MODELING MONEY DEMAND COMPONENTS IN LEBANON USING AUTOREGRESSIVE MODELS

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ABSTRACT

This paper analyses monetary aggregate in Lebanon and its different components using the methodology of AR model. Thirteen variables in monthly data have been studied for the period January 1990 through December 2005. Using the Augmented Dickey-Fuller (ADF) procedure, twelve variables are integrated at order 1, thus they need the filter $(1-B)$ *to become stationary, however the variable* $X_{13,t}$ *(claims on private sector) becomes stationary with the filter* $(1-B)(1-B^{12})$*. The ex-post forecasts have been calculated for twelve horizons and for one horizon (one-step ahead forecast). The quality of forecasts has been measured using the MAPE criterion for which the forecasts are good because the MAPE values are lower. Finally, a pursuit of this research using the cointegration approach is proposed.*

Keywords: monetary aggregate, autoregressive model, stationarity, forecasting

INTRODUCTION

Money supply in a country is a major concern for the economic and political authorities. Indeed, transactions between individuals and enterprises take place by means of different money forms. Monetary theory suggests that four main factors influence the total demand for money balances: the level of prices , the level of interest rates, real gross national product (GNP) and the pace of financial innovation. In the literature there are many studies which analyze the relationship between money demand and these main factors (Laidler, 1993; Bose & Rahman, 1996; Dreger *et al*., 2006). Total demand for money is obtained by adding the transactions, the precautionary and the speculative demands (Claassen, 1981). The speed of realization of these different transactions reflects the velocity of money circulation. An increase in the level of prices produces an increase in the velocity of money circulation. Therefore the velocity of money circulation deserves a specific analysis of its temporal evolution and of its relationship to interest rates and inflation (Samuelson, 1976). Unfortunately, in Lebanon, monthly, quarterly or yearly statistics that permit an econometric survey between the velocity of money circulation and the factors that depend on it are not available. In Lebanon, there are monthly data concerning the components of different money forms: M_1, M_2, M_3 and M_4 and the Lebanese state hasn't finished yet the construction of the Gross Domestic Product (GDP). For this, the present research focuses only on modeling and forecasting the four money forms and their components. A paper will be published that treats the econometric survey of money demand in Lebanon and particularly the causality analysis between the opportunity cost or rate-of-interest variable and the real money demand (Mourad, 2008). This survey is going to treat the stationarity using the Augmented Dickey-Fuller test (ADF) for every variable. Since generally, the economic and financial variables are not stationary (its variance is infinite, and its values do not tend to lie near its mean value), the Box-Jenkins's approach suggests the study of the behavior of the correlogram that is very useful for revealing patterns that occur over time in economic or financial variables. But the choice of the order of the filter (1-B) is somehow subject to the analyst's subjectivity: thus the interest of the Dickey-Fuller test (1979) and particularly the ADF statistic version. The ADF test permits to choose between a TS (trend stationary) time series and DS (difference stationary) time series. The nature specification of of the TS or DS time series has positive consequences on forecasts quality (Mourad, 2006). For each one of these fifteen variables, the autoregressive technique will be used to study the temporal evolution on the period 1990-2005 (192 monthly observations). This technique is the one mostly used by the analysts of the time series, because, on the one hand, it is simple to put it in practice, and on the other hand, it offers us a forecasting function that is very easy to manipulate. Forecasts quality will be measured by the Mean Absolute Percentage Error (MAPE). This criterion is a good measure of the accuracy of the forecast (Mourad, 2006). It is signalled that in Lebanon, the use of these techniques is nearly rare, except for a very recent article by Mourad (2007) that treats the " Modeling of the budget transactions in Lebanon ". After the validation of every identified and estimated model, forecasts will be done for the year 2005 considering the step by step forecast, ***i.e.*** the forecast at very short term (only one horizon).

The rest of the paper is organised as follows: in the next section, a literature review is presented. The description of data and the basic statistics are presented in the following section. The methodology employed is discussed in the fourth section and estimates for different models in the fifth section. The sixth section contains the prediction results for the short-run horizon , and the goodness of forecasts is investigated. Finally the conclusion is presented, and some recommendations are suggested.

LITERATURE REVIEW

Many publications have treated the subject of money and other factors that are in relation with it. Many of the practitioners propose the following model:

$$\ln\left(\frac{M^d}{P}\right)_t = \alpha_0 + \underset{(+)}{\alpha_1 \ln(Q_t)} + \underset{(\pm)}{\alpha_2 \ln b(ic_t)} + \underset{(-)}{\alpha_3 \ln((id_t)} + \underset{(-)}{\alpha_4 \rho_t^a} + \varepsilon_t$$

ic_t the national creditor interest rates id_t the interest rates on US dollar (Mamadou, 2001). Interest rates represent an opportunity cost indicator. According to the textbook presentations, the income variable Q_t should have a positive effect on holding money. Conversely, if the opportunity cost measures the earnings of alternative assets, its coefficient shall be negative.

The anticipated inflation rate ρ_t^a has a negative effect on money holding. Bose (1996) proposed a model for the money demand in Canada. The purpose of the Bose's paper is to estimate the long-run equilibrium relationship of money demand for the Canadian economy using the technique of cointegration. Hayo (1998) estimated a European money demand function for narrow money (usually M_1) and broad money (usually M_3) for 11 European Monetary Union countries based on quarterly aggregate data. Bahmani & Chi Wing Ng (2002) examined the long-run demand for money in Hong Kong using the autoregressive distributed lag (ARDL) cointegration procedure on quarterly data. Miyao (2003) (see also Bae *et al*. (2004)) studied the liquidity traps in the Japanese economy and he examined the presence and stability of an equilibrium money demand relation. With the double-log specification, a cointegration M_1 relationship exists and is found to be stable (*i.e.* no break in the interest elasticity). Gerlach & Kong (2005) estimated a vector error-correction model (VECM) where the vector contains the variables M_2 , real GDP and the CPI price level (level variables are in logarithms). Qayyum (2005) estimated a dynamic demand for money M_2 function in Pakistan employing cointegration analysis and error correction mechanism. The analysis reveals that interest rates, market rate and bond yield are important for the long-run money demand behaviour. Watanabe & Pham (2005) analysed the demand for money in Vietnam. The results show that the long-run demand for real broad money of domestic currency is determined by real income, domestic interest rate, inflation rate and rate of return of USD deposits, which satisfies the standard properties of the demand for money. They employed cointegration, error correction model, impulse response and variance decomposition and used quarterly data. Miyao (2003) (see also Bae *et al*. (2004)) studied the liquidity traps in the Japanese economy and examined the presence and stability of an equilibrium money demand relation. With the double-log specification, a stable cointegration M_1 relationship exists (*i.e.* no break in the interest elasticity).

To measure money aggregations in Lebanon, the following is used: money M_1 is the sum of coin and currency in circulation outside the banks, plus checkable demand deposits. Money M_2 includes money M_1 plus the saving deposits. Money M_3 contains money M_2 plus the deposits in foreign currencies and bonds. Money M_4 contains M_3 plus the treasury bills held by the non banking system. If all agents decide to liquidate their financial investments and to use their liquids assets in even time, the demand would increase and one would expect a price explosion . Even if such a situation is unlikely, it is understood that it is the necessary for the monetary authorities of a country to control the evolution of the money supply.

DATA DESCRIPTION

In this study, there are fifteen monthly time series for the monetary survey in Lebanon that cover the period 1990-2005 (192 observations). The source of all data is the Quarterly Bulletin of the Banque du Liban. In Table 1, basic statistics for the different variables will be computed.

TABLE 1

Basic Statistics of the Variables

Variables	Description in billions of LBP	Mean	Std Error	Minimum	Maximum
X_{1t}	Currency in Circulation	1039.39	379.18	190.3	1586.46
X_{2t}	Demand deposits in L.L.	746.52	419.48	85.90	1623.5
$X_{3t} = M_{1t}$	$M_{1t} = X_{1t} + X_{2t}$	1785.91	784.07	290.36	3163.44
X_{4t}	Other deposits in L.L.	11555.86	7232.1	656.20	23644.06
$X_{5t} = M_{2t}$	$X_{5t} = M_{1t} + X_{4t}$	13341.77	7994.82	946.56	26722.35
X_{6t}	Deposits in foreign currencies	21532.98	14106.44	1614.99	51260.58
X_{7t}	Bonds	177.45	120.21	7.96	385.06
$X_{8t} = M_{3t}$	$M_{3t} = M_{2t} + X_{6t} + X_{7t}$	34980.11	21732.96	2561.55	74445.98
X_{9t}	Treasury bills held by non banking system	3798.2	2411.9	142.09	7452.9
$X_{10,t} = M_{4t}$	$M_{4t} = M_{3t} + X_{9t}$	38778.31	23619.94	2703.64	77770.97
$X_{11,t}$	Net foreign assets	14347.07	4751.44	3474.61	24311.37
$X_{12,t}$	Net claims on public sector	14510.64	11825.45	622.2	35666.09
$X_{13,t}$	Claims on private sector	14759.25	8566.65	960.8	25492.76
$X_{14,t}$	Valuation adjustment	-3522.05	2153.59	-9056.6	0.0
$X_{15,t}$	Other items (net)	-5114.8	3512.47	-11545.49	-249.19

The variables $X_{14,t}$ (Valuation adjustment) and $X_{15,t}$ (Other items (net)) are negative and they reveal an important variation. These variables fluctuate highly from one time to the other. Thus, it is difficult to identify the best AR model having a forecasting performance. The aggregate monetary M_3 verifies the following:

The aggregate monetary M_3 = Foreign assets(net) + Claims on public sector + Claims on private sector + Valuation adjustment + Other items (net):

$$M_3 = X_{11} + X_{12} + X_{13} + X_{14} + X_{15}$$

Inspection of the graphs of some variables reveals that the arrival of martyr Hariri to the Prime minister's post in November 1992 have remarkably affected the annual growth of variables X_{1t} ($\cong$ 17 %), X_{2t} ($\cong$ 144 %), M_{1t} ($\cong$ 51 %), X_{4t} ($\cong$ 98 %), M_{2t} ($\cong$ 80 %), X_{6t} ($\cong$ 33 %).

AUTOREGRESSIVE INTEGRATED MODEL

In this section, the Autoregressive Integrated model (ARI) will be used to analyze the financial time series. In fact the ARI models are considered as members of the class of ARIMA models popularized by Box & Jenkins (1976). A big number of practitioners has used this type of models in different economic and financial domains. Consider now the path-order autoregressive model denoted AR(p) of the time series X_t :

$$X_t = \varphi_0 + \varphi_1 X_{t-1} + \ldots + \varphi_p X_{t-p} + \varepsilon_t \qquad (1)$$

The coefficients $\varphi_1, \ldots \varphi_p$ being the autoregressive coefficients for X_t on $X_{t-1}, \ldots, X_{t-p}$ with φ_0 denoting the constant term. If $\varphi_0 = 0$ then the process X_t is centered. The error term ε_t is a white noise. The stationarity conditions for the AR(p) model follow from the requirement that the roots of the auxiliary equation $\varphi(B) = 1 - \varphi_1 B - \ldots - \varphi_p B^p = 0$ should be greater than one in absolute value. If any root is ≤ 1 in absolute value, the process is non-stationary. Differencing and transformations may be used to induce stationarity. If the process is differentiated only one time, the process is called integrated at order 1 and is denoted I (1). According to the Box-Jenkins method, an AR(p) process is described by[1] an ACF that is infinite in extent and is a combination of damped exponentials and damped sine waves, and a PACF that is zero for lags larger than p. The sample partial autocorrelation function SPACF is usually calculated by fitting autoregressive models of increasing order. The estimate of the last coefficient in each model is the sample partial autocorrelation $\hat{\varphi}_{kk}$. If the data follow an AR(p) process, then for lags greater than p the variance of $\hat{\varphi}_{kk}$ is approximately T^{-1}, so that $\sqrt{T}\ \hat{\varphi}_{kk} \approx N(0,1)$. Thus the partial autocorrelations for lags larger than the order of the process are zero.

A number of information criteria have been proposed for allowing the data to determine the length of a distributed lag . The two most commonly used are the Akaike Information Criterion (AIC) (Akaike 1974)) and the Schwarz Bayesian Criterion (SBC) (Schwarz, 1978). There are a number of equivalent forms of these, the ones that will be used are:

$$AIC(p) = \log\left(\frac{RSS}{NOBS}\right) + \frac{2(p+1)}{NOBS}$$

$$SBC(p) = \log\left(\frac{RSS}{NOBS}\right) + \frac{\log(T)(p+1)}{NOBS}$$

RSS is the residual sum of squares, p is the order of AR model, and NOBS is the usable observations[2]. In this case, the proposition of this criteria is looked upon taking into

[1] See Mills (1999), p. 24.

[2] For a comparative survey of these two criteria and other criteria (Mourad & Keller, 1987; Mourad, 2006).

consideration the Ljung-Box Q statistic for several levels of the degrees of freedom. Under appropriate circumstances, for a null hypothesis of no serial correlation, Q is asymptotically distributed (see Table 1).

Non-stationary process

A non-constant mean level in equation (1) can be modelled in a variety of ways. One possibility is that the mean evolves as a polynomial of order d in times. This will arise if X_t can be decomposed into a trend component, given by the polynomial, and a stochastic, stationary, but possibly autocorrelated, zero mean error component. Thus, for AR(1) model as example, there could be:

$$X_t = \beta_0 + \beta_1 t + \varphi_1 X_{t-1} + \varepsilon_t \tag{2}$$

It is proven that :

$$E(X_t) = \mu_t = \frac{(\beta_0 + \beta_1 t)(1-\varphi_1) - \beta_1\varphi_1}{(1-\varphi_1)^2} \tag{3}$$

As the β_0, β_1 coefficients remain constant through time, such a trend in the mean is said to be deterministic. Trends of this type can be removed by a simple transformation. Lagging one period and subtracting the equation (2) yields:

$$X_t - X_{t-1} = \beta_1 + \varphi_1(X_{t-1} - X_{t-2}) + \varepsilon_t - \varepsilon_{t-1} \tag{4}$$

Using $\Delta = 1 - B$ known as the first difference operator, it is obtained:

$$\Delta X_t = \beta_1 + \varphi_1 \Delta X_{t-1} + \Delta\varepsilon_t \tag{5}$$

And ΔX_t is thus generated by a stationary but not invertible ARMA(1,1) process:

$$E(\Delta X_t) = \frac{\beta_1}{1-\varphi_1} = \text{CONSTANT} \quad .$$

In general, if the trend polynomial is of order d, and X_t is characterized by AR (p) process:

$$\begin{aligned} X_t &= \sum_{j=0}^{d} \beta_j t^j + \varphi_1 X_{t-1} + \ldots + \varphi_p X_{t-p} + \varepsilon_t \\ &= \sum_{j=0}^{d} \beta_j t^j + \varphi(B) X_t + \varepsilon_t \end{aligned} \tag{6}$$

Then $\Delta^d X_t = (1-B)^d X_t$ obtained by differencing d times the process X_t , will follow the process (Mills, 1999):

$$\Delta^d X_t = d!\beta_d + \frac{\Delta^d \varepsilon_t}{\varphi(B)} \qquad (7)$$

The model $\varphi(B)\Delta^d X_t = \varphi_0 + \varepsilon_t$ where ε_t is a white noise, is said to be an autoregressive-integrated process of order p and or ARI(p,d) and X_t is said to be integrated of order d, denoted I(d).

Consider now a DS process (difference stationary):

$X_t - X_{t-1} = \theta + \varepsilon_t$. X_t is said to follow a random walk with drift.

$$X_t = X_0 + \theta t + \sum_{i=0}^{t-1} \varepsilon_{t-i}$$

$$\begin{aligned} &E(X_t) = X_0 + \theta t \\ &V(X_t) = t\sigma^2 \\ &\mathrm{Cov}(X_t, X_{t-k}) = (t-k)\sigma^2, k \geq 0 \\ &\mathrm{Corr}(X_t, X_{t-k}) = \rho_k = \sqrt{\frac{t-k}{t}} \end{aligned} \qquad (8)$$

If t is large compared to k, all ρ_k will be approximately unity. The sequence of X_t values will therefore be very smooth, but will also be non-stationary since both its mean and variance will increase with t. The random walk is an example of a class of non-stationary processes known as integrated processes.

Augmented Dickey-Fuller (ADF) test

A non-stationary time series usually appears to have different mean values at different periods of time. Unfortunately, time paths examination can often be inconclusive and even misleading, so more objective procedures and tests are necessary. Econometricians have therefore spent much time in recent years devising formal statistical tests for stationarity.

In the following, the study is limited to the Augmented Dickey-Fuller (ADF) test. To illustrate this approach, the process is as follows:

$$\Delta X_t = \alpha + \beta t + \varphi X_{t-1} + \varphi_1 \Delta X_{t-1} + \varphi_2 \Delta X_{t-2} + \ldots + \varphi_{p-1} \Delta X_{t-p+1} + \varepsilon_t \quad \mathrm{ADF}(1)$$

$$\Delta X_t = \alpha + \varphi X_{t-1} + \varphi_1 \Delta X_{t-1} + \varphi_2 \Delta X_{t-2} + \ldots + \varphi_{p-1} \Delta X_{t-p+1} + \varepsilon_t \quad \mathrm{ADF}(2)$$

$$\Delta X_t = \varphi X_{t-1} + \varphi_1 \Delta X_{t-1} + \varphi_2 \Delta X_{t-2} + \ldots + \varphi_{p-1} \Delta X_{t-p+1} + \varepsilon_t \quad \mathrm{ADF}(3)$$

Testing the stationarity for the pth-order AR process is equivalent to testing whether or not $\varphi = 0$ in ADF(i), i=1,2,3. The null hypothesis of non-stationarity becomes $H_0 : \varphi = 0$, which can be tested against an alternative hypothesis $H_a : \varphi \prec 0$. Thus, if H_0 can be rejected in favour of H_a then this implies a stationary process. Practically, the OLS method is applied to ADF(i) and the t ratio is examined on the estimate $\hat{\varphi}$. If this is sufficiently negative compared to the critical values proposed by Dickey & Fuller (1979) then H_0 is rejected in favour of stationarity. Finally, it is noticed that Dolado *et al*. (1990) have proposed a strategy for testing for unit roots. In Table (2), The outcome of the ADF statistic for the the monetary aggregates and its components is reported. The inspection of this table shows clearly that all variables in level reveal non- stationarity, but the ADF statistics for the variables in first differences suggest stationarity.

Notes: Δ is the first difference operator. One asterisk indicates a rejection of the Null at the 5 % significance level. The critical values are taken from Dickey & Fuller (1979). In brackets [C,T,p,Q], C is constant, T is the linear trend, p is the AR order model for the variable in level, Q is the empirical value of the Q-statistic. For 36 degrees of freedom and 5 % significance level, $\chi^2_{0.05;36} = 50.7$. For a 250 sample size and 5 % significance level, $\tau_\tau = -3.43$ (Deterministic part contains a constant and a linear trend), $\tau_\mu = -2.88$ (Deterministic part contains a constant), and $\tau = -1.95$ (Deterministic part doesn't contain constant nor trend).

THE ESTIMATED AUTOREGRESSIVE MODELS

In this section, the results of the ADF statistics are taken into account, and the behavior of the ACF and PACF of the variables. In the following, the AR models are going to be estimated using the software RATS version 6.2 (ISAE-Beirut). For not having models overloaded in parameters, the OLS method is going to be applied to estimate the parameters of every AR model and only those that are not significantly different from zero are maintained, provided that the estimated model is accepted by the Ljung-Box statistic.

Variable X_{1t} : currency in circulation

$$\begin{aligned}
\hat{X}_t = {} & \underset{(2.4)}{8.32} \underset{(-4.3)}{- 0.31X_{t-1}} \underset{(-1.6)}{- 0.11X_{t-2}} \underset{(1.7)}{+ 0.13X_{t-6}} \underset{(-3.2)}{- 0.24X_{t-11}} \underset{(2.5)}{+ 0.2X_{t-12}} \underset{(-2.2)}{- 0.18X_{t-18}} \\
& \underset{(-2.6)}{- 0.18X_{t-19}} \underset{(2.1)}{+ 0.13X_{t-21}} \underset{(1.5)}{+ 0.12X_{t-23}} \underset{(3.6)}{+ 0.28X_{t-24}} \underset{(-2.4)}{- 0.17X_{t-29}} \underset{(-2.0)}{- 0.17X_{t-30}}
\end{aligned}$$

$\hat{\sigma} = 37 \quad Q(48) = 61.5$

TABLE 2

Variables and Unit Root Tests

Variables	ADF-Value	First differences	ADF-Value
X_{1t}	-2.02 [C,T,31;31]	ΔX_{1t}	-2.04* [29]
X_{2t}	-2.23 [C,T,13;20]	ΔX_{2t}	-4.88* [C,11]
$X_{3t} = M_{1t}$	-2.58 [C,T,13;23]	ΔM_{1t}	-4.21* [C,11]
X_{4t}	-2.98 [C,T,6;37]	ΔX_{4t}	-5.05* [C,4]
$X_{5t} = M_{2t}$	-3.02 [C,T,6;35]	ΔM_{2t}	-5.03* [C,4]
X_{6t}	-1.61 [C,T,15;39]	ΔX_{6t}	-3.69* [C,13]
X_{7t}	-2.0 [C,T,14;27]	ΔX_{7t}	-2.75* [12]
$X_{8t} = M_{3t}$	-2.49 [C,T,15;41]	ΔM_{3t}	-3.94* [C,13]
X_{9t}	-0.14 [C,T,6;42]	ΔX_{9t}	-4.46* [4]
$X_{10,t} = M_{4t}$	-2.03 [C,T,15;26]	ΔM_{4t}	-4.1* [C,13]
$X_{11,t}$	-2.11 [C,T,7;40]	$\Delta X_{11,t}$	-4.65* [C,5]
$X_{12,t}$	-2.42 [C,T,7;42]	$\Delta X_{12,t}$	-4.04* [C,5]
$X_{13,t}$	-2.56 [C,T,13;41]	$\Delta X_{13,t}$	-6.82* [11]
$X_{14,t}$	-2.31 [C,T,8;26]	$\Delta X_{14,t}$	-6.06* [6]
$X_{15,t}$	-2.62 [C,T,11;30]	$\Delta X_{15,t}$	-4.16* [C,9]

Variable X_{2t} : demand deposits in L.L.

$$\hat{x}_t = 14.54 - 0.36X_{t-1} - 0.20X_{t-2} - 0.13X_{t-6} - 0.14X_{t-7} - 0.12X_{t-11}$$
$$(3.1) \quad (-4.9) \quad (-2.7) \quad (-1.8) \quad (-1.9) \quad (-1.6)$$
$$\hat{\sigma} = 60 \qquad Q(48) = 38.2$$

Variable X_{3t} : The aggregate monetary M_1

$$\hat{x}_t = 16.3 - 0.25\,X_{t-1} - 0.12\,X_{t-2} + 0.19\,X_{t-12}$$
$$(2.7) \quad (-3.3) \quad (-1.6) \quad (2.4)$$
$$\hat{\sigma} = 76 \qquad Q(48) = 42.1$$

Variable X_{4t} : Other deposits in L.L.

$$\hat{x}_t = 69.65 + 0.55\,X_{t-1} - 0.30\,X_{t-2} + 0.13\,X_{t-4}$$
$$(1.81) \quad (7.91) \quad (-4.36) \quad (2.05)$$
$$\hat{\sigma} = 503 \qquad Q(48) = 57.03$$

Variable X_{5t} : The aggregate monetary M_2

$$\hat{x}_t = 82.69 + 0.52\,X_{t-1} - 0.28\,X_{t-2} + 0.11\,X_{t-4}$$
$$(2.0) \quad (7.4) \quad (-4.0) \quad (1.7)$$
$$\hat{\sigma} = 540 \qquad Q(48) = 55.2$$

Variable X_{6t} : Deposits in foreign currencies

$$\hat{x}_t = 19269 + 0.32X_{t-1} - 0.19X_{t-2} + 0.19X_{t-4} - 0.13X_{t-8} + 0.13X_{t-9} + 0.19X_{t-12} - 0.24X_{t-13}$$
$$(3.1) \quad (4.4) \quad (-2.7) \quad (2.7) \quad (-1.7) \quad (1.7) \quad (2.0) \quad (-2.6)$$
$$\hat{\sigma} = 560 \qquad Q(48) = 56.7$$

Variable X_{7t} : Bonds

$$\hat{x}_t = 0.13\,X_{t-10} - 0.19\,X_{t-12}$$
$$(1.5) \quad (-2.2)$$
$$\hat{\sigma} = 30 \qquad Q(48) = 59.0$$

Variable X_{8t} : The aggregate monetary M_3

$$\hat{x}_t = 362 + 0.24\,X_{t-1} - 0.09\,X_{t-3} + 0.1X_{t-5} - 0.09\,X_{t-7} - 0.11\,X_{t-10} - 0.15\,X_{t-11}$$
$$(4.7) \quad (3.2) \quad (-1.3) \quad (1.4) \quad (-1.3) \quad (-1.5) \quad (-1.9)$$
$$+ 0.35\,X_{t-12} - 0.17\,X_{t-13}$$
$$(4.6) \quad (-2.2)$$
$$\hat{\sigma} = 398 \qquad Q(48) = 62.5$$

Variable X_{9t} : Treasury bills held by non banking system

$$\hat{x}_t = 0.19\,X_{t-1} + 0.14\,X_{t-2} + 0.11\,X_{t-4}$$
$$(2.6) \qquad (1.9) \qquad (1.5)$$
$$\hat{\sigma} = 175 \qquad Q(36) = 44$$

Variable $X_{10,t}$: The aggregate monetary M_4

$$\hat{x}_t = 354.5 + 0.26X_{t-1} - 0.11X_{t-3} + 0.13X_{t-5} - 0.13X_{t-10} - 0.15X_{t-11} + 0.33X_{t-12} - 0.19X_{t-13}$$
$$(4.6) \quad (3.5) \quad (-1.6) \quad (1.8) \quad (-1.8) \quad (-2.1) \quad (4.4) \quad (-2.4)$$

$$\hat{\sigma} = 411 \qquad Q(36) = 39$$

Variable $X_{11,t}$: Net foreign assets

$$\hat{x}_t = 79.3 + 0.24X_{t-1} + 0.22X_{t-5} - 0.16\,X_{t-6}$$
$$(1.8) \quad (3.3) \quad (3.0) \quad (-2.1)$$
$$\hat{\sigma} = 578 \qquad Q(36) = 44$$

Variable $X_{12,t}$: Net claims on public sector

$$\hat{x}_t = 116.4 - 0.12\,X_{t-1} + 0.15\,X_{t-2} + 0.19\,X_{t-3} + 0.17\,X_{t-6}$$
$$(2.9) \quad (-1.7) \quad (2.1) \quad (2.5) \quad (2.4)$$
$$\hat{\sigma} = 422 \qquad Q(48) = 41$$

Variable $X_{13,t}$: Claims on private sector ($X_t = (1-B)\left(1-B^{12}\right)X_{13,t}$

$$\hat{x}_t = 0.25X_{t-1} + 0.15X_{t-4} - 0.14X_{t-6} - 0.14\,X_{t-7} - 0.4X_{t-12}$$
$$(3.8) \quad (2.4) \quad (-2.2) \quad (-2.1) \quad (-6.0)$$
$$\hat{\sigma} = 214 \qquad Q(36) = 41$$

ACCURACY OF THE FORECAST

Many applications of financial analysis require anticipating events before they happen. Schmidt (2005) proposes the following definition: " Forecasting is the use of econometrics to calculate predicted values of economic variables". Therefore the calculation of forecasts was always a main object for the economic series. Forecast and especially forecast with a minimum error requires the following (Mourad, 2007):

1- Knowing the reason of the non stationarity of the economic time series
2- Detecting the nature of seasonality: deterministic or stochastic
3- Distinguishing between seasonal integration of certain frequency and all seasonal frequencies, *etc*...

TABLE 3

Accuracy of Forecasts

Variable	MAPE 12 horizons	MAPE 1 horizon
X_{1t}	8.8	2.4
X_{2t}	7.2	5.5
X_{3t}	8.0	2.6
X_{4t}	23.7	7.7
$X_{5,t}$	21.5	6.9
$X_{6,t}$	3.0	2.3
$X_{7,t}$	4.6*	2.4
$X_{8,t}$	3.6	0.7
$X_{9,t}$	5.2	1.7
$X_{10,t}$	3.9	0.7
$X_{11,t}$	7.5	2.7
$X_{12,t}$	2.7	0.9
$X_{13,t}$	0.7	0.8

Forecasts calculated for eleven points: from January to November 2005.The observed value of December 2005 falls strongly.

Let's designate by P_t the forecasted value and A_t the real value of a time series . If $P_t = A_t$ then the forecastings are perfectly exact and the linear correlation coefficient between P_t and A_t is equal to 1 (t = 1,2,..., H; H = sample size of forecastings). However this case is unrealistic because in all modelling, there are errors due to the uncertain factors not explained by the proposed model, and other errors due to a fast decision when the statistical test behaviors are impertinent . To examine the accuracy of the forecastings, the behavior of the P_t and A_t sequences are going to be analyzed using the MAPE criterion (Mean Absolute Percentage Error) : $MAPE = \frac{1}{H}\sum_{i=1}^{H} APE_i \times 100$

with $APE_i = \frac{|A_i - P_i|}{A_i}$ (Absolute Percentage error). This is a good measure of the accuracy of the forecast.

To measure the forecasting performance of these models, first, the date for the period January 1990 through December 2005 is used to estimate these AR models, and the out-of-sample forecasts for the time periods January 2005 through December 2005 (12 horizons) are calculated, for which the actual values of the time series are known. The forecasts generated for the period January 2005 through December 2005 are known as ex-post forecasts. Because the data for the ex-post forecast period have not been used to obtain the estimates of the parameters, ex-post forecasts provide a true test of the model's forecasting ability. Secondly, a one-step ahead forecast (only one horizon) was done, for which the model is reestimated 12 times to forecast the year 2005 month per month. The results of accuracy of forecasts are given by Table 3. The comparison of forecast performance between forecasts for twelve horizons and forecasts for one horizon is in favour of the one-step ahead forecast: The MAPE was no more than 7.7 percent. In general, the forecast is good. The MAPE values vary between 0.7 percent and 7.7 percent for one horizon, and between 0.7 percent 8.8 percent for twelve horizons, exception for X_{4t} and X_{5t}, for which the MAPE are respectively 23.7 percent and 21.5 percent.

CONCLUSION

In this paper, the monthly evolution on the period 1990-2005 for fifteen variables that concern the different forms of aggregate monetary (M_1, M_2, M_3 and M_4) were studied with their different components. This research deserves to be appreciated because of its novelty and its importance for the Lebanese political authorities. The autoregressive technical method (AR model) has revealed a good adaptation with the set of the variables. The stationary analysis according to the Augmented Dickey-Fuller procedure have suggested to take the series in first differences (Series I(1), *i.e*. integrated at order 1). The obtained AR models were used in forecastble objective. This stain is judged to be primordial for all work of scheduling in Lebanon. Forecasts quality has been measured using the MAPE criterion. The weak values of MAPE allow us to propose these models as informants of forecasting for the monetary survey in Lebanon.

Future research focuses on modeling and forecasting two groups of variables: the first group contains the nominal aggregate monetary M_3 in Lebanon, the spread between the nominal rate at 3 months and the own rate of M_3 (variable STOWN) and the spread between the nominal rate at 24 months and the own rate of M_3 (variable LTOWN[3]). The second group contains the real money demand in logarithm, the consumer price index (base 100=December 1999)[4] and the opportunity cost or rate-of-interest variable. The monthly data covers the period from January 2000 through May 2008 (101 observations). This data shall be used to model the money demand M_3 and the real money demand m_3. Monetary theory suggests that

[3] See the developed research proposed by Calza, Gerdesmeier & Levy (2001).
[4] The monthly consumer price index in Lebanon (base 100 = December 1999). The basket includes over than 600 items.

the real money demand depends on a "scale variable " such as the GDP and an opportunity cost or rate-of-interest variable R_t (Thomas, 1997). For the opportunity cost variable, the equation $R_t = 1 + I_t / 100$ can be used where I_t is the interest rate in percentage terms (here I_t is Average Rate on Deposits in LBP : ARD_t). Thus the possible long–run relationship $ln(m_{it}) = \beta_0 + \beta_1 ln(R_t) + u_t, i = 2,3$ is going to be studied. If these static regressions are validated by testing for cointegration regression suggested by Engle-Granger procedure then the vector error correction model (VECM) will be constructed to generate forecasts. If the null hypothesis of cointegration regression is rejected then the unrestricted vector autoregression (VAR) model will be used to generate forecasts.

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