ESTIMATION OF LONG-RUN DEMAND FOR MONEY: AN APPLICATION OF LONG-RUN STRUCTURAL MODELLING TO SAUDI ARABIA*

1. Introduction: the issue motivating the paper

The study of the demand for money has important implications for monetary policy. The case of Saudi Arabia is of interest mainly for two reasons:

(i) firstly, we are aware of only a few studies, such as Crockett and Evans (1980), Darrat (1984) that have investigated the determinants of Saudi's money demand function in detail. However, these studies failed to take into account the non-stationary nature of the time series variables and hence the methodological problems involved in estimating the long-run money demand function with non-stationary variables remained unaddressed;

(ii) secondly, there is no capital control or any type of restrictions on the inflow or outflow of money in Saudi Arabia. This makes it a test case for quantifying the effect of international factors (such as the foreign interest rate and the exchange rate variable) on the domestic demand for money function.

The conventional view of the monetary transmission mechanism is that money supply will affect short-term interest rates, given the demand for money. The short-term interest rates are linked with the long-term interest rates through the term structure of interest rates. The long term interest rates will then affect investment through the investment function and finally, investment will affect output. This study is concerned with the examination of the stability of the demand for money in the above-mentioned long transmission channel. We would like to refer to a survey paper on the recent

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empirical money demand studies by Sriram (2001) that emphasises the critical role of demand for money in macroeconomic analysis, especially in selecting appropriate monetary policy actions.

For a number of decades, a 'stable money demand function' was considered as the heart of many macroeconomic models. The Monetarist models (Friedman, 1956) and the Monetary approach to exchange rate determination (Dornbusch,1976) assume it as a crucial proposition. It has an important role in New Classical models (Sargent and Wallace, 1975), in New Keynesian models (Mankiw, 1992), and in many empirical Real Business Cycle models (King *et al*., 1991).

Sections 2 and 3 indicate the major objective of the study followed by literature reviews and specification of the function to be used in our subsequent empirical work. Section 4 and 5 discuss the very recent methodology used in our analysis and the contributions of the paper. Data, empirical results and discussions are in Section 6. Conclusions and policy implications are given in the last Section.

2. The objective of the study

Given the crucial importance of the stability of demand for money as a prerequisite for effective money supply targeting of a country (particularly in the context of an open developing economy with free capital movement) *and* the need for an analytical technique that is free from the limitations of the traditional regression analysis, we want to estimate the long-run demand for money through the application of a very recently developed time series technique called Long-Run Structural Modelling (LRSM) by Pesaran and Shin (2002). Saudi Arabia is used as a case study.

3. Literature review and specification of the money demand function

In the literature on the money demand function in less developed countries (LDCs), only two studies that we are aware of by Crockett and Evans (1980), and Darrat (1984), discussed the case of Saudi Arabia.

The conventional money demand function which has been used in many studies is as follows:

$$M^d = f\ (Y,\ r)$$

Where M^d is the real stock of money demand. Y is a measure of the transactions variable and r is the domestic interest rate and serves as a proxy for the opportunity cost of holding money. This

form has been criticized for ignoring the effect of foreign financial markets, especially under the current regime of flexible exchange rates. Most current empirical studies of money demand in LDCs have assumed that the domestic money market is isolated from the foreign financial influences (see Sriram, 2001 for an excellent survey of the recent empirical money demand studies).

However, in the context of an open developing economy with free capital movement, the stability of the demand for money is likely to be affected by the international factors (on top of real income and the domestic interest rate). There is need to augment the traditional money demand function by the well-known portfolio or asset balance approach in the context of an open developing economy. According to this theory, if foreign bonds are an alternative investment opportunity, then foreign interest rate should be included in the money demand function. On the other hand if foreign money is an alternative investment opportunity, then the rate of change of the exchange rate should be included in the money demand function. The literature on direct currency substitution usually focuses on the exchange rate variable, whereas the literature on capital mobility usually focuses on the foreign interest rate variable (McKinnon, 1982; Cuddington, 1983; Leventakis, 1993). The higher is the expected return on holding the foreign bond, the lower is likely to be the demand to hold domestic money. As to the effect of the change in exchange rate on domestic money demand, a depreciation of domestic currency increases the value of foreign securities held by domestic residents. If this is considered as an increase in wealth, the demand for domestic cash balances might rise (Arango and Nadiri, 1981). However, from the point of view of currency substitution, if the residents expect further depreciation of domestic currency, they may substitute foreign money for domestic money and the demand to hold domestic money may rather fall (Bahmani-Oskooee and Techaratanachai, 2001).

Hence based on the traditional money demand function augmented by the portfolio/asset balance theory, a new specification of money demand has been developed for the open developing economies with free capital movement. This new specification takes the form:

$$M = f\ (Y,\ R)$$

Where R is a vector of proxies for the opportunity cost of holding domestic money. Early studies on the phenomenon of currency substitution as an indication of the presence of foreign monetary or financial influences considered (apart from the domestic interest rate) two

proxies for the opportunity cost of holding domestic money: the foreign interest rate and the expected percentage change in the exchange rate[1].

4. Methodology used

It has, by now, become almost a standard procedure (helped by easy access to standard software packages) that any regression analysis should start off, not mechanically, but by testing the stationarity and cointegration properties of the time series involved. It is, by now, well established that most economic time series are non-stationary in their original 'level' form. If the variables are non-stationary, the conventional statistical tests (such as R^2, t, etc.) are not valid.

If the variables are non-stationary but cointegrated, the ordinary regression without the error-correction term(s) derived from the cointegrating equation is mis-specified. However, if the variables are non-stationary but not cointegrated, then an ordinary regression with 'differenced' variables (which will be stationary) can be estimated but the conclusions drawn from such an analysis will be valid only for the short run and no conclusions can be made about the (long run) theoretical relationship among the variables since the theory has typically nothing to say about the short run relationship. This is due to the fact that the 'differenced' time-series variables have no information about the long run relationship between the trend components of the original series since these have, by definition, been removed. The long run co-movement between the variables cannot be captured by 'differenced' variables.

Hence on the one hand, if the variables taken are 'non-stationary' at their original 'level' forms, the conventional statistical tests are not valid because the variances of these variables are changing and the relationship estimated will be 'spurious'. On the other hand, if the variables taken are turned 'stationary' by 'first-differencing', the long-term information contained in the trend element in each variable has been, by definition, removed and the relationship estimated gives only the short run relationship between the variables and the regression does not test any theory.

Hence the regression analysis that has been applied for many decades to estimate the long-run money demand is now considered

[1] Some of the old studies that have discussed this issue in the developed countries include Hamburger (1977), Arango and Nadiri (1981), McKinnon (1982), and Chung (1983) among others.

to have either estimated a spurious relationship (if the original 'level' form of the variables was non-stationary) or estimated a short-run relationship (if the variables were 'differenced' to make the original variables stationary).

This *damaging limitation* of the traditional regression analysis (i.e., either spurious or not testing theory) has been addressed by the recent and ongoing cointegration time series techniques. The significant contributions made by the time series cointegration techniques starting with the publication of the seminal paper by Engle and Granger (1987) has been recognized through the recent award of the Nobel Prize in Economic Science to Engle and Granger in 2003 (for further details see Diebold, 2004; 2003 and Granger, 2003).

Although the cointegrating procedure has made an important advance on regression analysis by focusing on the point that any regression analysis should start off, not mechanically, but by testing the stationarity and cointegration properties of the time series involved, a limitation of the estimated cointegrating vectors is that they are atheoretical. The LRSM procedure that we propose to apply is going to take care of that limitation**.** LRSM endeavours to estimate theoretically meaningful long-run (or cointegrating) relations by imposing on those long-run relations (and then testing) both identifying and over-identifying restrictions based on theories and information of the economies under review.

For testing each restriction the results are presented in tables and one should check the LR statistic in each case whether the null of restriction/s should be rejected or accepted.

5. The contributions of the paper

The study will depart from earlier works and also advance the field in the following ways:

(i) using a portfolio balance approach, this study makes an initial attempt to examine the importance of international factors, measured by capital mobility and/or currency substitution, on the stability of the long-run money demand function in the context of this region, in particular Saudi Arabia;

(ii) the application of the most recently developed 'Long-run structural modelling technique' (which is an improvement on and an extension to the standard cointegrating techniques) will also be the first attempt in this region. The stability of the functions has also been tested by CUSUM and CUSUMSQ;

(iii) the findings of the study on the 'stability of the demand for money' will have distinct policy implications for the transmission of monetary channel in Saudi Arabia.

6. Data, empirical results and discussions

As stated earlier, the main objective of the paper is to estimate the long-run demand function of money with a particular focus on the impact of foreign financial markets (such as, foreign interest rate and foreign exchange rate) on money demand in the context of an open economy like Saudi Arabia.

Based on the portfolio balance approach, we took the following variables to estimate the money demand function through the application of Long Run Structural Modelling (LRSM). Since the boundaries of narrow money (M1) keep changing over time to accommodate the new financial instruments, arguments have been advanced in favour of adopting broad money (M2 and M3) in empirical estimation (Akinlo, 2006). For the M3 function, the variables which were finally taken were real gross domestic product (LGDPCON), twelve month rate of interest (TWELVEM), foreign interest rate (FORINT). The M2 function was also estimated for the sake of checking the robustness of the results.

All the variables (excepting the interest rates) are transformed into logarithms to achieve stationarity in variance. The source of all domestic variables is the Saudi Arabian Monetary Agency (SAMA) and the source of foreign interest rate and nominal effective exchange rate is IFS published by the IMF. The period covered in the study (1986-2004) depended mainly on the availability of consistent data for all the variables.

We first started with the M3 function. We tested the unit roots of all the variables and found them I(1) on the basis of ADF and PP tests. We also found that the optimal lag could be taken as two on the basis of AIC and SBC criteria. We applied the standard Johansen cointegration test (Table 1) and found them to have one cointegrating vector on the basis of maximal eigen value test. An evidence of cointegration implies that the relationship among the variables is not spurious, i.e., there is a theoretical relationship among the variables and that they are in equilibrium in the long run. However, in order to make the coefficients of the cointegrating vector consistent with the theoretical and *apriori* information of the economy, we applied 'long run structural modeling' procedure.

TABLE 1 - *Johansen ML Results for Multiple Cointegrating Vectors – Real M3, Real GDP, 12-Month Interest Rate and Foreign Interest Rate, (1986-2004)*

H_0	H_1	Statistic	95% Crit	90% Crit
Maximum Eigen value Statistics				
r = 0	r >= 1	31.90	31.79	29.13
r <= 1	r >=2	22.88	25.42	23.10
Trace Statistic				
r = 0	r >= 1	76.53	63.00	59.16
r <= 1	r >=2	44.63	42.34	39.34

The underlying VAR model is of order 2 and is computed using 19 annual observations.

Note: The statistics refer to Johansen's log-likelihood based maximal eigenvalue and trace test statistics based on cointegration with unrestricted intercepts and restricted trends in the VAR. From the above results we select 1 cointegrating vector based on the eigenvalue statistics.

We imposed exact identifying restrictions on the coefficient of M3 (Table 2, Panel A) and found all the coefficients of the cointegrating vector as highly significant and then based on theory, we imposed an

TABLE 2 - *Exact and Over Identifying Restrictions on the Cointegrating Vector*

	Panel A	Panel B
LMTHREE	1.00	1.000
	(*None*)	(*None*)
LGDPCONS	1.49*	1.000
	(0.22)	(*None*)
TWELVEM	1.53*	1.04*
	(0.37)	(0.40)
FORINT	-1.3843*	-0.98
	(0.47)	(0.63)
Trend	-0.03*	-0.03*
	(0.00)	(0.00)
Log Likelihood	239.18	236.76
Chi-Square	None	4.82 [0.028]

The output above shows the maximum likelihood estimates subject to exactly identifying (Panel A) and over identifying (Panel B) restrictions. The 'Panel A' estimates show that all the variables are significant (standard errors are in parenthesis). *Indicates significance at the 5% level or less. All the coefficients have the correct signs. However, the over-identifying restriction on real GDP equal to one is rejected (with a p-value of only 0.028 error while rejecting the null) and as a result we proceed with 'Panel A' for the remainder of the paper.

over-identifying restriction of unity on the coefficient of real GDP but it was rejected by the chi-square statistic (Table 2, Panel B). Hence we proceed with 'Panel A' for the remainder of the paper for the M3 function.

Cointegration, however, cannot tell us the direction of Granger-causality as to which variable is leading and which variable is lagging (i.e., which variable is exogenous and which variable is endogenous). For discerning the endogeneity/exogeneity of the variables we applied the vector error-correction modeling technique (Table 3). Looking at the significance or otherwise of the error-correction coefficients, we find that the M3 variable is endogenous but the foreign interest variable is exogenous. That tends to indicate that the M3 variable responds to the foreign interest variable. The error-correction term in the M3 equation is significant. It implies that the deviation of the

TABLE 3 - *Error Correction Models – Real M3, Real GDP, 12-Month Interest Rate and Foreign Interest Rate*

Dependent Variables	*dLMthree*	*dLGDPCON*	*dTWELVEM*	*dForint*
dLMTHREE(1)	0.38	-0.03	-0.04	0.09
	(0.31)	(0.11)	(0.09)	(0.15)
dLGDPCON(1)	-0.42	0.02	-0.35	0.08
	(0.46)	(0.16)	(0.13)	(0.22)
dTWELVEM(1)	1.56	0.84	-0.13	1.54
	(1.61)	(0.56)	(0.47)	(2.05)
dFORINT(1)	-0.64	-0.21	-0.13	-0.05
	(0.59)	(0.21)	(0.17)	(0.28)
ECM(-1)	-1.20	-0.39	0.17	-0.12
	(0.52)*	(0.18)*	(0.15)	(0.25)
Chi-sq SC(1)	2.71[0.100]	0.66[0.42]	0.05[0.83]	0.14[0.71]
Chi-sq FF(1)	1.63[0.202]	0.04[0.85]	2.40[0.12]	0.03[0.87]
Chi-sq N (2)	0.29[0.87]	0.59[0.74]	0.22[0.90]	0.78[0.68]
Chi-sq Het(1)	0.68[0.41]	0.58[0.45]	0.19[0.66]	0.92[0.34]

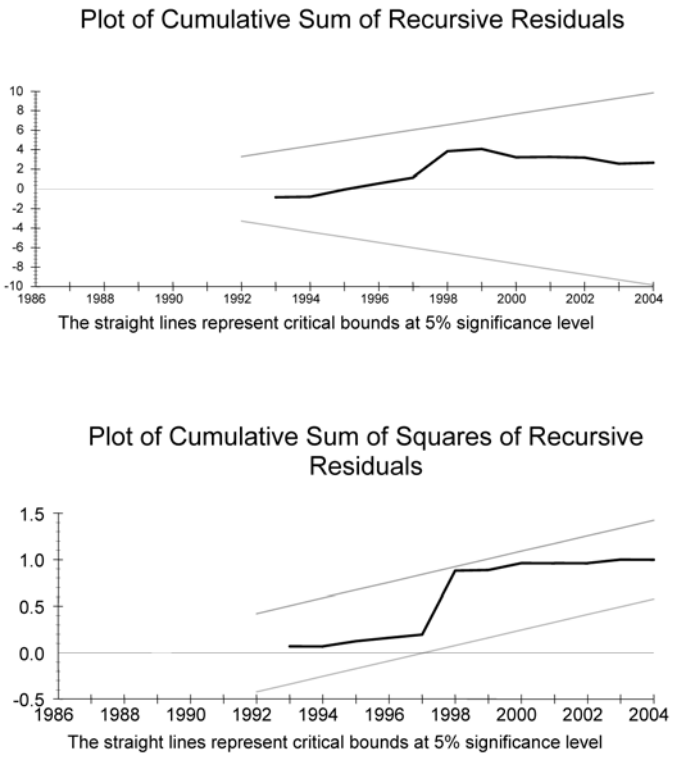
Standard errors re given in parenthesis. *Indicates significance at the 5% level or less. The diagnostics are chi-squared statistics for: serial correlation (SC), functional form (FF), normality (N) and heteroskedasticity (Het) and indicate that the equations are well specified.

variables (represented by the error-correction term) has a significant feedback effect on the M3 variable that bears the burden of short-run adjustment to bring about the long-term equilibrium. The error-correction model also helps us distinguish between the short term and long term Granger-causality. The error-correction term stands for the long-term relations among the variables. The impact

of each variable in the short term is given by the 'F' test of the joint significance or insignificance of the lags of each of the 'differenced' variables.

The diagnostics of all the equations of the error-correction model (testing for the presence of autocorrelation, functional form, normality, and heteroscedasticity) tend to indicate that the equations are well specified. We also checked the stability of the coefficients by the CUSUM and CUSUM SQUARE tests (Figure 1) which indicate that they are stable.

FIGURE 1 - *(LMTHREE)*



Although the error-correction model tends to indicate the endogeneity/exogeneity of a variable, we had to apply the generalized variance decomposition technique (Table 4) to discern the relative degree of endogeneity or exogeneity of the variables. The relative exogeneity or endogeneity of a variable can be determined by the

TABLE 4 - *Generalized Variance Decompositions*

		Percentage of Forecast Variance Explained by Innovations in:			
		ΔLMTHREE	ΔLGDPCON	ΔTWELVEM	ΔFORINT
Years	Relative Variance in ΔLMTHREE				
1		55.42	38.00	4.34	2.24
3		45.36	34.95	3.46	16.23
5		43.47	33.14	2.75	20.64
	Relative Variance in ΔLGDPCON				
1		40.12	46.43	2.79	10.65
3		36.14	49.19	4.31	10.37
5		35.65	50.56	4.61	9.18
	Relative Variance in ΔTWELVEM				
1		24.30	4.69	64.55	6.47
3		39.29	9.52	33.70	17.49
5		41.71	10.03	30.35	17.91
	Relative Variance in ΔFORINT				
1		0.36	10.50	27.93	61.21
3		10.74	6.13	38.89	44.24
5		15.74	4.76	39.38	40.13

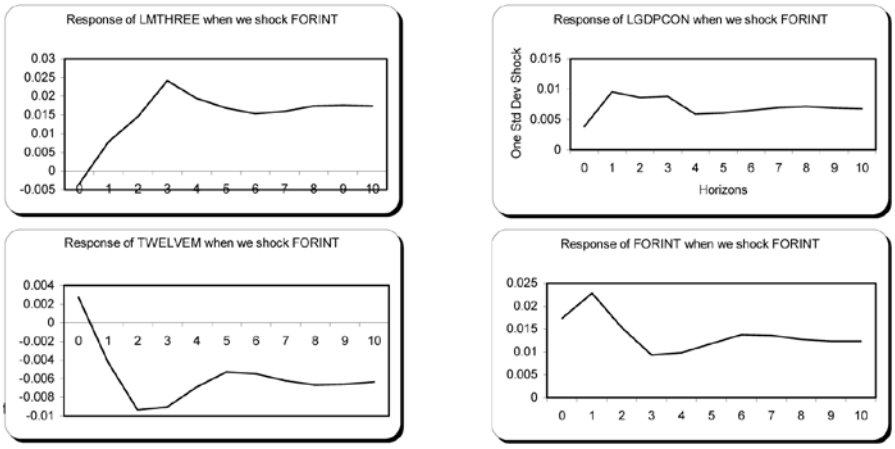
proportion of the variance explained by its own past. The variable that is explained mostly by its own shocks (and not by others) is deemed to be the most exogenous of all. In our table, at the end of the forecast horizon number five, the contributions of different variables towards explaining the forecast error variance of the M3 variable are as follows: own shocks (43%), real GDP variable (33%), foreign interest rate variable (21%), and domestic interest rate variable (3%). The results tend to indicate that the foreign interest rate has a significant role in explaining the forecast error variance of the M3 variable.

We then applied the generalized impulse response functions (Figure 2) and found that the M3 variable does respond well to a one per cent standard deviation shock to the foreign interest variable.

Finally, an application of the persistence profile analysis (Figure 3) indicates that if the whole cointegrating relationship is shocked, it will take about four years for the equilibrium to be restored.

We then estimated the M2 function for the sake of checking the robustness of the results. In the case of M2 function also, we

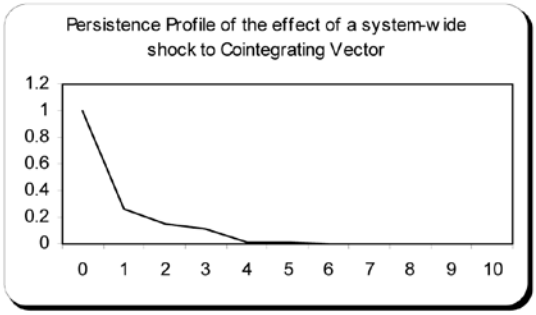
FIGURE 2 - *Generalized Impulse Responses*



The above Generalized Impulse Response functions are generated when we impose a one standard error shock in the equation for FORINT

applied all the above tests with the help of the above techniques (such as, tests for cointegration, long-run structural modeling, vector error-correction, diagnostics, stability of coefficients, generalized variance decompositions, generalized impulse response functions and persistence profiles (tables 5-8) and figures (4-6). The empirical results are mostly similar to those of M3 function. Given our focus on the effects of international factors on the broad demand for money, the major difference between the M3 and M2 functions

FIGURE 3 - *Persistence Profile*



The above graph show the persistence profile from a system wide shock, which indicates that it takes approximately 4 years for the entire system to reach equilibrium.

TABLE 5 - *Johansen ML Results for Multiple Cointegrating Vectors – Real M2, Real GDP, 12-Month Interest Rate and Nominal Effective Exchange Rate (1986-2004)*

H_0	H_1	Statistic	95% Crit	90% Crit
Maximum Eigen value Statistics				
r = 0	r >= 1	38.21	31.79	29.13
r <= 1	r >=2	21.20	25.42	23.10
Trace Statistic				
r = 0	r >= 1	73.09	63.00	59.13
r <= 1	r >=2	34.88	42.34	39.34

The underlying VAR model is of order 2 and is computed using 19 annual observations.

Note: The statistics refer to Johansen's log-likelihood based maximal eigenvalue and trace test statistics based on cointegration with unrestricted intercepts and restricted trends in the VAR. From the above results, we selected 1 cointegrating vector based on the eigenvalue statistics.

TABLE 6 - *Exact and Over Identifying Restrictions on the Cointegrating Vector*

	Panel A	Panel B
LMTWO	1.00	1.000
	(*None*)	(*None*)
LGDPCONS	0.54	1.000
	(0.41)	(*None*)
TWELVEM	1.69*	2.00*
	(0.78)	(0.79)
NOMIEX	-0.82*	-0.74*
	(0.33)	(0.30)
Trend	-0.02*	-0.02*
	(0.00)	(0.00)
Log Likelihood	227.68	2226.96
Chi-Square	None	1.42 [0.233]

The output above shows the maximum likelihood estimates subject to exactly identifying (Panel A) and over identifying (Panel B) restrictions. The 'Panel A' estimates show that the interest rate and nominal effective exchange rate are significant (standard errors are in parenthesis) and have the correct signs. * indicates significance at the 5% level or less. The over-identifying restriction on real GDP equal to one is accepted (with a p-value of 0.233 error while rejecting the null).

is that the foreign interest rate variable was significant in the M3 function, whereas the nominal effective exchange rate variable was

TABLE 7 - *Error Correction Models – Real M2, Real GDP, 12-Month Interest Rate and Nominal Effective Exchange Rate*

Dependent Variables	*dLMtwo*	*dLGDPCON*	*dTWELVEM*	*dNomiex*
dLMTWO(1)	-0.14	-0.28	0.05	-0.33
	(0.18)	(0.09)	(0.08)	(0.13)
dLGDPCON(1)	0.78	-0.02	-0.42	-0.048
	(0.48)	(0.24)	(0.23)	(0.36)
dTWELVEM(1)	-0.04	-0.20	0.13	-0.80
	(0.63)	(0.33)	(0.31)	(0.49)
dNOMIEX(1)	0.19	-0.04	-0.05	0.28
	(0.19)	(0.10)	(0.09)	(0.14)
ECM(-1)	-0.70	-0.05	0.10	0.56
	(0.19)*	(0.10)	(0.09)	(0.14)*
Chi-sq SC(1)	0.01[0.910]	0.65[0.421]	0.00[0.983]	0.14[0.71]
Chi-sq FF(1)	0.000[0.997]	0.36[0.546]	0.86[0.354]	0.03[0.87]
Chi-sq N (2)	0.2.64[0.267]	0.34[0.845]	1.82[0.402]	0.78[0.68]
Chi-sq Het(1)	0.61[0.435]	0.16[0.692]	0.013[0.908]	0.92[0.34]

Standard errors are given in parenthesis. *Indicates significance at the 5% level or less. The diagnostics are chi-squared statistics for: serial correlation (SC), functional form (FF), normality (N) and heteroskedasticity (Het) and indicate that the equations are well specified.

TABLE 8 - *Generalized Variance Decompositions*

		Percentage of Forecast Variance Explained by Innovations in:			
		ΔLMTWO	ΔLGDPCON	ΔTWELVEM	ΔNOMIEX
Years	Relative Variance in ΔLMTWO				
1		63.39	0.43	13.21	22.97
3		42.20	0.59	36.23	20.98
5		36.87	0.98	43.42	18.74
	Relative Variance in ΔLGDPCON				
1		10.66	51.35	5.99	32.00
3		8.01	52.22	3.95	35.83
5		7.82	51.75	3.49	36.94
	Relative Variance in ΔTWELVEM				
1		3.64	7.36	83.77	5.23
3		6.98	9.42	75.13	8.47
5		7.25	10.77	71.99	9.98
	Relative Variance in ΔNOMIEX				
1		23.39	15.45	2.25	58.91
3		36.85	7.52	12.66	42.97
5		40.19	4.88	18.87	36.06

FIGURE 4 - *(LMTWO)*

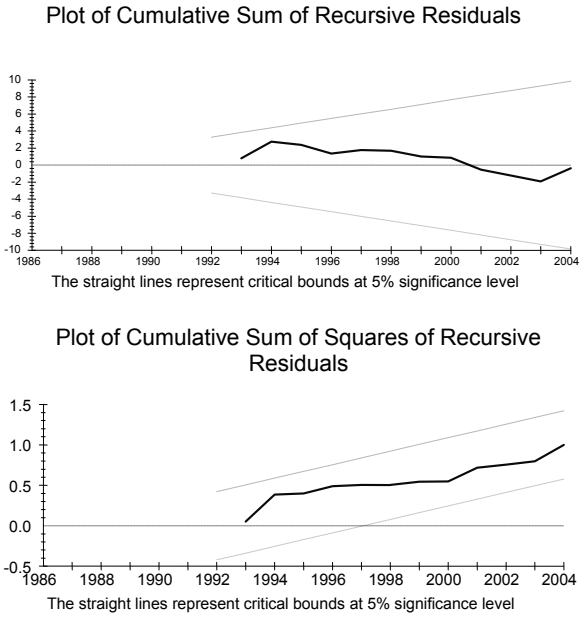
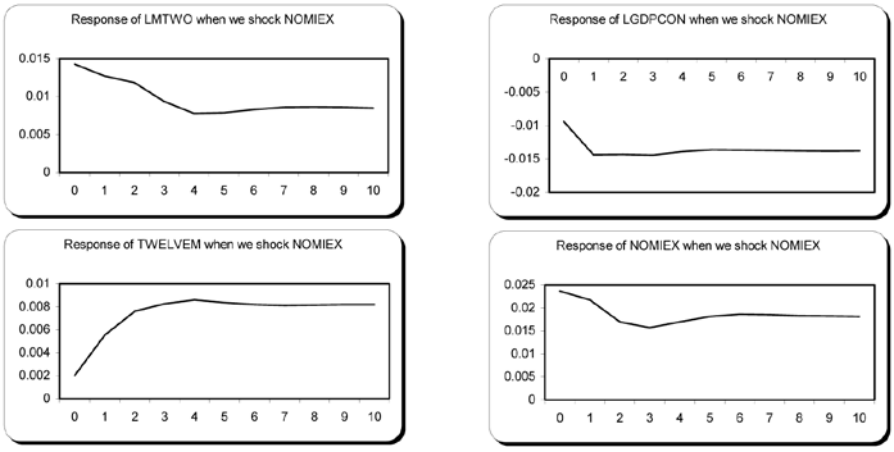
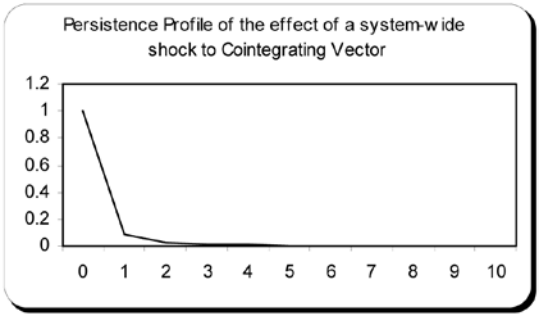


FIGURE 5 - *Generalized Impulse Responses*



The above Generalized Impulse Response functions are generated when we impose a one standard error shock in the equation for NOMIEX

FIGURE 6 - *Persistence Profile*



The above graph shows the persistence profile from a system wide shock. It indicates that it takes approximately 3 years for the entire system to reach equilibrium.

significant in the M2 function. The results are plausible because M3 is composed of M2 and other *quasi* monetary deposits, the bulk of which consists of residents' foreign currency deposits which respond to foreign interest rates. The coefficient of the foreign interest rate variable is significant and negative. That implies that when the foreign interest rate rises, residents would like to substitute foreign assets for domestic assets and the demand to hold domestic money falls. In the M2 function, the coefficient for the nominal effective exchange rate is significant and negative. That implies that when the exchange rate depreciates leading to the expectation of further depreciation, the residents would substitute foreign money for domestic money and the demand to hold domestic money declines.

7. CONCLUSIONS AND POLICY IMPLICATIONS

The effectiveness of monetary policy depends crucially on whether the demand for money function is stable or not. This paper investigates this particular issue in the context of an open economy with free capital movement, such as Saudi Arabia. Using a portfolio balance approach, this study makes an initial attempt to examine the importance of international factors, such as foreign interest rate and nominal effective exchange rate in an effort to capture the effects of capital mobility and/or currency substitution on the stability of long-run money demand function in Saudi Arabia. Unlike other previous studies, this paper applies a recently developed time

series technique called Long-Run Structural Modelling (LRSM) (Pesaran and Shin, 2002). Many conventional cointegrating estimates have a major limitation in that they are atheoretical in nature. By imposing exactly identifying and overidentifying restrictions on the cointegrating vector, the LRSM technique has tried to address that limitation. Moreover, the stability of the functions has also been tested by CUSUM and CUSUMSQ.

Our findings tend to suggest that the foreign interest rate and the nominal effective exchange rate (on top of the real income and domestic interest rate) have significant effects on the stability of the long-run money demand function of M3 and M2 respectively. The results are indicative of the significant effects of capital mobility and /or currency substitution in the broad money demand functions in Saudi Arabia. Since the stability of the 'demand for money' function has a critical place in the formulation of the monetary policy, our findings (based on the portfolio balance theory and the application of a very recent rigorous time series technique known as the 'long run structural modelling'), have strong policy implications in the sense that any failure to take into account these two international factors in the broad money demand functions may result in the functions being unstable thereby leading to a far less effective monetary policy.

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REFERENCES

Akinlo, A.E. (2006), "The Stability of Money Demand in Nigeria: An Autoregressive Distributed Lag Approach", *Journal of Policy Modeling*, 28(4), 445-452.

Arango, S. and M.L. Nadiri (1981), "Demand for Money in Open Economies", *Journal of Monetary Economies,* 7(1), 69-83.

Bahmani-Oskooee, M. and A. Techaratanachai (2001), "Currency Substitution in Thailand", *Journal of Policy Modeling*, 23(2), 141-145.

Chung, J.W. (1983), "Sustainability between Currencies: The Dollar Versus the Mark and the Yen", *Quarterly Review of Economics and Business,* 23(3), 19-28.

Crockett, A.D. and O.J. Evans (1980), "Demand for Money in Middle Eastern Countries", *IMF Staff Papers,* 27(3), 543-577.

Cuddington, J.T. (1983), "Currency Substitutability, Capital Mobility, and Money Demand", *Journal of International Money and Finance*, 2(2), 111-133.

Darrat, A.F. (1984), "The Money Demand Relationship in Saudi Arabia: An Empirical Investigation", *Journal of Economic Studies,* 11(3), 45-50.

Diebold, F. (2004), "The Nobel Memorial Prize for Robert F. Engle", *Scandinavian Journal of Economics*, 106(2), 165-185.

Diebold, F. (2003), "The ET Interview: Professor Robert F. Engle", *Econometric Theory,* 19(6), 1159-1193.

Dornbusch, R. (1976), "Expectations and Exchange Rate Dynamics", *Journal of Political Economy*, 84(6), 1161-1176.

Engle, R.F. and C.W.J. Granger (1987), "Co-integration and Error Correction: Representation, Estimation and Testing", *Econometrica,* 55(2), 251-276.

Friedman, M. (1956), *The Quantity Theory of Money: a Restatement,* in: M. Friedman (Ed.), "Studies in the Quantity Theory of Money", University of Chicago Press: Chicago.

Granger, C. (2003), Time Series Analysis, Cointegration, and Applications (The Nobel Lecture), Stockholm.

Hamburger, M.J. (1977), "The Demand for Money in an Open Economy: Germany and the United Kingdom", *Journal of Monetary Economics,* 3(1), 25-40.

King, R.G., C.I. Plosser, J.H. Stock and M.W. Watson (1991), "Stochastic Trends and Economic Fluctuations", *American Economic Review*, 81(4), 819-840.

Leventakis, J.A. (1993), "Modelling Money Demand in Open Economies Over the Modern Floating Rate Period", *Applied Economics*, 25(8), 1005-1112.

Mankiw, G.N. (1992), "The Reincarnation of Keynesian Economics", NBER Working Paper No. 3885.

McKinnon, R.I. (1982), "Currency Substitution and Instability in the World Dollar Standard", *The American Economic Review,* 72(3), 320-333.

Pesaran, M.H. and Y. Shin (2002), "Long-Run Structural Modelling", *Econometric Reviews*, 21(1), 49-87.

Sargent, T.J. and N. Wallace (1975), "Rational Expectations, the Optimal Monetary Policy Instrument, and Optimal Money Supply", *Journal of Political Economy*, 83(2), 241-254.

Sriram, S.S. (2001), "A Survey of Recent Empirical Money Demand Studies", *IMF Staff Papers*, 47(3), 334-365.

ABSTRACT

Using a portfolio balance approach, this paper makes an initial attempt to examine the importance of international factors, such as foreign interest rate and nominal effective exchange rate, on the stability of long-run money demand function in an open developing economy with free capital movement. Saudi Arabia is taken as a case study over the period (1986-2004). The method applied is the 'Long Run Structural Modelling' (LRSM) (Pesaran and Shin, *Econometric Reviews*, 2002) which has tried to address the *atheoretical* nature of a lot of conventional cointegrating estimates. The stability of the functions has also been tested by CUSUM and CUSUMSQ. Our findings tend to suggest that the foreign interest rate and the nominal effective exchange rate (on top of the real income and domestic interest rate) have significant effects on the stability of the long-run money demand function of M3 and M2, respectively. The results are indicative of the significant effects of capital mobility and/or currency substitution in the broad money demand functions. A clear policy implication is that a failure to incorporate these two international factors in the money demand function may result in the function being unstable and the monetary policy being far less effective.

Keywords: Money Demand, Long Run Structural Modelling
JEL Classification: E41, C32

RIASSUNTO

La domanda di moneta nel lungo periodo: un modello strutturale di lungo periodo per l'Arabia Saudita

Attraverso l'utilizzo del *portfolio balance approach*, questo studio tenta di esaminare l'importanza di fattori internazionali, quali i tassi di interesse esteri e il tasso di cambio nominale effettivo, per la stabilità di lungo periodo della funzione della domanda di moneta, in un'economia aperta e con libera circolazione di capitali. Si considera il caso dell'Arabia Saudita nel periodo 1986-2004. Il metodo applicato è il *Long Run Structural Modelling (LRSM)* (Pesaran e Shin, 2002) che ha cercato di affrontare la natura "ateorica" di molte stime convenzionali cointegrate. La stabilità delle funzioni è stata testata anche dai metodi CUSUM e CUSUMSQ. I risultati ottenuti suggeriscono che il tasso di interesse estero e il tasso di cambio nominale effettivo (oltre al reddito reale e tasso di interesse interno) hanno effetti significativi, nel lungo periodo, sulla stabilità della funzione della domanda di moneta, rispettivamente, di M3 e di M2. I risultati indicano inoltre che vi sono effetti significativi su mobilità dei capitali e/o sulla sostituzione valutaria. Una chiara implicazione dell'analisi svolta è che l'esclusione di questi due fattori internazionali dalla funzione della domanda di moneta può determinare instabilità della funzione stessa e minore efficacia della politica monetaria.