variables included in the model are stationnary, i.e. if the mean and variance of these variables are finite and do not vary over time. This verification is crucial, since as Granger (1986) and Hendry (1986) have shown, the results of econometric estimations on non-stationary variables are not statistically valid, since the conventional tests, Student's t test and the F test, are biased. These results lead, in fact, to spurious regressions and not to a genuine correlation between an endogenous and independent variables.

The statsitcal properties of the variables in equation (2) will be analyzed with the Augmented Dickey-Fuller (1981), ADF, and the Phillips-Perron (1988), PP, tests of non-stationarity to detect the presence of the unit root in the series and determine the order of integration of the variables.

4.4. Cointegration of variables

The cointegration technique makes it possible to test the existence of a long-run equilibrium relationship between economic non-stationary variables. Engle and Granger (1987) have shown that even if the individual variables are non-stationary, a linear combination may exist between these variables such that they form a new series that, over time, converges toward equilibrium ; in this case, these variables are said to be cointegrated.
In this research, the cointegration test in a multivariate system developed by Johansen (1988) and applied by Johansen and Juselius (1990) has been used. This technique relies on the maximum likelihood method to determine the coefficients, the number and the significance of the cointegration vectors in the data. This approach also makes it possible to test restrictions suggested by economic theory on the estimated parameters.

Figure 2 : Variables of the model : LM2R, Lyr, REF, Lib et DEPAN



The Johansen and Juselius procedure starts with a general vector autoregressive (VAR) model:

(4) $X_t = \Pi_1 X_{t-1} + \ldots + \Pi_k X_{t-k} + \mu + \psi D_t + \varepsilon_t$ (t =1, ……, T)

in which X_t is a vector (n x 1) of endogenous variables (the variables used in the model) , Π_i is the matrix (n x n) of the model's parameters, μ is the constant, D_t is a vector of exogenous

variables (including seasonal dummies) and ψ is the matrix of the parameters associated with these variables, while ε_t is the error term.

This model is reformulated into a vector error-correction model (VECM) in the form:

(5) $\Delta Xt = \Gamma_1 \Delta_{t-1} + \ldots \Gamma_{k-1} \Delta X_{t-k-1} - \Pi X_{t-k} + \mu + \psi D_t + \varepsilon_t$

where $\Gamma_i = -(I - \Pi_1 - \Pi_2 - \ldots \Pi_i)$ $(i = 1, \ldots, k-1)$ and $\Pi = -(I - \Pi_1 - \ldots - \Pi_k)$

Specified in this way, the model combines information relative to the short and long-run adjustments that occur following changes in the variables X_t, through the parameters in Γ and Π, respectively. Testing for cointegration amounts to the determination of the rank r of the matrix Π , that is finding the number of the cointegrating vectors in the system.

When the matrix Π is of reduced rank , that is $0 \leq r \leq n$, this means that there are r cointegrating vectors and this implies that $\Pi = \alpha\beta$, where α and β are n x r matrices . The β are interpreted as the parameters of the r cointegrating vectors or long run relationships, while the α are the corresponding short-run adjustment coefficients. Johansen procedure uses two likelihood ratios, the trace test (λ_{trace}) and the maximum eigenvalue test (λ_{max}) to determine the number of cointegration relationships and the corresponding parameters in the model.

4.5. Dynamic model

According to Granger's representation theorem (Engle and Granger, 1987), if it has been established that the variables are cointegrated, it follows that there are forces that tend to restore the equilibrium relationship between the variables when it is broken. This also implies that the return to equilibrium occurs through a process of short-term dynamic adjustment that can be represented by an error-correction mechanism. The error-correction model is specified with the first difference values of the variables, ΔX_t, and the error-correction term ECM_{t-1}. Based on equation (2), the general error-correction model can be formulated as follows (Randa ,1999):

(5) $A(L) \Delta LM2R_t = \alpha_o + B(L) \Delta Lyr_t + C(L) \Delta REF_t + D(L) \Delta Lib_t + E(L) \Delta DEPAN_t - \gamma ECM_{t-1} + CS_t + \varepsilon_t$

where Δ is the first difference operator and A (L) …E (L) are polynomials of the form A (L) = $\Sigma\alpha_i L^i$ in which L is a lag operator such that $L^i x_t = x_{t-i}$, ECM_{t-1} is the error-correction term, and S_t represents seasonal dummy variables.

In equation (5), the error-correction term, ECM_{t-1}, is computed from long-term equation (2) as the difference between the actual and estimated values at period t-1; its coefficient γ, which measures the speed of adjustment of real balances to their equilibrium position must have a negative sign and be significantly different from zero.

V. ESTIMATIONS AND INTERPRETATION OF THE RESULTS

5.1. Unit root tests

The results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests applied to the variables in equation (2) are summarized in Tables 3a and 3b for the variables in level and in first difference. We have used both tests because they are complementary. The PP test is indeed less restrictive than the ADF test and its results are valid even if the condition of absence of autocorrelation and heteroscedacity in the errors is not satisfied. These tests have been performed with constant and with constant and trend. It appears that all the variables, except for the variable $DEPAN_t$, are not stationary in level but become stationary , that is I(0) in first difference ; they are thus integrated of order one, I (1) .

Table 3: Unit root tests

Table 3a: ADF Test

Variables	in level		in first difference	
	with constant	with constant and trend	with constant	With constant and trend
Lm2r	-1.104494	-1.618780	-5.207705	-5.332705
Lyr	-1.806273	-1.728648	-4.946644	-4.957583
Lib	-3.430300	-3.922097	-3.933241	-4.234663
REF	-2.255242	-4.009060	-4.731035	-4.702315
DEPAN	-6.546963	-6.699957	-9.942984	-9.894565
Critical values at 1% significance level	-3.4972	-4.0530	-3.4979	-4.0540

Table 3b: PP Test

Variables	in level		in first difference	
	with constant	with constant and trend	with constant	with constant and trend
Lm2r	-1.216753	-1.705480	-9.471423	-9.489048
Lyr	-2.386103	-2.351717	-5.864348	-5.839418
Lib	-2.333597	-2.441396	-7.901926	-7.986801
REF	-2.215450	-3.187350	-9.369428	-9.327275
DEPAN	-4.588417	-4.595297	-8.853162	-8.786092
Critical values at 1% significance level	-3.4946	-4.0494	-3.4952	-4.0503

5.2. Cointegration tests

This section analyses the cointegration or the long-run relationship between the variables of the model, i.e. real balances, income, Libor and the variation of exchange rate. The interest

rate was removed from the model since it was not significant and did not have the right sign in all the specifications we tried.

Prior to cointegration estimation, it is crucial to determine the optimum number of lags to be included in the model. To this end, we have adopted the procedure proposed by Haffer and Jansen (1991) and the appropriate number of lags was set to five using the likelihood ratio statistic; this result has been confirmed by the Akaike information criterion (AIC).

The results of the estimations with the Johansen (1988) and Johansen and Juselius (1990) procedure are presented in Tables 4.

These results indicate that on the basis of the two tests, λ_{trace} and λ_{max}, the hypothesis of non-cointegration is rejected. They rather allow to conclude that there are two cointegration relationships according to the trace test (λ_{trace}), while the maximum eigenvalue test (λ_{max}) indicates only one cointegration relationship. As the trace test is more powerful than the maximum eigenvalue test (Serletis and King, 1997), we retained the result from the trace test indicating two cointegrating vectors; this is also consistent with the recommendation by Johansen and Juselius (1990) in case these two tests are in conflict.

However, the presence of two cointegrating vectors calls for some clarifications. The cointegration test has been applied to a vector autoregressive model containing I(1) variables , LM2R , Lyr , Lib and one I(0) variable , DEPAN.

According to Harris (1995), though the same integration order is required for variables to run a cointegration test, I (0) variables can be associated with I(1) variables in the Johansen procedure to establish a long-run relationship if economic theory a priori suggests that such I(0) variables might play a key role in the relationship and hence should be included . The practical consequence of this inclusion will be that for every stationary variable included, there will be an additional cointegrating vector[4]. In their study where the Phillips-Perron unit root test revealed that one variable in their model (Government expenditure) was I(0) , while the other two variables (Income and Money supply) were I(1) , Cheng and Lai (1997) could apply the Johansen procedure using only the two I(1) variables , but they preferred to include the I(0) variable , because by incorporating the I(0) variable in the Johansen test , it improves the efficiency of cointegration estimates. We have adopted the same approach in our study.

It follows that in our results, one of the cointegrating vectors is associated to the stationary variable, DEPAN, in the model. To ensure that the second vector corresponds to a relationship that can be interpreted as a demand for money function, we have normalized on the variable of interest, that is LM2R, and the matrix β containing the parameters of the cointegrating vector has been examined to check if the coefficients had the characteristics anticipated by economic theory.

In light of the signs and values of β parameters, it appears that the second cointegration relationship can be interpreted as a function of long-term demand for money. All the variables of the cointegration relationship have the anticipated signs and are significant at **1%** significance level (Table 4a and Table 4b). Conventional diagnostic tests on the properties of the residuals were performed to examine the model's robustness (Table 5). Tests concerning the autocorrelation of errors, the presence of heteroscedasticity and the model's functional misspecification did not reveal any particular problem. However, the hypothesis of the normality of errors was rejected, but as Gonzalo (1994) has demonstrated, Johansen's procedure produces robust results even when the hypothesis of normality of errors is not satisfied. The weak exogeneity test was performed (Table 4c) and the results show that this hypothesis is rejected for the variables LM2R, Lyr and DEPAN, while it was accepted for the variable Lib; it follows that the three first variables are endogenous while the Libor is exogenous as was expected. These results imply that the process to restore the long run equilibrium is carried out through the adjustments of the money stock, income and the exchange rate. This means also that changes in money affect not only the exchange rate but have a real impact on income.

The results of the estimations are presented in equation (6) where the income coefficient is interpreted as elasticity while the coefficients of the other variables (Lib and DEPAN) are interpreted as semi-elasticities[5]:

(6) $LM2R_t = 1.588\ Lyr_t - 0.0978\ Lib_t - 1.922\ DEPAN_t$

and in equation (7) where all the coefficients represent elasticities[6] :

(7) $LM2R_t = 1.578\ Lyr_t - 0.665\ Lib_t - 0.138\ DEPAN_t$

All the variables in the models have signs as anticipated by economic theory. Income affects positively the demand for real balances and the value of the elasticity coefficient of balances with respect to income is higher than unity, 1.578. The conventional income unitary elasticity hypothesis was tested but the hypothesis was rejected as shown by the result of the restriction test, Chi^2(1) = 8.4600 [0.0036]** , that is , this coefficient is significantly different from unity . This result is similar to those found by Aghevli, Khan and al.. (1979) and Arize (1999) in their studies on African and Asian countries, but differs from Nachega's (1999) result in his research on the demand for in Rwanda where a coefficient of 1.09 for the income elasticity was found and was not significantly different from unity.

We have mentioned earlier that the interest rate was removed from the long run model because it was not significant and had not the expected sign in all the specifications we have tried. A close analysis of the behavior of this variable through the period covered by this study could help to understand this finding. The refinancing rate, like the other interest rates, was still subject to control during the major part of this period and it only started to fluctuate freely in 1995. Between 1995 and 1996, it remained at 16% and during the same period the money supply increased by 11.5%. During the subsequent years , that is between 1997 and 2000, the money supply increased, on average, by 14.9%, while the refinancing rate declined from 16% to 11.7%.

Table 4 : Cointegration tests : Johansen procedure

Sample period: 1982(2)-2005(4)
Number of lags: 5

Table 4a : Cointegrating vectors

Rank	Trace test [Prob]	Max test [Prob]	Trace test (T-nm)	Max test (T-nm)
0	110.89 [0.000]**	79.33 [0.000]**	87.54 [0.000]**	62.63 [0.000]**
1	31.55 [0.030]*	19.61 [0.081]	24.91 [0.170]	15.48 [0.268]
2	11.95 [0.161]	11.86 [0.116]	9.43 [0.333]	9.36 [0.263]
3	0.09 [0.765]	0.09 [0.765]	0.07 [0.790]	0.07 [0.790]

Beta (scaled on diagonal; cointegrating vectors in columns)

LM2R	1.0000	1.8301	111.35	2.6121
Lyr	-1.5878	1.0000	-160.93	-1.5552
Lib	0.097804	0.37979	1.0000	0.041701
DEPAN	1.9216	-1.1761	-185.73	1.0000

Alpha

LM2R	-0.045560	-0.0018437	0.00017460	-0.0040691
Lyr	0.077732	-0.0021653	0.00040772	-0.0023056
Lib	-0.41826	-0.33814	0.0044001	0.010272
DEPAN	-0.18800	0.047044	0.0012936	0.0022539

Table 4b: Statistic for testing the significance of each variable

	LM2R	Lyr	Lib	DEPAN
Chi^2(1) =	10.495	22.578	16.363	26.339
p-value	[0.0012]**	[0.0000]**	[0.0001]**	[0.0000]**

Table 4c : Weak exogeneity test

	LM2R	Lyr	Lib	DEPAN
Chi^2(1) =	7.6727	25.228	3.7333	17.037
p-value	[0.0056]**	[0.0000]**	[0.0533]	[0.0000]**

Table 5: Diagnostic tests

Vector Portmanteau (11) = 175.032
Vector AR 1-5 test = F (80,183) = 1.3500 [0.0512]
Vector Normality test = Chi^2(8) = 91.877 [0.0000]**
Vector hetero test = F (400,213) = 0.59247 [1.0000]

Note : * Indicates the rejection of the null hypothesis at 5% significance level and
** indicates the rejection of the null hypothesis at 1% significance level.

It should be noted that during the sub-period 1997-2000, nominal GDP rose by 13%. For the period 2001-2005, in which the economy experienced a high excess liquidity in the banking system, the refinancing rate was rather accommodating and was not used to tighten credit at a time when liquidity was increasing in the economy.

A comparative study of the impact of the refinancing rate and the interest rate on Treasury bills would probably have made it possible to assess which of the two would be most effective in the regulation of liquidity. Unfortunately, data relating to interest rate on Treasury Bills are not available over a long period, as the money market was introduced in 1997 and operations on Treasury Bills started only in 1998. In a recent study on the countries of the West African Monetary Union (UMOA), Kako Nubukpo (2003) showed that the money market rate had a stronger effect than the refinancing rate.

We also intended to include in our model the spread between interest rate on time deposit and the interest rate on Treasury Bills as Nachega (2001) did in his study on demand for money in Uganda, but due to reasons already mentioned above, the spread could not be calculated for the whole period covered by our research.

In the literature on demand for money in developing countries, many empirical studies have established that inflation was an important determinant of money demand and reflected the substitution effect between money and real assets. In our study, we tried to integrate the inflation rate in our estimations, but it was not statistically significant and its sign was constantly positive, it was then abandoned[7]. However, this does not mean that in Rwanda, inflation has no effect on economic agents' expectations or that it has no impact on the demand for money balances. This impact is indeed reflected in the depreciation rate of the

Rwanda franc, the developments of which are closely linked to expected inflation; this was confirmed by the high correlation between inflation and the depreciation of the Rwanda franc.

The variables representing the external determinants of demand for money in the, i.e. which are intended to capture the influence of capital movements and the substitution between the domestic and foreign currency, are changes in the nominal exchange rate (an approximation of the anticipated depreciation of the Rwanda franc) and the Libor.

As anticipated, the coefficients of the two variables have negative signs. The coefficients of semi-elasticity and elasticity of the exchange rate changes, DEPAN, are respectively -1.922 and -0.138**.** The behavior of the exchange rate as revealed by this study implies that when the Rwanda franc depreciates, the public anticipates other depreciations and the demand for foreign currency rises to the detriment of demand for the domestic currency. Thus, it appears that, to avoid capital losses on their assets, economic agents acquire not only real assets but also foreign currency, which explains the meaning of the negative sign of the exchange rate fluctuation coefficient in the model. This substitution of foreign currency for domestic currency in the public's portfolio is confirmed by the growing importance of foreign currency deposits in banks, whose relative share in the money supply (M_2) rose from 3.5% to 20% between 1990 and 2005. The increase in foreign currency deposits was especially significant since 1995, the year in which the foreign exchange market liberalization measures were adopted. Moreover, this increase occurred to the detriment of time deposits in Rwanda francs, which suggests that the owners of these accounts consider the foreign currency, even though it does not yield any interest, to be a better store of value when compared to other financial assets offered by the banking system. The long-term elasticity of the exchange rate fluctuation is -0.138, which means that a 10% increase in the exchange rate fluctuation will lead to a reduction of 1.38% in Rwanda franc balances in favor of the acquisition of foreign currency.

The substitution of foreign currency for domestic currency in the assets of economic agents can take many forms: currency accounts in local banks, currency accounts in foreign banks

and accumulation of foreign currency in cash. The volume of the assets that rwandese economic agents may hold in cash or in foreign accounts is hard to measure. However, for the assets potentially held in foreign accounts, the coefficients of semi-elasticity and elasticity of -0.098 and -0.665 in equations (6) and (7) for the variable Lib, provide useful indications. The negative sign of this coefficient indicates that the demand for money in Rwanda is sensitive to the rate of return on foreign financial assets as represented by the LIBOR. This would suggest that rwandese residents enter into arbitration operations in the long run between domestic currency and foreign financial assets in the composition of their portfolios and that, consequently, part of their liquid assets is invested abroad. Based on the long-run coefficient for the Lib variable , that is -0.665 , it follows that a 10% increase in the rate of return of foreign assets would lead to a drop of 6.65 % in the demand for domestic balances in favor of the acquisition of foreign assets. One might conjecture in this regard that such capital movements leaving the country legally or fraudulently might be attributable to individuals seeking protection for their savings by investing in hard currencies abroad. However, it might also be thought that foreign companies operating in Rwanda engage in such transactions by transferring part of their liquid assets to foreign banks. Our research is the first one to empirically establish the importance of the rate of return of foreign financial assets in the demand for money in Rwanda; the other studies have indeed limited their investigation to the exchange rate to capture the effects of external shocks. In other experiences with African countries, Nachega (2001) has also showed that the demand for money in Uganda was sensitive to changes of the “Libor”, while Owoye and Onafowora (2007) demonstrated that the demand for money in Nigeria was significantly influenced by the interest rate on Treasury Bills in the United States.

The negative signs of the coefficients of the exchange rate and Libor, in the demand for money in Rwanda might also reflect the thriving activity in the parallel exchange market. This market responds indeed to the excess demand for foreign currency not satisfied at the official exchange rate by the banking system for authorized operations and provides the resources needed for intraregional transactions with neighboring countries or elsewhere

(Dubai). However, it might also be thought that individuals acquire foreign exchange on this market to engage in illicit import operations and capital flight.

In economies that have experienced high inflation and strong depreciation of the domestic currency, the substitution of foreign currency for the domestic currency in various forms (holding of foreign exchange cash or bank accounts) has been confirmed by extensive empirical research. It has been revealed that when the external determinants of the demand for money have a significant impact, they can lead to a balance of payments crisis (Marquez, 1987). Moreover, they affect the conduct of monetary policy since they are sources of uncertainty that makes unpredictable the impact of such policy (Arize, 1999). Another possible outcome is that when the various forms of substitution reinforce each other, economic agents prefer over time to hold balances in foreign exchange not only as a store of value but also as a medium of exchange in current transactions. This preference leads gradually to the dollarization of the economy as has been the experience in several Latin American countries. The consequences of dollarization are well known, in particular the loss of an independent monetary policy and the weakening of the economy due to the instability of capital movements.

Before concluding our remarks on the results of the long-run model, we would like to make further comments on the value of the income elasticity coefficient in the model, since the hypothesis of unitary elasticity and that of the constancy of the velocity of money are important notions in the literature on the demand for money. As we mentioned earlier, it has been shown in various empirical studies on developing countries that the income elasticity coefficient in the demand for money function was in many cases higher than unity. Studies by Aghevli, Khan and *al*. (1979) and Tseng and Corker (1991) on several developing countries in Asia found in the first case a value for income elasticity ranging between 1.3 and 1.85, while it was between 1 and 2.62 in the second case. Similar research on African countries also showed that income elasticity was in many instances higher than unity. In his study devoted to five African countries (Congo, Côte d'Ivoire, Mauritius, Morocco and Tunisia), Simmons (1992) found that the value of this coefficient fell between 1 and 1.49 and in another study dealing with 12 African and Asian countries, Arize (1999) obtained results

showing that for the group of African countries (Ghana, Morocco, South Africa and Tunisia) the value of the coefficient was ranging between 1.27 and 1.54. In studies by Arize (1999) and Aghevli, Khan and *al*. (1979), the hypothesis of the unitary elasticity was rejected in most of the cases .

These results imply that the changes in income lead to a greater increase in money balances and a reduction in the velocity of money.These results have been interpreted as emphasizing the importance of the transactions motive; they have also been attributed to the rapid monetization of the economies in the developing countries in which the gradual absorption of the non-monetary sector by the monetary sector has been accompanied by a higher change in money balances than in income. It has also been pointed out that this situation might be explained by the lack of financial assets, the preference for liquid assets and the absence of economies of scale in the developing nations. In the case of Rwanda, strengthening of monetization is confirmed by the increase in the M_2/GDP ratio, which rose from 13.1% to 16.4% between 1980 and 2005. Moreover, alternative substitutes to money are limited and the preference for liquid assets seems obvious in the rwandese economy as measured by the share of the currency in circulation in the money supply (22.1% in 2005) ; so , it seems quite consistent that income elasticity exceeds unity in the demand for money in Rwanda.

5.3. Dynamic model

The short-run model provides information on the adjustments that occur between the different variables to restore long-run equilibrium in response to short-run deviations in the demand for money. It is an error-correction model (ECM) that contains an error-correction term whose role is to ensure that the short-run deviations with regard to the long-run relationship are corrected and has been specified on the basis of the long-run model of equation (6).

The specification of the short run model was done in two steps. In a first step, a general dynamic error-correction model whose values were the first differences of the variables of

the long-run model was estimated, including the same number of lags. The error-correction term, ECM_{t-1}, corresponds to the lagged residual for the period t-1, computed using the long-run equation (6). Since the values of the variables are stationary, the model has been estimated by the ordinary least squares method.

In a second step and on the basis of the results obtained in the general dynamic model, a parsimonious model was estimated in which the non-significant elements of the general dynamic model were eliminated following the value of the Student's **t** statistic. This procedure of "general to specific strategy" allows a simplification of the model that confers greater reliability on the estimations and enhances the strength of test statistics. It is this parsimonious version of the model represented in equation (8) that was retained and whose results have been analyzed below:

$$\textbf{(8)}\ \Delta LM2R_t = 0.404 - 0.259\ \Delta LM2R_{t-1} + 0.538\ \Delta Lyr_t + 0.419\Delta Lyr_{t-1} + 0.014\Delta REF_{t-2} + 0.016\ \Delta\ Lib_{t-5} + 0.088\ DEPAN_{t-1} - 0.082\ ECM_{t-1} + 0.024\ Dummy2 - 0.045\ Cseasonnal$$

The quality of the estimations is satisfactory according to the results of various tests presented in Tables 6 and 7. The parameters of all the variables are individually and jointly significant according to Student's t test and F test.

The multiple-determination coefficient R^2 is equal to 0.72, which is reasonable with estimations in first differences, Randa (1999). Moreover, all the conventional diagnostic tests do not reveal any particular problems concerning the properties of the residuals.

Table 6 : Short run parsimonious model

	Coefficient	Std.Error	t-value	t-prob	Part.R^2
$\Delta LM2R_{t-1}$	-0.258697 -	0.07618	3.40	0.001	0.1159
Constant	0.404534	0.05188	7.80	0.000	0.4086
ΔLyr_t	0.538756	0.08688	6.20	0.000	0.3041
ΔLyr_{t-1}	0.419110	0.09192	4.56	0.000	0.1911
ΔREF_{t-2}	0.0138234	0.005441	2.54	0.013	0.0683
$\Delta Llib_{t-5}$	0.0161761	0.005428	2.98	0.004	0.0917
$\Delta DEPAN_{t-1}$	0.0876541	0.03060	2.86	0.005	0.0853
ECM_{t-1}	-0.0825433	0.01063	-7.76	0.000	0.4064
dummy2	0.240065	0.04072	5.90	0.000	0.2832
CSeasonal	-0.0452773	0.01051	-4.31	0.000	0.1741

Table 7 : Diagnostic tests of the short run model

sigma	0.0438755	RSS =	0.169405383
R^2	0.723272	F(9,88) =	25.56 [0.000]**
log-likelihood	172.605	DW =	2.18
no. of observations	98	no. of parameters =	10
mean (DLM2R)	0.00731802	var (DLM2R)	0.00624666

AR 1-5 test	: F(5,83) =	2.2776 [0.0542]
ARCH 1-4 test	: F(4,80) =	0.62189 [0.6482]
Normality test	: Chi^2(2) =	0.23878 [0.8875]
hetero test	: F(16,71) =	0.47790 [0.9501]
hetero-X test	: F(46,41) =	0.56744 [0.9684]
RESET test	: F(1,87) =	0.64091 [0.4256]

In this model, the income coefficient has the expected positive sign, meaning that even in the short run, changes in real income lead to an increase in demand for real balances. The refinancing rate, REF, is significant but has a positive sign, that is the contrary of what was expected. This confirms the finding of the long run model in which the refinancing rate was eliminated because it was not significant and had not the expected sign.

The coefficients of the variables DEPAN and Lib, have positive signs, i.e. changes in the exchange rate and the rate of return on foreign assets affect positively the short-run demand for money, contrary to the results obtained in the long-run model in which these coefficients had negative signs. This observation calls some comments. Indeed, we would have expected negative signs for these coefficients indicating the substitution of foreign currency for domestic currency when the latter depreciates and when the return on foreign assets improves. This type of result, which at first glance seems counterintuitive, has been obtained, among others, by Henstridge (1999) in the case of of Uganda, Fielding (1994) in the case of Kenya and Adam (1999) in the case of Zambia. According to Adam (1999), this apparently occurs because the expectation of domestic currency depreciation encourages individuals to accumulate balances in domestic currency in the short run in order to exchange them against foreign currency on the parallel market. The real balance effect pointed out by Arango and Nadiri (1981) also comes to mind. Indeed, according to these authors, the depreciation of the

domestic currency increases the value of the assets held in foreign currency. If the economic agents consider this effect as an increase in their wealth, their demand for money balances in the domestic currency will also increase.

The error-correction term, $ECM_{t-1,}$ is significant and, as required by the stability condition of the dynamic model, its sign is negative and it consequently confirms the existence of the cointegration relationship. The value of the coefficient of the error-correction term, -0.082, implies that 8.2% of the excess balances observed in period t-1 will be eliminated in period t. Since this model is formulated using quarterly data, this means that the excess of real money balances observed during a quarter will be corrected by 8.2% in the following quarter. The excess balances will be eliminated by means of a restrictive monetary policy, through the recomposition of the economic agents' portfolio, or by means of the price adjustment mechanism.In this case, the adjustment speed of the demand for money to the equilibrium position in the rwandese economy following exogenous shocks is slow, which reflects the underdevelopment of the financial market and the presence of high transaction costs in the economy. Such shocks may be due to fluctuations in the money supply (monetary shocks) or other variables of the model .The results of this research suggest that in the current structure of the rwandese economy, the equilibrium of the demand for money is restored after twelve quarters, which corresopnds to an approximate period of three years; this is also an indication of persistent monetary disequilibrium in the economy. The value of the adjustment coefficient obtained in this paper is of the same order as those found in other similar empirical studies in African countries. In his study, Arize (1999) found for four African countries (Ghana, Morocco, South Africa and Tunisia) a coefficient ranging between -0.29 and -0.59 , while in his research on five other African countries (Congo, Côte d'Ivoire, Morocco, Mauritius and Tunisia), Simmons (1992) found a coefficient varying between -0.22 to -0.56. Since both authors used annual data, their coefficients suggest that the adjustment of the demand for real balances in these countries occurs, on average, within two to three years in the first case, and two to five years in the second case.

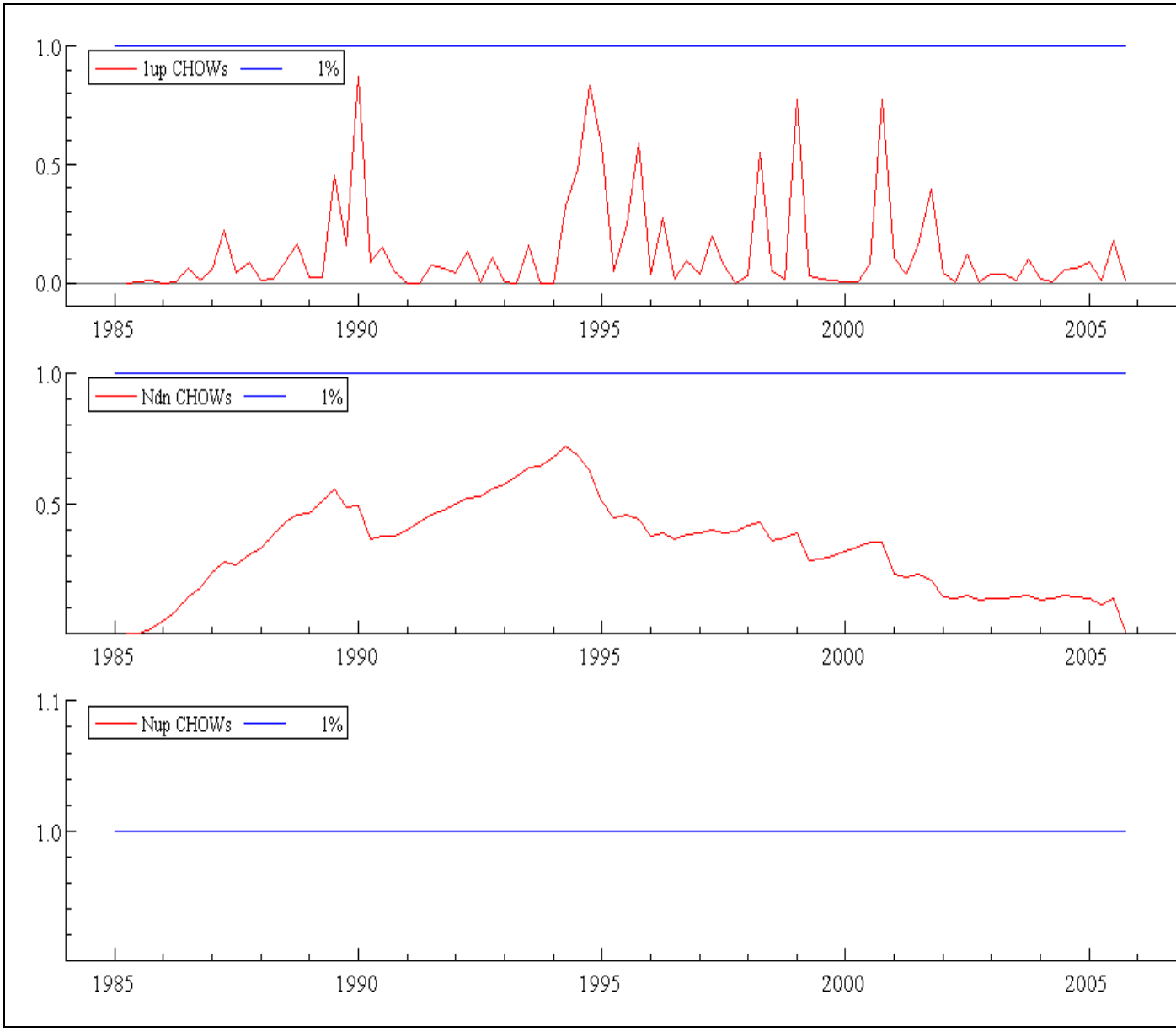
5.4. Stability tests

The implementation of a monetary policy aiming to stabilize prices and income through the control of a monetary aggregate depends crucially on the hypothesis of stability of the relationship established between the demand for money and the determinant variables. Indeed, the impact of the money supply on the real variables is predictable only if the demand for money is stable, allowing monetary authorities to intervene effectively.

If, on the contrary , this function is unstable because, for example, of various innovations due to institutional or technological changes, the impact of any intervention may be reduced or even lead to unexpected consequences.

In a linear regression model that contains a random-error term, the vector of the parameters is assumed to be constant over time .Thus, the stability of the parameters of the demand for money function indicates the historic behavior of the equation and ensures that the estimation of the function at different sub-periods of the sample yields the same results, while the precision of the forecasts beyond the sample period reflects its predictive power and its usefulness in forecasting money demand for monetary and economic stabilization policy purposes. Given the economic reforms carried out in Rwanda since early 1990s onwards, notably concerning the liberalization of the financial sector, it was necessary to check for the structural stability of the demand for money function in the rwandese economy, which may have been affected by these changes. To assess the stability of the short run model, recursive estimates of Chow structural break and predictive tests have been performed and the results of these tests are presented by the graphs in Figure 3; the graphs have been plotted with the null hypothesis of parameter constancy. As it is shown by these graphs, no point in the Chow tests is higher than the 1% significant level, indicating that the parameter constancy hypothesis can not be rejected during the period covered by this study. However, it should be noted that the model displayed some degree of instability during some sub-periods, i.e. in 1990, 1995 and 1999-2001, but overall, these disturbances did not significantly affect the fundamental behavior of the parameters in the model.

Figure 3: Stability tests of the short run model: Chow Tests



VI. CONCLUSION

The objective of this study was to estimate a long-run and short-run demand for money function in the rwandese economy during the sample period 1980-2005. To this end, the Johansen (1988) and Johansen and Juselius (1990) procedure was used and this study has established the existence of a stable long-run demand for money function in Rwanda. The dynamic parsimonious model has also shown the existence of a stable short-run relationship between demand for money, income, refinancing rate, Libor and exchange rate changes.

These results have many policy implications. It emerges that in Rwanda, the monetary aggregate M_2 is the appropriate intermediate monetary target for monetary and economic stabilization policy purposes. This lends a posteriori support to the choice of monetary authorities.

This study has revealed the importance of the external determinants in the demand for money, i.e. those that link the rwandese economy to the rest of the world, namely, the exchange rate and the rate of return on foreign financial assets. They significantly affect the demand for real balances, which implies that they must be taken into account when designing monetary policy. This study's findings have confirmed the hypothesis of currency substitution in Rwanda and the potential trade-off between domestic money balances and foreign financial assets. Such information lends support to economic policies intended to stabilize exchange rate on the one hand, and to keep real positive interest rates on the other hand, in view to maintain confidence in domestic currency.

Another interesting result obtained in this study concerns the role of the central bank's refinancing rate. This variable was not significant in the long-run model of demand for money, i.e. it did not appear to have any impact on changes in the money supply and thus on the banking system's behavior and the short-run model confirmed this result. This suggests that the refinancing rate or the leading rate of the Central Bank should play a more active role as an instrument to regulate short-term liquidity and reflect the relative scarcity of financial

resources in the economy. In the current context, the effectiveness of this rate can only be considered if the excess liquidity that characterized the banking system in recent years is eliminated in order to enhance the effectiveness of the Central Bank's interventions on the money market.

Lastly, the stability of the relationship established between demand for money and the determining variables is important information for monetary authorities. It was plausible to think that the reforms implemented to liberalize the domestic economy during the period covered by this study might have affected the stability in the demand for money function, but the empirical findings show that these reforms did not significantly affect the stability of this relationship. This might be explained by the fact that these reforms were carried out gradually and the macroeconomic variables adjusted progressively to the shocks caused by these changes.

To conclude, we would like to mention that these findings must be updated at due time since the Central Bank has decided to revise the monetary aggregates by incorporating into the country's monetary survey the position of "Other non-bank financial institutions." It will be necessary to assess in the wake of this operation the impact that such a modification could have on the estimated model.

VII. NOTES

1. In order to find the parallel market exchange rate for Rwanda franc against the US dollar, we referred to the work by Carmen M. Reinhart and Kenneth Rogoff "The modern history of exchange rate arrangement : a reinterpretation », Princeton University,2002 ; unfortunately , Rwanda was not in the list of countries whose parallel exchange rates are in the authors' data base. We also consulted the traditional sources on parallel exchange rates, that is, World Currency Year Book, 24 th Edition, 1990-1993 and International Currency Analysis, Inc (1994-1995), but in both documents, quarterly and monthly data are not available for the

periods 1980-1988 and 1995-1996. In the National Bank of Rwanda, data on parallel exchange rate series are available since 1997.

2. Hendry and Ericsson (1991) have used a similar dummy variable to capture the effects of the introduction of "Competition, credit regulation and floating exchange rates" on the economy of the United Kingdom in the period 1971-1975 and in his study on the demand for money in Zambia, Adam (1999) included in his specification a dummy variable to account for the effect of potential regime change in the demand for money due to economic reforms. Armour and al…(1996)have also used the same kind of dummy variable to account for the introduction and progressive dissemination of the financial innovations in the Canadian economy since early 1980s.

3. The method proposed by Gandolfo (1981) uses the following formula to generate data for each quarter, given that the annual data are represented by y_t :

1rst quarter : $y_t^{(1)} = 0.0546875y_{t-1} + 0.234375y_t - 0.0390625y_{t+1}$

2nd quarter : $y_t^{(2)} = 0.0078125y_{t-1} + 0.265625y_t - 0.0234375y_{t+1}$

3rd quarter : $y_t^{(3)} = -0.0234375y_{t-1} + 0.265625y_t + 0.0078125y_{t+1}$

4th quarter : $y_t^{(4)} = -0.0390625y_{t-1} + 0.234375y_t + 0.0546875y_{t+1}$

where y_t is the value for the current period

y_{t-1} is one period lagged value

y_{t+1} is the value for the next period

Smith (1998) used Monte Carlo experiment to examine the effects of linearly interpolating technique on Johansen framework and found that Gandolfo's methodology does not introduce any bias into the estimates of the cointegrating vectors even with series covering relatively short periods.

4. It has nevertheless to be noted that in the case of two variables, the combination of I(1) and I(0) variables is excluded .

5. All the estimations have been made with the econometric software Pc Give 11.04 by Jurgen . A Doornik and David F. Hendry, 2006.

6. To obtain coefficients representing the elasticities of the variables Lib and DEPAN; the values of the semi-elasticities have been multiplied by the average values of the two variables.

7. It should be noted that none of the studies mentioned on the demand for money in Rwanda included inflation as a determinant variable.

VIII. REFERENCES

1. Adam, C., On the dynamic specification of money demand in Kenya, Journal of African Economies, Vol. 1, pp. 233-270, 1992.
2. Adam, C. (b), Financial liberalisation and currency demand in Zambia, Journal of African Economies, Vol. 8, pp. 268-306, 1999.
3. Adenkule, J.O., The demand for money: evidence from developed and less developed countries, IMF Staff Papers, Vol. 15, pp. 220-266, 1968.
4. Aghevli, B.B. and Khan, M.S., Government deficit and the inflation process in developing countries, IMF Staff Papers, Vol. 25, pp. 383-416, 1978.
5. Aghevli, B.B., Khan M.S. and alii., Monetary Policy in Selected Asian Countries, IMF Staff Papers, Vol. 26, pp. 775-824, 1979.
6. Arango, S. and Nadiri, M.I., Demand for money in open economy, Journal of Monetary Economics, Vol. 7, pp. 69-83, 1981.
7. Armour,J., Atta-Mensah , J. and Hendry , S . , A distant early warning model of inflation on M1 disequilibria , Working Paper 96-5 , Banque du Canada , 1996 .
8. Bahmani-Oskooee and Pourheydarian, Exchange rate sensitivity of demand for money and effectiveness of fiscal and monetary policies, Applied Economics, Vol. 22, pp. 917-

925,1990.

9. Bahmani-Oskooee , M. et A. Tanku , Black market exchange rate , currency substitution and the demand for money in LDCs , Economic Systems , Vol . 30, pp. 249-263, 2006.
10. Baumol, W.J., The transactions demand for cash: an inventory theoretic approach, The Quarterly Journal of Economics, Vol. 66, pp. 545-556 , 1952.
11. Berg, A. et Borensztein , E . , The choice of exchange rate regime and monetary target in highly dollarized economies , IMF Working Paper ,WP /00/29 , IMF , 2000.
12. Cagan, P., The monetary dynamics of hyperinflation, in M. Friedman (ed.) Studies in the Quantity Theory of Money, University Press of Chicago, Chicago, 1956.
13. Cheng ,B.S . and Lai , T.W, Government expenditure and Economic Growth in South Korea : A Vatr Approach , Journal of Economic Development ,Vol.22 , n°1 , pp.11-24 , 1997.
14. Cheung, Y.W. et Lai , K.S., Finite sample size of Johansen's likelihood ratio tests for cointegration , Oxford Bulletin of Economics and Statistics , Vol. 55 ,pp313-328 ,1993 .
15. Chow, G.C., Tests of Equality between sets of coefficients in two linear regressions, Econometrica, Vol. 28, pp. 599-605, 1960.
16. Crockett, D.A. and Owen, E.J., Demand for money in Middle Eastern countries, IMF Staff Papers, Vol. 27, pp. 543-578, 1980.
17. Dekle, R., and Mahmood, P., Financial liberalisation and the money demand in ASEAN countries : implications for the monetary policy, IMF WP / 97/ 36, Washington 1997.
18. Dickey, D. and Fuller W., Likelihood ratio statistics for autoregressive time series with unit root, Econometrica, Vol. 49, pp. 1057-1072.1981.
19. Domowitz, I and I. Elbadawi, An error correction approach to money demand-The case of Sudan, Journal of Development Economics, Vol. 26, pp. 257-275, 1987.
20. Engle, R.F. and Granger, C.W.J., Cointegration and Error-Correction : Representation, Estimation and Testing, Econometrica, Vol. 55, pp. 251-276, 1987.
21. Ericsson, Neil R, Empirical modelling of money demand, Empirical Economics, Vol. 23, pp. 295-315, 1998.
22. Ericsson, Neil R. and Sunil Sharma, Broad money demand and financial liberalisation in Greece, IMF WP / 96 /62, Washington, 1996 .
23. Fielding, D, Money demand in four African countries, Journal of Economic Studies, Vol.

21, N° 2, pp. 3-37, 1994.

24. Friedman, M., The quantity theory of money-A restatement, in M. Friedman (ed.) Studies in Quantity Theory of Money, University of Chicago Press, Chicago, 1956.
25. Gandolfo, G., Quantitative analysis and econometric estimation of continuous time dynamic models , North Holland Publishing company ,Amsterdam , 1981.
26. Goldfeld, S.M., The demand for money revisited, Brookings Papers on Economic Activity, Vol. 3, pp. 577-646, 1973.
27. Gonzalo, J., Five alternative methods of estimating long run equilibrium relationships, Journal of Econometrics , Vol. 60, pp. 203-233, 1994.
28. Granger, C.W.J., Developments in the Study of Cointegrated Economic Variables, Oxford Bulletin of Economics and Statistics, Vol. 48, pp213-228, 1986.
29. Hafer, R..W. and Dennis W, Jansen, The Demand for money in the United States: Evidence from cointegration tests, Journal of Credit, Money and Banking, Vol. 3, pp. 155-168, 1991.
30. Harris , R.I.D. ,Using cointegration in economic modelling , Prentice Hall , Harvester-Wheatsheaf , London ,1995.
31. Hauner, D., and Di Bella ,G , How useful is monetary econometrics in low-income-countries ? The case of money demand and the multipliers in Rwanda, IMF Working Paper , n°05/178, 2005.
32. Hendry, D.F., Economic modelling with cointegrated variables: an overview, Oxford Bulletin of Economics and Statistics, Vol. 48, pp. 201-212, 1986 .
33. Hendry, D.F and N.R. Ericsson, An econometric analysis of U.K. money demand in " Monetary trends in the United States and the United Kingdom" by Milton Friedman and Anna J.Schwartz , American Economic Review, Vol.81, pp.8-38, 1991.
34. Jenkins, C, Money demand and stabilisation in Zimbabwe, Journal of African Economies, Vol. 8, pp. 386-419,1999.
35. Johansen, S., Statistical analysis of cointegration vectors, Journal of Economic Dynamics and Control, Vol. 12, pp. 231-254, 1988.
36. Johansen, S. and Katarina, J., Maximum likelihood estimation and inference on cointegration-With applications to the demand for money, Oxford Bulletin of Economics and Statistics, Vol. 52, pp. 169-210, 1990.

37. Khan, M.S., Monetary shocks and the dynamics of inflation, IMF Staff Papers, Vol. 27, pp. 250-284, 1980.
38. Kigabo, R., Estimation d, une fonction de demande de monnaie : le cas du Rwanda, Revue Scientifique de l'Université Libre de Kigali, Décembre 2001, pp. 7-26.
39. Laidler, David E.W., The demand for money : Theories and evidence, 2e Edition, New York,1977.
40. Laumas, G.S. and Laumas, P.S., The permanent income hypothesis in an underdeveloped economy, Journal of Development Economics, Vol. 3, pp. 289-297, 1976.
41. Marquez J., Money demand in open economies: currency substitution model for Venezuela , Journal of International Money and Finance, Vol. 6, pp. 167-178, 1987.
42. Miller, S.M., Monetary dynamics: An application of cointegration and error correction techniques, Journal of Money, Credit, and Banking, Vol. 23, pp. 139-154, 1991.
43. Nachega, J.C., A cointegration analysis of broad money demand in Cameroon, IMF WP/2001/ 26, 2001.
44. Nachega, J.C., Financial liberalization, money demand, and inflation in Uganda, IMF WP/2001/118, 2001.
45. Owoye , O. and Onafowora ,O.A. , M2 Targeting , Money Demand and Real GDP Growth in Nigeria: Do rules Apply? , Journal of Business and Public Affairs, Vol.1, n°2, pp.1-20 , 2007.
46. Randa, J., Economic reform and the stability of the demand for money in Tanzania, Journal of African Economies, Vol. 8, pp. 307-344.
47. Serletis, A. and M. King, Common trends and convergence in European stock markets, The Manchester School of Economics and Social Studies, Vol. 65, pp. 44-57, 1997.
48. Simmons, R., An Error-correction approach to demand for money in five African developing countries, Journal of Economic Studies, Vol. 19, pp. 29-47, 1992.
49. Smith , S. , Cointegration tests when data are linearly interpolated ,Unpublished Paper , State University of New York at Albany, 1998.
50. Sriram, S.S., Survey of literature on demand for money : Theoretical and empirical work with special reference to error-correction models, IMF Working Paper, WP/99/64, IMF, Washington , 1999.
51. Sriram, S.S., Demand for M2 in an emerging-market economy: an error-correction model

for Malaysia, IMF Working Paper, WP/99/173, IMF, Washington, 1999.

52. Tobin, J., The interest elasticity of transactions demand for cash, Review of Economics and Statistics, Vol. 38, pp. 241-247, 1956.
53. Tobin, J., Liquidity preference as behavior towards risks, The Review of Economic Studies,Vol. 25, pp. 65-86, 1958.
54. Tseng, W, and R. Corker, Financial liberalization, money demand, and monetary policy in Asian countries, IMF Occasional Paper 84, IMF, 1991.