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بسم الله الرحمن الرحيم

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Demand for Money

In a Small Open Economy

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Abstract

Understanding the function of money demand is central to the conduct of monetary policy, because money demand function shows the economy's capacity to absorb changes in money supply and in turn changes in money stock are important in determining the causes of economic growth.

Saudi Arabia has a unique economy in a way it depends on one major source of income, generated from oil revenues, and that all natural resources are owned by the state including oil resources. Thus, it is possible that monetary and fiscal policies are related and oil prices and revenues will have important effects on exchange rates and in turn changes in exchange rates will affect the demand for money by individuals and businesses in Saudi Arabia.

This study uses recent developments in econometrics to investigate the money demand behavior in a small developing and open economy, Saudi Arabia.

The results show that a long run relationship between money demand and its determinants exist. Further, regression analysis results show that changes in income have significant impact on the demand for money as expected. Exchange rates and foreign interest rates also have significant negative impact on demand for money. Thus, these results indicate the degree of openness of the Saudi Arabian economy and its impact on the demand for money in the short and long run.

الطلب على النقود
في اقتصاد صغير ومفتوح

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مستخلص

التوصل إلى معرفة جيدة لدالة الطلب على النقود يعتبرمرتكزا أساسيا لأدارة السياسه النقديه، وهذا لأن دالة الطلب على النقود توضح القدرة الأستيعابية للأقتصادلأمتصاص التغيرات في عرض النقود وكذلك فأن التغيرات في كمية النقود مهمة في معرفة المحددات للنمو الأقتصادي.

الاقتصاد السعودي يعتبر الى حد كبير فريدا من نوعه فهو يعتمد على مصدر وحيد للحصول على الدخل، فهذا الدخل يتم الحصول عليه من البترول، كما أن الموارد الطبيعية كلها مملوكة للدوله ومن ضمنها البترول. لهذا فأنه من المحتمل أن تكون العلاقة بين السياستين النقدية والمالية وثيقة وقويه، كما أن أسعار البترول والدخل الناتج من البترول تؤثر بشكل مباشر على أسعار الصرف، وفي المقابل فأن أسعار الصرف سيكون لها تأثير مباشر على الطلب على النقود من قبل الأفراد والمنشأت في المملكه.

هذه الدراسة تستخدم الأساليب الحديثة في الأقتصاد القياسي من أجل دراسة محددات الطلب على النقود في المملكه.

النتائج التي تم التوصل البها تدل على وجود علاقة طويلة الأجل بين الطلب على النقود ومحدداته. اضافة إلى ذلك فأن نتائج التحليل الأحصائي للمعادلات الخطيه تظهر أن التغير في الدخل يؤثر بشكل ايجابيي وقوي على الطلب على النقود. من جانب اخر فأن أسعار الصرف وكذلك أسعار الفائده الخارجيه تؤثر سلبا على الطلب على النقود وبشكل قوي أيضا. وهذا ربما يوضح درجة الأنفتاح في الأقتصاد السعودي والتأثيرات قصيرة وطويلة الأجل على الطلب على النقود.

Demand for Money
In a Small Open Economy

Introduction:

Over the years, a large number of studies have theoretically and empirically investigated the demand for money in both developed and developing countries, however, much of the research has centered on money demand in developed countries. An understanding of money demand function is central to the conduct of monetary policy because money demand function shows the economy=s capacity to absorb changes in money supply and in turn changes in money stock are important in determining the causes of economic growth. Thus, for developing countries such as Saudi Arabia, studies of demand for money are of potential importance in that inappropriate monetary policies can deprive a country part of the benefits of development efforts.

Various models have been formulated to explain demand for money. A correctly specified money demand function should include some measure of a budget constraint variable and some measure or measures for the opportunity cost of holding money.

The evidence, however, does not fully support all factors that economists argue to influence money demand. In addition, empirical approaches are not immune from criticism. In particular the issue of stability and predictability are frequently questioned. One possible explanation of the continuing movements in holding money balances is financial innovation. It has been argued that improvements in the financial sector=s ability to provide liquidity services that are alternative to currency and demand deposits can be responsible for permanent increase in velocity. For example, Grilli (1989) showed that velocity has undergone a permanent increase in several European countries that he attributes to improvements in the banking system.

Saudi Arabia has a unique economy in a way it depends on one major source of income, generated from oil revenues, and that all natural resources are owned by the state including oil resources. Moreover, oil revenues accrue directly to the government and these

revenues are used in government expenditures through its budget. Thus, in this case it is possible that monetary and fiscal policies are related and oil prices and revenues will have important effects on exchange rate and in turn changes in exchange rates will affect the demand for money by individuals and businesses in Saudi Arabia. This is besides the fact that the economy of Saudi Arabia is an open economy. According to Hamburger (1977) it is important to inquire as to how the openness and the institutional setting might influence the demand function for money and the definition of the quantity of money appropriate for that function. In the mean time the Saudi Arabian economy is one of few developing economies that have experienced a fundamental transformation. Beginning from the early 1970's, the Saudi Arabian financial system has undergone a structural change because of *Saudization* of banking sector and innovation. Recently the Saudi Arabian financial market has witnessed increasing use of credit and debt cards that have enabled individuals to economize on cash holdings. In addition, the introduction of cash-point facilities may lead individuals to reduce the average inventory of notes held, by making cash withdrawals more convenient. At the same time the trend has been for an increasing proportion of wages and salaries to be paid by checks or credit transfers directly into bank accounts. Certainly, institutional changes have influence on the demand for money.

Thus, these developments may have implications for the stability of the demand for money function. They affect stability of money demand function through creation of financial assets with attractive yields. A portfolio shift may occur from monetary assets to the newly introduced financial assets with high returns and low risks. In addition, the increased competition among banks lowers financial transaction costs, which may cause money demand to respond differently to changes in interest rate. Thus, it is important to investigate external effects and financial innovations on the demand for money in Saudi Arabia. It is also important to indicate that these factors have an important and significant implications for the effectiveness of monetary policy. Monetary policy actions aimed at stabilizing the economy contracting the impact of external shocks upon domestic economy must take into account the response of domestic money demand to these external factors.

This paper attempts to analyze the demand for money in Saudi Arabia and the effects of financial development and innovations on this function. Estimation of the demand for money in Saudi Arabia has been attempted by a number of authors (Crockett and Evans, 1980; Darrat, 1984, 1986; Metwally and Abdel Rahman, 1987; Presley and Westaway, 1988; MacDonald, 1990; Ghamdi, 1989; Assery, 1997; and AlBazai, 1998). However, most of these studies either have used traditional methodology or have not taken account of financial innovation. This paper focuses on the experience of the Saudi

Arabian economy where the main institutional changes in financial sector have been fostered by the government through its *Saudization* plan of the banking sector and through its introduction of government bonds in 1988 and treasury bills in 1991 to finance public deficit.

By using quarterly data covering the period 1970.1 to 1998.4, the purpose of the study is to investigate empirically the money demand behavior in a small developing and open economy, namely Saudi Arabia. In particular, the paper has several objectives, it examines the time series properties of the individual variables in the money demand function. Second, given the significant implications that co-integration has for econometrics analysis, the model pays particular attention to the problem of obtaining adequate representations to the non-stationary data. Then, the paper examines the information content of the co-integrating relationship by examining the short run dynamics implied by the associated vector error correction model (VECM). The error correction model received little or no attention in the Saudi Arabian money demand literature. Finally, it illustrates how the process of financial innovation can be expected to affect the demand for money in the Saudi Arabian economy. This is done by including a proxy for financial innovation as an additional explanation variable in the preferred money demand function. Further, results obtained from this study may provide the monetary authorities-the Saudi Arabian Monetary Agency (SAMA)-with information regarding the choice of policy instrument.

Literature Overview:

A common theme in many theoretical macroeconomic models is an aggregate money demand function that links real balances, a measure of real income or transactions activity, and a short term interest rate or other measure of the opportunity cost of holding real balances. In the conventional money demand function, real income represents the increasing demand for money as a producer=s and consumer=s good, by way of an income effect, as income rises. This is some times referred to as > transaction demand=. The interest rate term represents the interest elasticity of both the transactions demand for money and the speculative demand for money through the portfolio balance model, and may represent a potential substitutability against bonds in production and consumption decisions (Branson, 1989). Recent work studying the stability of the demand for money relationship has produced mixed results. As pointed out by Huffman et al. (1995), a stable long run money demand function is a central proposition to monetarist models, new classical money models, and even some New Keynesian models and real business cycle models that incorporate inflation and the general price level. Empirically, however, the literature on long run money demand equations has documented periods of >missing money=. The most famous of these studies was conducted by Goldfeld (1976) who first documented this Phenomenon in the United States. Others have found that conventional money demand functions are often plagued by the problem of unstable parameters (Breuer and Lippert, 1996).

Examination of money demand have typically focused on obtaining estimates of the elasticity of money with respect to income and interest rate. These estimates can be used to more accurately predict future money supply growth provided they are stable over time. It is important to have information about the stability of money demand in order to implement effective and appropriate monetary policy.

Given that monetary policy may have significant implications for the macroeconomy, early studies of money demand focused mainly on the stability of individual coefficient estimates. Studies of this type include those by Goldfeld (1973,1976), Arango and Nadiri (1981), Boughton (1981), McKinnon et al.(1984), and Fair (1987) among others.

Given recent advances in macro econometrics modeling (Engle and Granger, 1987 among others), it is possible to examine the joint time series properties among a set of variables in addition to the individual time series properties. The identification of stable money demand functions can be accomplished by examining the cointegrating relationship among a monetary aggregate and its determinants. A number of studies have used cointegration techniques to examine money demand functions, including those by Baum and Funo(1990), Hafer and Jansen (1991), Hendry and Ericsson (1991), Hoffman and Rasche (1991), Hoffman et al. (1995), Miller (1991), Choudahry (1992), McNown and Wallace (1992), Mehra (1991), Arrau and De Gregorio (1993) Arrau et al. (1995), Bahmani-Oskooee and Shabsigh (1996), Breuer and Lippert (1996), Darrat and Al Mutawa (1996), Chowdhury (1997), Al Bazai (1998), Ewing and Payne (1999) and Funke and Thornton (1999). The central theme in these papers is the stability of the money demand function; however, a general consensus concerning the existence of a stable money demand relationship has not emerged. A variety of factors may be responsible for the mixed findings such as differences in sample periods, measures of money, income, and the interest rate, or the co-integration technique used. It is quite possible also that studies fail to identify stable money demand relationships suffer from the omitted variable problem. For example, the omission of a relevant determinant such as the effective exchange rates and foreign interest rates could explain the inability to identify a stable money demand function. (See, Hamburger, 1977 and Ewing and Payne, 1999, among others).

Thus, recent studies employing co-integration analysis to study the demand for money relationship find that a stable long run relationship exists. Hoffman et al. (1995) report the results from a multicountry study of money demand in large industrial countries, finding that the demand for money relationship is stable in each country. They also find that they can reject the hypothesis that the demand for money is unitary elastic with respect to income in four of five countries. Similarly, Norrbin and Ruffet (1996) estimate a stable empirical money demand functions while using income and interest rate as explanatory variables. However, Miyao (1996) in a study which uses income and interest rate as independent variables, points out that for the U. S. economy there is only weak proof for the existence of a co-integration in the demand for money (i.e., M2) relationship.

A finding of co-integration indicates stable money demand and provides evidence that the particular monetary aggregate may be useful as a policy instrument. It has been always suggested to start with a conventional money demand function and seek and identify a stable long run relationship among money, income, and the interest rate. However, given the fact that Saudi Arabia is an open economy, it may be that developments in financial market and exchange market could destabilize the conventional money demand relationship as a result of portfolio shifts between domestic and foreign currency (Arrango and Nadiri, 1981). Over thirty years ago it was proposed that the demand for money could depend on the exchange rate in addition to income and the interest rate, although it was not formally tested at that time (Mundell, 1963). McKinnon et al. (1984), and Bahmani- Oskooee and Shabsigh (1996) introduced effective exchange rate to the specification in order to identify a stable money demand function.

The idea of financial innovation is not totally new. Accordingly, Gurley and Shaw (1960) and Tobin (1965) have argued that financial market developments are not likely to be fully captured by traditional money demand specifications. Further, Lieberman (1977) argued that increased uses of credit, better synchronization of receipts and expenditures, more intensive use of money substitutes, and more efficient payment systems will tend to decrease the transaction demand for money over time. Ochs and Rush (1983) also suggested that once innovations that economize on the use of currency have taken place, the impact on the demand for currency is likely to be permanent since these innovations require long lived capital investment with very substantial sunk costs but low operating costs.

Laidler (1993) argued that the instability of the money demand function gives rise to widespread criticism of policy regimes based on money growth targets. He observed that various studies have related this instability mainly to institutional changes in the financial sector. Traditionally, financial innovation has been considered to undermine monetary policy effectiveness because it increases the interest elasticity of the demand for money, and it produces instability of the demand for money. However, Tobin (1969) pointed out that an increased number of substitutes need not increase the elasticity of money demand if such innovations reduce the desire to hold transaction balances such that the remaining balances held are insensitive to movements in interest rates. This would be the case if a certain minimum balance is needed to conduct transactions and will be held regardless of movements in the opportunity costs.

Further, Marty (1961) argued that the development of assets rival to money may actually reduce rather than raise interest elasticity. According to this view, the introduction of a money substitute will have two distinct effects: it will make the slope of the money demand schedule flatter for each individual, and it will shift each schedule to the left. His argument suggests that the second effect is likely to be stronger for the more elastic schedules since the latter pertains to individuals who are more likely to substitute the new assets for a relatively larger fraction of their money balances. As a result, the final market schedule may well be less elastic than the initial one since the weight of agents whose demand is relatively inelastic will be larger. Akhand and Milbourne (1986) and Duca and Whitesell (1995) developed theoretical cases where the use of credit cards may lower or have no significant effect, rather than increase, the income elasticity of money demand. Miller (1991) reported some evidence of declining income elasticity of money demand for the United States following financial deregulation.

In his examination of the demand for narrow money in the united States, Lieberman (1977) incorporated a time trend in the money demand equation as a proxy for the unobservable technological change. On the other hand, Bordo and Jonung (1990) and Siklos (1993) modeled financial innovation more explicitly by using such time series as the ratio of nonbank financial assets to total financial assets and the currency-money ratio as a proxy for the unobserved process. However, Hester (1981), Hendry and Ericsson (1991a), and Baba et al. (1992) used nonlinear models of the learning process. Moreover, Hall et al. (1990) found that a long run co-integration vector cannot be established for M0 without inclusion of a measure of financial innovation among the set of explanatory variables. Wesaway and Walton (1991) also found that financial innovation variables must be considered before a long run co-integrating vector can be established for MO.

Judd and Scadding (1982) and Garcia and Park (1979) argued that the most likely cause of the apparent instability in the demand for money function is institutional change, and in particular innovation in financial arrangements, which allowed the private sector to economize on its holdings of transaction balances. These changes appeared to have been induced by high interest and inflation rates, and the existence of legal impediments to the payment of a market rate of return on transaction balances. Cover and Keeler (1987) found a role for an indirect measure of financial innovation. They used the previous peak interest rate as a proxy for financial innovation and argued that high interest rates in the past encourage innovations in the management of cash balances and cause money holdings to fall via a kind of >rachet= effect.

Methodology:

A simple long run real money demand function may be assumed to depend in a stable manner on a small number of economic variables. More specifically:

$$Mt=\alpha 0+\alpha 1Yt+\alpha 2\pi t+\alpha 3rf+\alpha 4ext+ut \quad (1)$$

where: mt is the quantity of desired real balances, Yt is income measure, πt is the inflation rate, rft is foreign interest rate, ext is the expected change in exchange rate, ut is error term with zero mean and constant variance, and t is time period. Equation (1) postulates that real balances elasticity with respect to price is zero. Prior economic reasoning suggests that: $\alpha 1>0$, $\alpha 2<0$, $\alpha 3<0$, $\alpha 4<0$.

In closed economy, individuals= portfolios are exclusively composed of domestic currency denominated assets. For domestic opportunity cost, inflation rate is usually argued to be the relevant measure. First, there are few money substitutes in the form of financial assets due to the lack of a well developed financial market. Second, interest rate is not considered a perfect measure of opportunity cost in economies like Saudi Arabia due to the fact that interest is prohibited in Islam. Also, as has been argued by Baba et al. (1992), a capital market imperfection characterized as a spread between borrowing and lending rates calls for inclusion of a risk return tradeoff measure. The relevant measure is inflation rate since the tradeoff is between safe money and risky assets (i.e. bonds). Furthermore, Arango and Nadiri (1981) and Brissimis and Leventakis (1985) and Liventakis (1993) suggest that in open economies, like Saudi Arabia, there would be a portfolio balance and margin of substitution between domestic money and foreign assets. The assets that residents in two countries, home country and the foreign country, hold include domestic money, foreign money, domestic bonds, and foreign bonds. The home country residents= demand for domestic money is assumed to depend on a scale variable and the rates of return of the four assets.

Assuming that money yields no pecuniary return, the nominal rate of return on domestic money is zero, whereas the expected rate of return on foreign money is the expected depreciation of the domestic currency relative to the foreign currency. The domestic interest rate represents the nominal rate of return on domestic bonds, whereas the foreign interest rate adjusted for the expected depreciation rate measures the nominal rate of return on foreign bonds. An increase in the expected rate of depreciation of the domestic currency lowers the demand for domestic money by leading to its substitution with foreign money and foreign bonds (see, Bahmani-Oskooee and Pourheydarian, 1990 and Arango and Nadiri, 1981) the first of these effects is known as direct currency substitution and the second as capital mobility effect. Further more, Warner and Kreinin (1983) have argued that, although less developed countries peg their currencies to a major currency, as the case of Saudi Arabia, or basket of currencies they cannot avoid fluctuations in their effective exchange rate as long as major currencies fluctuate against one another. Therefore, given the high degree of openness of the Saudi Arabian economy and in order to take this in account, foreign interest rate, rf, and expected change in exchange rate, ex, are included in equation (1) to account for the influences of international monetary on domestic money holdings. An increase in foreign interest rate will, ceteris paribus, induce change in domestic residents holdings of real balances. The change in expected exchange rate is included to pick up the substitution effects between domestic and foreign currencies.

Several studies have examined time series variables properties and concluded that most macroeconomic time series data follow random walks. While Nelson and Plosser (1982) documented that 14 major macroeconomic variables exhibit non-stationarity behavior over time, Hall (1978) shows that the aggregate consumption follows a random walk process.

Thus, econometrics studies, Phillips (1986), Granger (1986), Granger and Newbold (1974), and Ohanian (1988), have demonstrated that if time series variables are non-stationary, all regression results with these series will differ from the conventional theory of regression with stationary series. That is, regression coefficients with non-stationary variables will be spurious and misleading. Therefore, analysis of time series properties of variables used in macroeconomic research is particularly important when examining the relationship between variables that exhibit a common trend (Granger, 1986; Engle and Granger, 1987; and Johansen, 1991). Thus, to avoid spurious relationships and misleading results and to provide valid evidence to the money demand function, before proceeding to the co-integration analysis and the estimation of long run money demand, the time series properties of the individual variables are examined by conducting stationarity or unit root tests. A variable that is stationary in level forms is I(0), however, a time series containing a unit root follows a random walk and requires first differencing to obtain stationarity, and is said to be first order integrated, I(1).

Researchers have developed several procedures to test for the order of integration. The most popular ones are the augmented Dicky Fuller (ADF) test due to Dickey and Fuller (1979, 1981), and Phillips-Perron (PP) due to Phillips (1988) and Phillips and Perron (PP) (1988). Augmented Dickey Fuller test relies on rejecting a null hypothesis of unit root (the series are non-stationary) in favor of the alternative hypotheses of stationarity.

$$\Delta Xt=\mu+(\alpha-1)Xt+\Sigma\gamma t\Delta Xt-1+ut \quad (2)$$

Where: Xt is a random variable, Δ is first difference operator, ut is a stationary random error, t time period n is number of lags for the dependent variable which is chosen to ensure that the residuals are white noise. The t-statistics of (α-1) is used to test the null hypothesis that this coefficient is equal to zero (i.e. that is α =1). However, the critical values for the t-statistics do not have the familiar distribution. Thus, several authors have constructed appropriate critical values for the distribution of the t-statistics (i.e. Fuller,1996; MacKinnon, 1991). A problem with the ADF test is that it involves the inclusion of extra differences terms in the testing equation. This results in a loss of degrees of freedom and a resultant reduction in the power of the testing procedure. Alternatively, the Phillips Perron (PP) approach allows for the presence of unknown forms of autocorrelation and conditional heteroscedasticity in the error term. Perron (1988) demonstrates that if a series is stationary about a linear trend but no allowance for this is made in the construction of the unit root test, then the probability of a type II error will be high. Thus, PP test corrects for serial correlation in equation (2) using a non parametric procedure. This procedure modifies the statistic after estimation in order to take into account the effect that autocorrelated errors will have on the results. Asymptotically, the statistic is corrected by the appropriate amount , and so the same limiting distribution applies. Perron (1988) suggests estimating the following regression by ordinary least squares:

$$Xt = \mu + \lambda(t - T/2) + \delta Xt\text{-}1 + ut \qquad (3)$$

There are more than one method of conducting co-integration tests. The empirical testing in this paper uses the multivariate co-integration method developed by Johansen (1988) and Johansen and Jueslius (1990). This approach is preferred to the Engle-Granger (1987) method for several reasons. Engle-Granger procedure depends upon the normalization of the variables and may be sensitive to the choice of dependent and independent variables in the co-integrating equation. It is possible that the arbitrary choice of one variable as the dependent variable and the other as independent variable may lead to the conclusion that the variables are co-integrated, whereas reversing the choice of dependent and independent variables may indicate no co-integration. Further, because the Engle-Granger procedure relies on a two step estimator in which the first step is to generate the residuals from the co-integration regression and the second step is to use the residuals generated from step one to test for unit roots, any errors introduced in first step also affects the second step. On the other hand Johansen-

Jueslius approach provides a very flexible format for investigating the properties of the estimators under various assumptions about the underlying data generating process.

Another advantage is that, unlike Engle-Granger co-integration methodology, the Johansen-Jueslius procedure is capable of determining the number of co-integrating vectors in the relationship. In the case of more than two variables, Banerjee et al. (1993) and Cuthbertson et al. (1992) showed that Johansen-Jueslius procedure is preferred. Phillips (1991) has also shown that this procedure to have optimal properties in terms of symmetry unbiasedness, and efficiency. Further, Gonzalo (1994) compared the performance of five co-integration tests using a Monte Carlo study and found that Johansen-Jueslius procedure is the most powerful even for the bivariate system. He showed that Johansen-Jueslius approach has consistent estimates even if the errors are non Gaussian and the dynamics are not known. The Johansen-Jueslius method applies the maximum likelihood procedure to determine the presence of co-integrating vectors in non stationary time series. Johansen and Jueslius provided two different tests, the trace test and the maximum eigenvalue test, to determine the number of co-integrating vectors. The presence of a significant cointegration vector or vectors indicates a stable relationship between the relevant variables. Johansen (1988) showed that both tests will have non-standard distribution under the null hypothesis, even in large samples.

The co-integration approach seems promising and found to be useful in modeling demand for money in developed countries (see for example, Hafer and Jansen, 1991; Baba et al. 1992; Mehra, 1991; Hendry and Ericssion, 1991, for the UK; Hurely and Guiomard, 1989, 1990, for Ireland; Boughton, 1991, for five industrial countries; and Arize and Shwiff, 1993, for Japan, among others). Although few studies exist, promising results have been obtained from applying this approach to the demand for money in developing countries (see for example, Fielding, 1994, for four African countries; Simmons, 1992, for five African countries; Domowitz and Elbadawi, 1987, for Sudan; Darrat and Al Mutawa, 1996, for UAE; and Al Bazai, 1998 for Saudi Arabia, among others).

As outlined in Hoffman et al. (1995), Darrat and Al Muttawa (1996) and Ewing and Payne (1999), the Johansen-Jueslius approach to testing for co-integration considers a p-dimensional vector auto regression (VAR) model:

$$X= \Pi 1Xt\text{-}1+.....+\Pi\ kXt\text{-}k +\varepsilon t \qquad t= 1, ..., T \qquad (4)$$

this autoregressive model may be written as a conventional error correction model as follows:

$$\Delta Xt=\mu+\square\ \Gamma t\Delta Xt\text{-}1+ ......+\Pi\ Xt\text{-}k +\varepsilon t \qquad (5)$$

where $\Gamma = -1 + \Pi 1 + \ldots.. + \Pi t$

$\Pi = 1 - \Pi 1 - \ldots\ldots. - \Pi k$

the Π matrix contains information about the long run relationships between the variables. Let the rank of the Π matrix be denoted by r. When $0 < r < p$, the Π matrix may be factored into αβ□, where α may be interpreted as a p x r matrix of error correction parameters and β as a p x r matrix of co-integrating vectors. The vector of constants, μ, allows for the possibility of deterministic drift in the data series. Maximum likelihood estimates for α, β, and Γt are derived in Johansen (1988). To test the hypothesis that there are at most r co-integrating vectors, one calculates the trace statistic (λtrace). The maximum eigenvalue test (λmax) is based on the null hypothesis that the number of co-integrating vectors is r against the alternative of r+1 co-integrating vectors. Johansen and Jueslius (1990) provide critical values for λtrace and λmax statistics and Osterwald-Lenum (1992) developed an extended version of these critical values.

Data and Empirical Results

Data used are quarterly data and covers the period from 1970.1 to 1998.4.

To approximate the scale variable, most researchers use real Gross Domestic Product (GDP) as the constraint on private money holdings. However, in oil dominated economies like that of Saudi Arabia, non oil GDP (Y) is used. Oil revenues in Saudi Arabia accrue to the government and have thus no direct impact upon the liquidity of the private sector. GDP (Y) data are obtained from Saudi Arabian Monetary Agency (SAMA) reports.

On the other hand, the cost of holding any asset for a certain period of time can be defined as the discounted real return expected on the best alternative investment. Hence, the opportunity cost of holding money should consist of the rate of return on holding physical assets, measured by the expected inflation rate. Thus, because of the lack of accurate data on domestic interest rate inflation is used here as a proxy for opportunity cost. Data on inflation (Inf) are taken from reports on inflation issued by the Central Statistical Department.

Given the high degree of openness of the Saudi Arabian economy, demand for money should take into account the potential impact of external (international) monetary and financial factors on domestic money holdings. Laidler(1993, 156) points out that A ... there is no systematic difference between a long and a short rate as far as explanatory power is concerned. ......a single interest rate in the function is best interpreted as standing as a representative measure of the rates of return to be earned on holding the money assets that agents could substitute for money in their portfolios, rather than as the >correct= indicator of the opportunity cost of holding money.@ Thus, Foreign interest rate (Int) is represented here by the Eurodollar three month interest rate (see, Ghamidi, 1989 and AlBazai, 1998) . Data on this variable are taken from International Monetary Fund (IMF) International Financial Statistics. Since the Saudi Arabian currency (Riyal) is pegged to the US $ and the exchange rate is fixed, thus, exchange rate variable in this study (Ex) is calculated as the exchange rate of the Riyal with the major trade partners of Saudi Arabia (the US, UK, Germany, Japan and France), as suggested by Warner and Kreinin (1983) and data are taken from SAMA reports. Financial innovation is represented here by the currency-money ratio as suggested by Bordo and Jonung (1990), Siklos (1993) and Al Bazai (1998), among others.

For most developed economies, having mature financial markets, the range of assets that should be examined for empirical requirements can be quite wide. However, in the absence of diverse financial assets in most developing economies, including that of Saudi Arabia, the empirical choice in defining money can be limited, beside currency in circulation (M0), to three aggregates. They are M1 (consisting of currency held by the non bank public plus demand deposits); M2 (consisting of M1 plus saving deposits of the non bank public); and M3 (defined by SAMA as M2 plus quasi money). These three alternative measures of money stock, and M0, are used in estimating the money demand function to determine the most appropriate measure or measures among them. Data on money are taken from (SAMA) reports.

Table 1 shows the results of the unit roots tests , tables 2, 3, 4 and 5 present the Johansen co-integration tests for the variable determining demand for money in Saudi Arabia with respect to M0, M1, M2, and M3. While error correction tests are presented in table 6 regression analyses are reported in table 7. The results of stationarity (unit roots) tests, which are conducted by using ADF and PP methods, show that the variables are in general non-stationary and after differencing they become integrated of degree one, I(1). The results of the co-integration tests are mixed, however they show that there is a long run relationship between money demand and its determinants. M0 seems to have the most reliable estimates. Since it's co-integrated with its determinants, namely Y and Int, but this long run relation was achieved only when financial innovation proxy (Fr) was included. However, M3 has long relationship with its determinants especially when exchange rate is included as one of the determinants. Again the long run relation between M3 and its determinants was achieved only when a proxy for financial innovation was included. Moreover, the inconclusive results may be related to the fact that there is no formal interest rate in Saudi Arabia due to the rule of Islamic law and when interests are paid on savings they are fixed by monetary authorities. However, it should be noted that interest rate used here is foreign to the economy (i.e., the Eurodollar rate).

On the other hand it is expected for an open economy, like Saudi Arabia, with virtually no restrictions on capital mobility, that foreign interest rates may play rule in the demand for money function. However, as the results show, this may stress the argument that money demand by individuals is less sensitive to changes in foreign interest rates since it was suggested by some researchers that, money demand in Saudi Arabia might not be affected by foreign interest rate and it would be erroneous to conclude that external interest rate factors react through domestic demand deposit in Saudi Arabia, even though when there are many accounts at the commercial banks in foreign currencies (more than Saudi Riyal, SR 51 billion at the end of 1999). Thus, A The banks themselves, rather than their depositors or potential depositors, respond to external interest rates stimuli by holding foreign funds.@ (Looney, 1990, 132).

According to Engle and Granger (1987) a system of co-integrated variables can be represented by a dynamic error correction model. Having obtained the results which show that co-integration between variables then a long run and stable relationship exists, the short run dynamics in the vector error correction model is estimated. Vector error correction results in table 6 show the coefficients of the VEC which indicate the process by which the dependent variable adjust in the short run and the speed of adjustment to the long run equilibrium on one hand and the direction of causality on the other. It provides a channel through which Granger causality can occur in an addition to the traditional lagged independent variables (Granger, 1986), the coefficients on these vector error correction coefficients are significant at the 5 percent level. Thus coefficients on this VEC term, which ranges between 0.022 and 0.05, reflect the process by which the dependent variable adjusts to in the short run to its long run equilibrium. Further, regression analyses reported in table 7 show that other than inflation (Inf) all variables have the right signs and significant at 1% level. Income (Y) has as expected positive and significant impact on the demand for money especially M2 and M3, an increase in income (Y) by 10 percent will have around 5 percent increase in money demand. However, the significant negative impact of exchange rate (Ex) shows the high degree of openness of the Saudi Arabian economy.

The fact that inflation has a positive coefficient may be due to the fact that inflation measure used here is proxied by the consumer price index (CPI) which measures the cost of living in Saudi Arabia. However, because of the CPI deficiency caused by the government intervention, a disruptive in the expectation may occur. In Saudi Arabia, direct and indirect financial and economic policies could disrupt the usefulness of the CPI as a measure of changes in the cost of living. The direct government intervention, aimed at curbing inflation, affected prices through commodity subsidization, in the 1970's and 1980's, and housing policies. The indirect are those policies that until recently influenced and supported domestic industry, agriculture and services production. These policies by the government might distorted the validity of this measure.

By incorporating different proxies for financial innovation the interest is in finding answers to the following questions. First, does the introduction of financial innovation term enter significantly and help the specification in overcoming the parameters instability problem?. Second, does the financial innovation term affect the significance of other variables?. Last, whether the hypothesis that those financial innovation effects increased during and after the second half of the 1980's is consistent with the data.

Three different proxies have been used by researchers: time trend which was used first by Lieberman (1977), the currency-money ratio as suggested by Bordo and Jonung (1990) and Siklos (1993), and a stochastic trend process, in the form of a random walk, as suggested by Arrau and De Gregorio (1993, 1995). Here currency money ratio is used as a proxy for financial innovation.

Including a measure of financial innovation into the money demand function gives indication of co-integration. However, these results do not conclusively support the view that financial innovations have major effects on money demand equation. The only financial innovation that supported this view is the money ratio. Thus, including this variable (money ratio) provides results showing presence of co-integration. Further, these results show the existence of a long run and stable relationship between money demand in Saudi Arabia and its determinants.

To model the development in the Saudi Arabian financial system that are accompanied the introduction and issuing Banker's Security Deposits Accounts (BSDA) in 1985, government bonds in 1988, and in November 1991 replacing

BSDA with Treasury Bills (TB) which are prompted by the need to finance the public deficit. This, however, differs from financial innovation since it concerns the introduction of a default free asset rival to money. However, it is possible to trace the effect of these developments in the Saudi Arabian financial system by dividing the whole time period into two sub periods, before and after the introduction of these government bills and bonds and compare the results. These sub periods are: 1970.1-1984.4 and 1985.1-1998.4 . It appears that while in the first period a co-integration exists the results on second period indicate the absence of co-integration (results are not shown) which might suggest that money demand function for the second period is unstable.

Further, the problem of parameters non-constancy was tested. Figures 1-4 present Cumulative Sum of Squares tests for the equations in table 7 (M0, M1, M2, M3). This test is based on tests by Brown et al. (1975) using recursive regressions. The figures plot the CUMSUM statistics, which are based on the residuals of the recursive regressions together with lines drawn at the percent level of significance. If either of the lines is crossed the null hypothesis that the regression model is correctly specified is rejected at the 5 percent level of significance. Brown et al. (1975) argued that this test is useful in situations where the departure from constancy of the regression coefficient is haphazard and sudden. It appears from figures 1, 2 and 3 that the CUMSUM of models (M0, M1, M2) are in side the critical lines. However, figure 4 shows that the squares of the recursive of residual of models (M3) crossed the critical lines in 1977 and crossed back in 1987 and have remained within the critical lines since then. This may indicate that money demand parameters (M3) shifted during the 1977-1987 period but then returned to their pre-1977 level. This may reflect greater financial sophistication , and more accelerated financial innovation and development of the Saudi Arabian financial sector.

Conclusion and Policy Implications:

This paper attempts to model the demand for money in Saudi Arabia. Instead of using the conventional modeling this study employs and utilizes the recent developments in econometrics modeling. It tests for the presence of unit roots, uses co-integration vector error correction methods and OLS analysis to investigate if there are long run and stable relationships between money demand represented by M0, M1, M2, and M3 and to find out about the short run dynamic adjustment and the determinants of the money demand in Saudi Arabia for the period 1970 to 1998 on a quarterly base. Even though when the results are mixed, these empirical results show that there exist a long run and stable relationship and these results can be used as base for monetary policy by the authorities at the central bank (SAMA). The finding that financial innovation may affect the stability of the demand for money has implications for the structure of the financial sector and for its repercussions on the monetary policy and the real sector. Thus, the relationship of the money stocks to the real sector might be disturbed by financial innovation and the validity of monetary policy may be impaired. Moreover, effects of financial innovations and openness on money demand function in Saudi Arabia give indications that policy makers can take these results as a policy guidance in formulating monetary policy.

The fact that foreign interest rate appears to be important in the long run has important implication. That is that the long run impacts of capital mobility have to be taken into account by the monetary authorities. Additionally, the financial system in the country may have to take into consideration the need to offer investors returns and/ or a range of services that match those of international financial markets. Another implication is the impact of changes in real exchange on the demand for money in Saudi Arabia. This result may have important effect on monetary base and monetary policy based on the decisions made by domestic and foreign residents to evaluate their portfolios when exchange rates change.

Further, M1 and M2 may act as good monetary policy instruments, since M1 is a very good measure of liquidity in the economy and it mainly includes financial assets held for transaction purposes. SAMA can control this monetary aggregate more accurately than broader definition of money. This is due to the fact that demand for M3 function may become increasingly unstable with time.

Table 1 Stationarity Tests

Variables	ADF Levels	ADF Differenced	PP Levels	PP Differenced
lnY	-2.684	-2.377	-1.287	-13.669*
lnInf	-2.889	-4.233*	- 4.794	-15.513*
lnInt	-3.657	-4.233*	-2.688	-10.455*
lnEx	-4.250	-3.576*	-2.895	-10.991*
lnM0	-1.942	-2.944**	-3.475	-8.628 *
lnM1	-1.081	-4.882*	-1.204	-19.213*
lnM2	-1.022	-6.552*	-2.286	-23.174*
lnM3	-0.918	-6.680*	-2.233	-23.534*

Table 2 The Johansen Co-integration Test (M0)

Eigenvalues	λmax	λtrace	5% for λmax	5% for λtrace	Hypothesis
		lnM0=f (lnY, lnInt)			
0.1789	21.879	42.690	20.97	34.55	r= 0*
0.1241	14.905	20.811	14.07	18.17	r 1**
0.0535	6.106	6.106	3.74	3.74	r 2**
		lnM0=f(lnY, Inf)			
0.1740	21.222	37.078	20.97	29.68	r=0*
0.0870	10.10	15.857	12.05	15.41	r1**
0.0505	5.755	5.755	3.76	3.76	r2**
		lnM0=f (lnY, lnEx)			
0.2293	28.903	50.982	20.97	34.55	r= 0*
0.1382	16.505	22.079	14.07	18.17	r 1**
0.0490	5.574	5.574	3.74	3.74	r 2**
		lnM0=f (lnY, lnInt, lnEx)			
0.2810	36.615	80.415	27.97	54.64	r= 0*
0.1775	21.688	43.800	20.97	34.55	r 1*
0.1325	15.78	22.112	14.07	18.17	r 2**
0.0554	6.33	6.33	3.74	3.74	r 3**
		lnM0=f (lnY, lnInt, lnEx, Inf)			
0.4251	61.444	125.443	33.46	77.74	r= 0*
0.1918	23.636	63.999	27.97	54.64	r 1*
0.1639	19.864	40.363	20.97	34.55	r 2*
0.1499	18.029	20.499	14.07	18.17	r 3*
0.0220	2.470	2.470	3.74	3.74	r 4*
		lnM0=f (lnY, lnInt, lnEx, Inf, fr)			
0.4285	62.111	179.797	39.46	104.94	r= 0*
0.3485	47.557	117.686	33.46	77.74	r 1*
0.2273	28.619	70.129	27.97	54.64	r 2*
0.1669	20.275	41.510	20.97	34.55	r 3*
0.1572	18.989	21.236	14.07	18.17	r 4**
0.0200	2.247	2.247	3.74	3.74	r 5

* Significant at 1% level, ** significant at 5% level, *** significant at 10% level.

Table 3 The Johansen Co-integration Test (M1)

Eigenvalues	λmax	λtrace	5% for λmax	5% for λtrace	Hypothesis
		lnM1=f (lnY, Inf)			
0.1741	21.229	35.802	20.97	29.68	r=0*
0.0938	10.933	14.573	14.07	15.41	r1***
0.0323	3.64	3.640	3.76	3.76	r 2***
		lnM1=f (lnY, lnInt)			
0.1478	17.756	30.572	20.97	24.31	r= 0*
0.0945	11.018	12.816	14.07	12.53	r 1**
0.0161	1.798	1.798	3.76	3.84	r 2
		lnM1=f (lnY, lnEx)			
0.2092	26.057	51.506	20.97	34.55	r=0*
0.1617	19.577	25.449	14.07	18.17	r 1*
0.0516	5.872	5.872	3.74	3.74	r 2**
		lnM1=f (lnY, lnEx, Inf)			
0.398	56.409	100.812	27.97	54.65	r= 0*
0.2004	24.818	44.403	20.97	34.55	r 1*
0.131	15.629	19.585	14.07	18.17	r 2*
0.035	3.956	3.956	3.74	3.74	r 3*
		lnM1=f (lnY, lnInt, Inf, lnEx)			
0.41432	59.382	152.1521	33.46	68.52	r= 0*
0.31321	41.706	92.7696	27.97	47.21	r 1*
0.22851	28.796	51.0640	20.97	29.68	r 2*
0.13567	16.186	22.2677	14.07	15.41	r 3*
0.05331	6.082	6.0815	3.76	3.76	r 4**
		lnM1=f (lnY, lnInt, Inf, lnEx, fr)			
0.445	65.252	180.811	39.46	104.94	r= 0*
0.308	40.935	115.559	33.46	77.74	r 1*
0.217	27.214	74.624	27.97	54.64	r 2*
0.206	25.564	47.410	20.97	34.55	r 3*
0.164	19.82	21.846	14.07	18.17	r 4*
0.018	2.026	2.026	3.74	3.74	r 5

* significant at 1% level, ** significant at 5% level, *** significant at 10% level.

Table 4 The Johansen Co-integration Test (M2)

Eigenvalues	λmax	λtrace	5% for λmax	5% for λtrace	Hypothesis
		lnM2=f (lnY, lnInt)			
0.1711	20.832	37.512	20.97	34.55	r= 0**
0.0793	9.178	16.680	14.07	18.17	r 1***
0.0654	7.507	7.507	3.74	3.74	r 2*
		lnM2=f (lnY, Inf)			
0.1688	20.518	34.753	20.97	29.68	r= 0**
0.0962	11.229	14.235	14.07	15.41	r 1***
0.0267	3.006	3.006	3.76	3.76	r 2***
		lnM2=f (lnY, lnEx)			
0.1966	24.300	48.991	20.97	34.55	r= 0*
0.1421	17.012	24.691	14.07	18.17	r 1*
0.0669	7.679	7.679	3.74	3.74	r 2*
		lnM2=f (lnY, lnInt, lnEx)			
0.2331	29.459	74.1666	29.97	54.64	r= 0*
0.1866	22.919	44.708	20.97	34.55	r 1*
0.1258	14.929	21.789	14.07	18.17	r 2**
0.0599	6.86	6.8600	3.74	3.74	r 3*
		lnM2=f (lnY, Inf, lnInt, lnEx)			
0.36525	50.453	108.7965	33.46	68.52	r= 0*
0.20864	25.975	58.3440	27.97	47.21	r 1*
0.12140	14.366	32.3693	20.97	29.68	r 2**
0.09917	11.593	18.0026	14.07	15.41	r 3**
0.05611	6.4093	6.40931	3.76	3.76	r 4*
		lnM2=f(lnY, Inf, lnInt, lnEx, fr)			
0.4359	63.549	175.6185	39.46	104.94	r=0*
0.3095	41.107	112.070	33.46	77.74	r 1*
0.2036	25.264	70.963	27.97	54.64	r 2*
0.1793	21.931	45.699	20.97	34.55	r 3*
0.1647	19.981	23.768	14.07	18.17	r 4*
0.0336	3.787	3.787	3.74	3.74	r 5**

* significant at 1% level, ** significant at 5% level, *** significant at 10% level.

Table 5 The Johansen Co-integration Test (M3)

Eigenvalues	λmax	λtrace	5% for λmax	5% for λtrace	Hypothesis
		lnM3=f (lnY, Inf)			
0.1728	22.671	40.581	20.97	29.68	r= 0*
0.1157	13.659	19.527	14.07	15.41	r 1**
0.0515	5.871	5.871	3.76	3.76	r 2**
		lnM3=f (lnY, lnInt)			
0.1587	19.174	34.649	20.97	29.68	r= 0**
0.1051	12.32	15.475	14.07	15.41	r 1**
0.0280	3.155	3.155	3.74	3.76	r 2***
		lnM3=f (lnY, lnEx)			
01909	23.513	47.739	20.97	34.55	r= 0*
0.1442	17.284	24.226	14.07	18.17	r 1*
0.0606	6.942	6.942	3.74	3.74	r 2*
		lnM3=f (lnY, lnInt, lnEx)			
0.2346	29.674	73.394	27.97	54.64	r= 0*
0.1881	23.133	43.720	20.97	34.55	r 1*
0.1213	14.35	20.587	14.07	18.17	r 2**
0.0546	6.237	6.237	3.74	3.74	r 3**
		lnM3=f (lnY, Inf, lnInt, lnEx)			
0.40074	56.839	126.018	33.46	77.74	r= 0*
0.19413	23.957	69.1786	27.97	54.55	r 1*
0.18062	22.111	45.2217	20.97	34.55	r 2*
0.15972	19.316	23.1104	14.07	18.17	r 3**
0.03361	3.794	3.794	3.74	3.74	r 4**
		lnM3=f (lnY, Inf, lnInt, lnEx, fr)			
0.4484	66.028	179.085	39.46	104.94	r= 0*
0.3184	42.539	113.057	33.46	77.74	r 1*
0.2039	25.322	70.518	27.97	54.64	r 2*
0.1795	21.961	45.196	20.97	34.55	r 3*
0.1643	19.916	23.235	14.07	18.17	r 4**
0.0.295	3.316	3.319	3.74	3.74	r 5***

* significant at 1% level , ** significant at 5% level ***significant at 10% level..

Table 6 Vector Error Correction Results (VEC) Tests

**Coefficients of VAR Model: M0

ΔlnM0=0.538 -0.0083lnM0t-1 -0.958lnYt-1 -25.33Inft-1 +1.58Intt-1 +14.43lnExt-1 -0.261Δln
M0t-1 -0.081ΔlnM0t-2 +0.159ΔlnYt-1-0.21ΔlnYt-2 -0.202ΔInft-1 -0.217ΔInft-2 +0.01ΔlnIntt-
1 -0.037ΔlnIntt-2 -0.0204ΔlnExt-1 +0.214ΔlnExt-2

**VEC: M0

ΔlnM0=0.0622 +0.159ΔlnYt-1 -0.21ΔlnYt-2 +0.009ΔlnIntt-1 -0.037ΔlnIntt-2 -0.202ΔInft-1

(3.795)* (0.844) (-1.113) (0.126) (-0.538) (-1.290)

-0.217ΔInft-1 -0.02ΔlnExt-1 +0.214ΔlnExt-2 -0.26ΔlnM0t-1 -0.081ΔlnM0t-2 -0.009VECt-1

(-1.449) (-0.053) (0.554) (-2.602)* (-0.807) (-2.763)*

R=0.218, F=2.32, AIC= -2.783, SC= --2.469, Log Likelihood= 170.238

**Coefficients of VAR Model: M1

ΔlnM1= 0.05887 +0.0531lnYt-1 + 0.7465Inft-1-0.2864lnExt-1- 0.0498lnIntt-1-0.06156lnMt-
- 0.384ΔlnYt-1 -0.453ΔlnYt-2 - 0.4581ΔlnInft-1 - 0.1562ΔlnInft-2 - 0.03135ΔlnExt-1 - 0.18
ΔlnExt-2 + 0.0 605ΔIntt-1 -0.06509ΔIntt-2+0.578ΔlnM1t-1 -0.022ΔlnM1t-2

**VEC: M1

ΔlnM1=0.052 + 0.11ΔlnYt-1 +0.203ΔlnYt-2 -0.045ΔIntt-1 -0.979ΔIntt-2 -0.235ΔInft-1

(3.653)* (0.768) (1.437) (-0.886) (-1.60)*** (-1.90)**

-0.08ΔInft-2 -0.556ΔlnExt-1 -0.123ΔlnExt-2 -0.124ΔlnM1 -0.092ΔlnM1t-2 -0.004VECt-1

(-0.714) (-1.90)** (-0.42) (-1.173) (-0.884) (-3.35)*

R=0.35, F= 4.51*, AIC = -3.394, SC= -3.08, Log Likelihood= 204.773

**Coefficients of VAR Model: M2

ΔlnM2= 0.0759 +0.2462lnYt-1 + 0.6056Inft-1 -0.654lnEXt-1 + 0.0644lnIntt-1 - 0.1808lnM2t
-0.8658ΔlnYt-1 -0.858ΔlnYt-2 -0.666ΔInft-1 -0.40875ΔInft-2 +0.253ΔlnExt-1 + 0.23Δ
lnExt-2 - 0.0844 ΔIntt-1 -+0.025ΔIntt-2 -0.5803ΔlnM2t-1 -0.2674ΔlnM2t-2

**VEC: M2

ΔlnM2=0.059 +0.0527ΔlnYt-1 +0.1154ΔlnYt-2 -0.018ΔlnIntt-1 -0.0444ΔlnIntt-2 -0.22ΔInft-

(4.31)* (0.390) (0.891) (-0.401) (-0.997) (-2.21)[*]

-0.094ΔInft-2 -0.484ΔlnExt-1 -0.0488ΔlnExt-2 -0.12ΔlnM2t-1 -0.119ΔlnMt-2 -0.0548VECt-

(-0.989) (-1.88)*** (-0.187) (-1.162) (-1.169) (-4.238)*

**Coefficients of VAR Model: M3

ΔlnM3 =0.0745 +0.2525lnYt-1 +0.1887Intt-1 -0.4616lnExt-1 +0.0538Inft-1 -0.183lnM3t-1
0.4808lnM3t-1-0.8501ΔlnYt-1 -0.7609ΔlnYt-2 -0.623ΔInft-1 -0.38145ΔInft-2 +0.27ΔlnExt-1
+0.05005ΔlnExt-2 -0.04401ΔIntt-1 +0.02485ΔIntt-2 -0.586ΔlnM3t-1 -0.2701ΔlnM3t-2

**VEC: M3

ΔlnM3=0.044 +0.164ΔlnYt-1 +0.255ΔlnYt-2 -0.021ΔItt-1 -0.045ΔIntt-2 -0.217ΔInft-1

(3.09)* (1.221) (1.94)** (-0.472) (-1.005) (-2.93)*

-0.08ΔInft-2 -0.319ΔlnExt-1 +0.146ΔlnExt-2 -0.005ΔlnM3t-1 -0.077ΔlnM3t-2 -0.022VECt-1

(-0.828) (-1.236) (0.562) (-0.049) (-0.700) (-2.416)**

R=0.378, F=5.059*, AIC=-3.654, SC=-3.341, Log Likelihood=219.467

Table 7 Regression Analysis Results

Ind.\ Dep. Vais	lnM0	lnM1	lnM2	lnM3
C	0.0288	0.0591	0.0552	0.0475
	(0.690)	(1.996)	(2.0207)	(1.8164)
lnY	0.4242	0.4138	0.5763	0.4796
	(0.9654)	(1.3267)	(2.0034)**	(1.7422)***
lnEx	-0.1097	-0.0947	-0.9575	0.11498
	(-2.8253)**	(-3.438)*	(-3.7679)*	(-4.7286)*
Inf	0.1697	0.2667	0.1946	0.1932
	(1.706)***	(3.778)*	(2.988)*	(3.099)*
Int	-0.1431	-0.4729	-0.4040	-0.2698
	(-0.3273)	(-1.600)***	(-1.412)	(-0.985)
Fr	-0.0002	-0.0003	-0.0003	-0.4746
	(-1.0187)	(-1.883)***	(-1.875)***	(-1.9585)**
Adj. R-sq	0.155	0.346	0.3395	0.365
F	4.000*	11.62*	11.205*	12.543*
D. W.	2.42	2.09	2.12	2.02
Log Lik	169.302	208.724	218.013	223.074
AIC	-2.84	-3.526	-3.687	-3.775
SC	-2.697	--3.382	-3.544	-3.632

* Significant at 1% level, ** Significant at 5% level, *** Significant at 10% level.

Ad. R-sq=adjusted R squared; F=F-statistics; D.W.=Durbin-Watson; Log Lik= Log Likelihood; AIC=Akaike Information Criterion; SC=Scwarz Criterion.

Figure 1 plot of Cumulative Sum of Squares of Recursive Residuals of (M0) in table

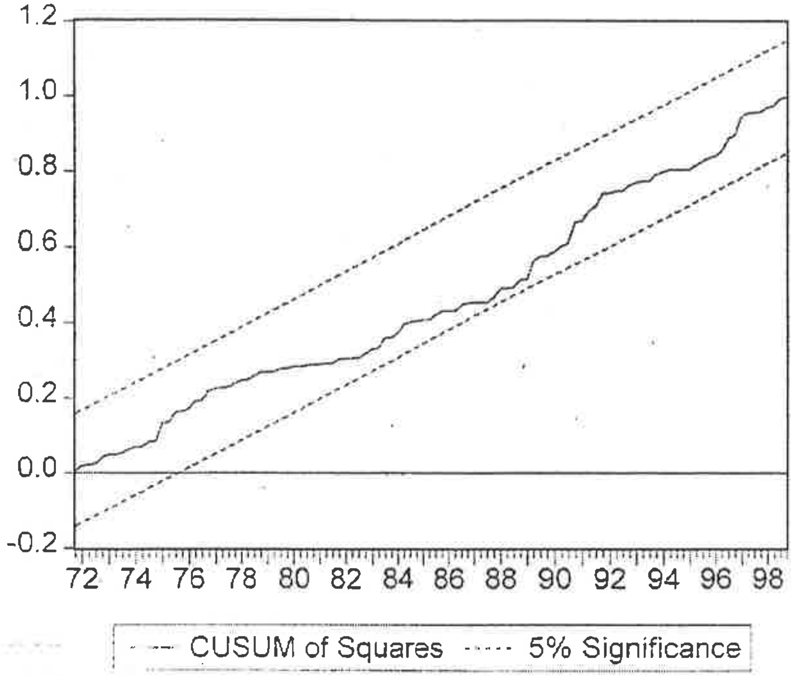


Figure 2 plot of Cumulative Sum of Squares of Recursive Residuals of (M1) in table 7.

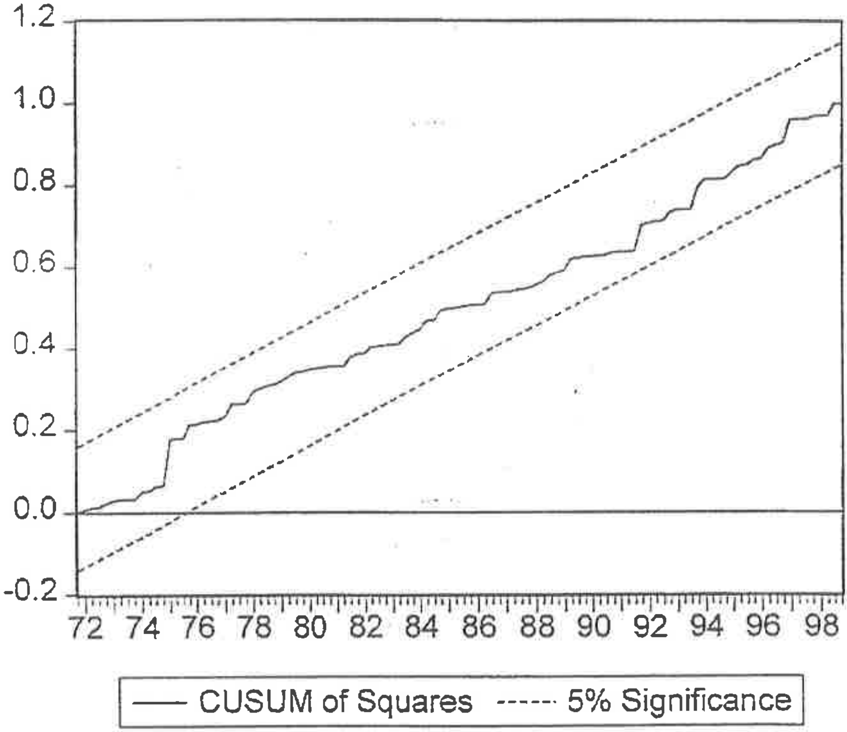


Figure 3 plot of Cumulative Sum of Squares of Recursive Residuals of (M2) in table 7.

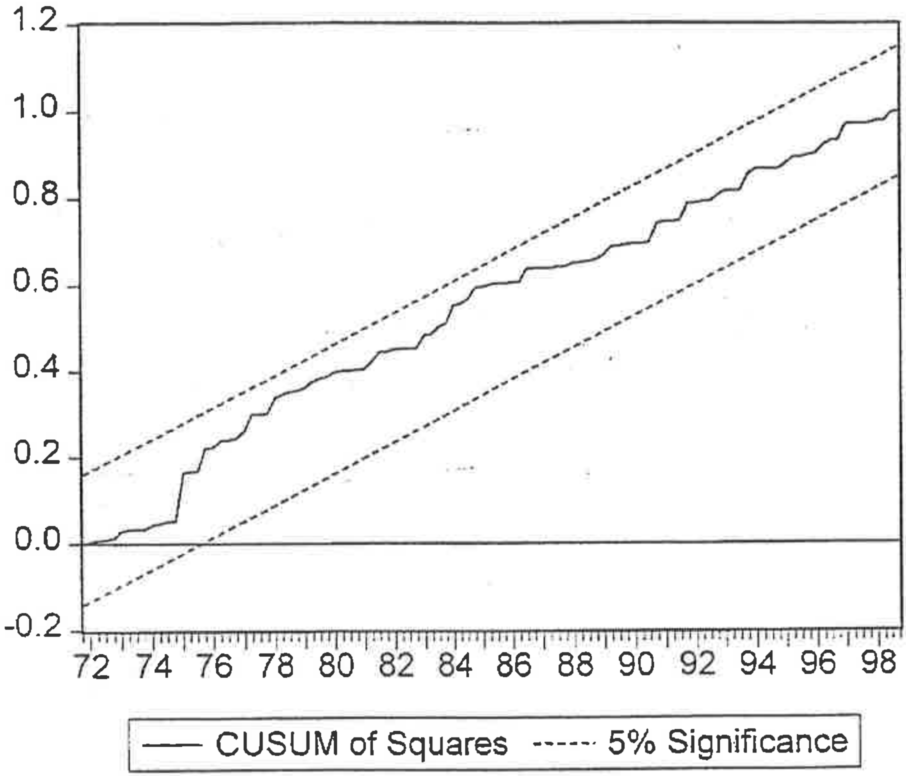
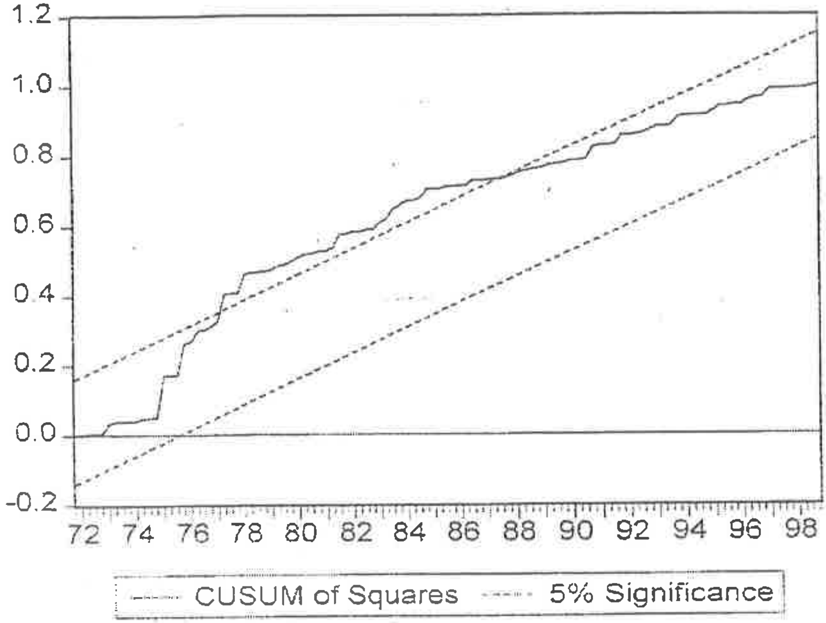


Figure 4 plot of Cumulative Sum of Squares of Recursive Residuals of (M3) in table 7.



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