Models to forecast inflation in Albania

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Abstract— The main purpose of this paper is modeling and forecasting the inflation in Albania using ARIMA and VAR econometric models. In this study, we are mainly based on the consumer price index(CPI), as the main indicator of inflation in the money supply(M2) and interest rates(lending rates).The analysis will be preceded by a brief review of international literature on the development of various models in time, mostly ARIMA and VAR models.In our study we obtained data of 17 years period about CPI, M2 and interest rates. Examining the performance of the predictive ability of the models we built respectively two econometric models for concluding about the impact of these variables on inflation. Results gained by this analysis indicate a significant relation between CPI, M2, interest rates and a statistically significant autoregressive relation to the CPI with time delay. Also worth pointing out that although the study focuses on the problem of macroeconomic forecasting, empirical results have a more general application for models in macroeconomic smaller scale.

Jel Code: E27 P24

Index Terms— Modeling and forecasting inflation, ARIMA, VAR.

1 PREFACE

In a market economy, the consumer price index traditionally named as the cost of living is the most useful measure of inflation. It measures changes in time of the prices of a fixed list of goods and services that a family usually consumes. The list, called basket deliberately kept constant to maintain a constant level of given living. This ensures that changes in the index come only as a result of price changes rather than other factors.

The consumer price index is widely used as a general indicator of inflation and as a tool for authorities to track price performance.It also provides a detailed picture of price changes for specific groups of goods and services and can help to show areas where supply factors can contribute to inflation. Also the consumer price index and its components are used by economists as deviations to develop national accounts at constant prices. Combined with the index of producer price and import it helps in determining the movement of prices in different markets. It is also used as a factor in determining the business, payroll, license fees, interest, insurance premiums and in judicial decisions (Sinaj, 2006).

For many reasons, the statistical data during the years 1990-1993 were very weak due to the inability of authorities to monitor, measure and publish the mainmacroeconomic statistical categories, low level of coverage of the private sector of economy, to numerous delays in the preparation and publication etc.

The first serious attempts to install and put into use a contemporary system ofmacroeconomic statistics in Albania dating back to the end of 1992. With the support and help of the Statistics Department of FMN, for the first time were thought and then presented statistics data such as balance of payments, monetary and banking statistics, consumer price index, etc.. From that time onwards, despite numerous fluctuations that Albania passed during the transition period, the general overall process of compiling statistical data in general has made progress.

In September 1996, data about money and statistics of banking system published by the Bank of Albania would be considered complete, reliable and accurate data to be included on the Bank of Albania Financial Statistics page (Cani & Kolasi, 2003).

CPI is an important indicator for the economy that is why our objective is to analyze its series to capture trends over time.

2 LITERATURE REVIEW

Detailed Hafer and Hein (1985) compared the accuracy of three different models for forecast inflation.The data presented were based on four monthly forecasts of inflation rates using the GNP deflator for the period 1970-1984. According to Hafer and Hein (1990), inflation forecasts derived from short-term interest rates are as accurate as predictions based on time series. Using monthly deposit rates and the consumer price index (CPI) for the period 1967-1986, their findings showed that inflation forecasts based on time series have the same or lower forecasting errors than predictions based rates interest. Quah and Vahey (1995) argued that the index of retail prices (RPI) measured was incorrectly replaced with core inflation, but the difference was more than a measurement error. They proposed a technique for measuring core inflation based on the

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long-term economic hypothesis. They created a measure of core inflation by placing dynamic restrictions on the auto-regressive model (VAR). Baillie and others (1996) took into account the application of long memorization processes to describe inflation for 10 countries. They implemented a new procedure to get a rough estimate of the maximum ARFIMA-GARCH model, which was integrated into fractionally I(d) with a superimposed components, stationary ARMA. Also this process was allowed to have heteroskedasticity of conditional GARCH type. Analyzing the monthly CPI data after the Second World War for ten countries, they found that in all countries except Japan, model inflation was not stationary. Bidarkota and McCulloch (1998) argued that monthly inflation in the U.S. showed aberration in the form of large shocks or changesof market in the level of the series. Hahn (2003) investigated the occurrence of shocks, such as oil prices, exchange rates and commodity prices of non-oil imports, seeing inflation in various stages of distribution (import prices, producer prices and consumer). The analysis was based on VAR model, which includes the distribution chain price.According to the results the speed and size of the occurrence of these shocks was falling along the distribution chain.External shocks explained a large part of the variance of all price indices.They seem to have greatly contributed to inflation in the euro area since the start of European monetary union.

3 METHODOLOGY

3.1 Data

Key variables of this study are: the consumer price index (CPI), money supply (M2) and the borrowing interest rate (lending rates). In connection with these variables are collecting data from the World Bank for 17 years, respectively, for the years 1995-2011.

3.2 Used Model

- **ARIMA model**

In an effort to determine the inflation forecasting model in Albania, this paper uses theARIMA model (Autoregressive Integrated Moving Average) and VAR (Autoregressive Vector) to achieve the objectives set. In identifying the ARIMA model, the study adopts Box-Jenkins methodology. The selection criteria of ARIMA model are used to determine the optimal lag and evaluation of the model. As noted by the Valle (2002), the goal of ARIMA models is for forecasting inflation and providing a reference point for other predictive models due to the comprehensiveness and flexibility, so we estimate an ARIMA model as a base model.The general form of the ARIMA (p, 1, q) model is:

$$\Delta cpi = a_0 + \sum_{t=1}^{p} \alpha_p * cpi_{t-p} + u_t + \sum_{t=1}^{q} \theta_q * u_{t-q}$$

ARIMA model estimated for the series of CPI is ARIMA model (3, 1, 3)[1].

Dependent Variable: d(CPI)

Variable	Coefficient	Prob.
C	111.6360	0.0000
AR(1)	0.601639	0.0107
AR(2)	-0.603403	0.0015
AR(3)	0.600924	0.0187
MA(1)	0.741253	0.0128
MA(2)	0.976578	0.0027
MA(3)	-0.030425	0.0043

R-squared	0.948898	Mean dependent var	99.67054
Adjusted R-squared	0.905096	S.D. dependent var	11.37035
S.E. of regression	3.502813	Akaike info criterion	5.651862
Sum squared resid	85.88788	Schwarz criterion	5.971391
Log likelihood	-32.56304	Hannan-Quinn criter.	5.622284
F-statistic	21.66335	Durbin-Watson stat	1.839917
Prob(F-statistic)	0.000344		

The model is important and can be used to forecast the CPI by accepting a certain level of error.

- **VAR(p) models**

VAR models were introduced in the early 80 ', in response to criticism of "structured models" based on simultaneous systems (SES). Economic and financial variables are often not only auto correlated but alsocross correlated because of various delays. In the analysis of time series with many variables is used vector autoregressive model or VAR model, whose use was proposed by Sims in 1980. VAR models are very much used for the analysis of causality. In general, in the empirical analysis of economic data, cause-effect relationship is very difficult to determine. If we consider two variables x and y and see that these variables show a high correlation then we can say that they have an apparent tendency to move together, but in the absence of more information, cannot add more about the direction of causality.

A modelis an autoregressive vector whetherin it each variable is expressed by itself and other variables with the same number of delays, which are usually marked with p. The number of variables used determines the dimension of the VAR.

A VAR model (p) k-dimensional is presented in its general form by the following system:

$$\begin{cases} Z_{1,t} = \sum_{i=1}^{p} \alpha_{1i} Z_{1,t-i} + \sum_{i=1}^{p} \alpha_{2i} Z_{2,t-i} + \ldots \sum_{i=1}^{p} \alpha_{ki} Z_{k,t-i} + \varepsilon_{1,t} \\ Z_{2,t} = \sum_{i=1}^{p} \beta_{1i} Z_{1,t-i} + \sum_{i=1}^{p} \beta_{2i} Z_{2,t-i} + \ldots \sum_{i=1}^{p} \beta_{ki} Z_{k,t-i} + \varepsilon_{2,t} \\ \ldots\ldots \\ Z_{k,t} = \sum_{i=1}^{p} \gamma_{1i} Z_{1,t-i} + \sum_{i=1}^{p} \gamma_{2i} Z_{2,t-i} + \ldots \sum_{i=1}^{p} \gamma_{ki} Z_{k,t-i} + \varepsilon_{k,t} \end{cases}$$

[1]For more see the CPI Sinaj 2009 Models

In each equation of the VAR are included residuals which should have a normal distribution.If we mark with Ethe vector of VAR residuals then the vector E must have k dimensional normal distribution.

Through VAR models we try to discover whether there is a stable causal relationship between consumer price index, money supply and interest rates. The results have implications for policy makers and researchers by highlighting the scale to which theory agrees with reality during the study period. VAR model has proven successful in predicting short-term values of economic variables (Watson, 1994). In a VAR model the length of the lag is selected using Akaike and Schwarz criteria. To prove stationarity is used the root unit test, Augmented Dickey-Fuller (ADF) and for correlation is used Durbin-Watson (DW).

To build a VAR model in this study will use three time series:the CPI, the interest rate for borrowing money supply and therefore will have a VAR (p) three-dimensional.Initially not knowing the optimal number of lag we try different number of lags to build VAR models.

Number of lag	AIC	Schwarz criterion
1	59.52572	60.10517
2	57.84747	58.83874
3	**54.59731**	**55.96672**

Given the above results and taking into account that the optimal number of lag is the one who has the smaller AIC, we conclude that the optimal number of lag is 3. This number is limited by the small number of data analyzed.

The overall shape of our VAR(3)model three-dimensional for our series is:

CPI = C(1)*CPI(-1) + C(2)*CPI(-2) + C(3)*CPI(-3) + C(4)*LENDINGRATES(-1) + C(5)*LENDINGRATES(-2) + C(6)*LENDINGRATES(-3) + C(7)*M2(-1) + C(8)*M2(-2) + C(9)*M2(-3) + C(10)

LENDINGRATES = C(11)*CPI(-1) + C(12)*CPI(-2) + C(13)*CPI(-3) + C(14)*LENDINGRATES(-1) + C(15)*LENDINGRATES(-2) + C(16)*LENDINGRATES(-3) + C(17)*M2(-1) + C(18)*M2(-2) + C(19)*M2(-3) + C(20)

M2 = C(21)*CPI(-1) + C(22)*CPI(-2) + C(23)*CPI(-3) + C(24)*LENDINGRATES(-1) + C(25)*LENDINGRATES(-2) + C(26)*LENDINGRATES(-3) + C(27)*M2(-1) + C(28)*M2(-2) + C(29)*M2(-3) + C(30)

The estimated model is:

VECTOR AUTOREGRESSION ESTIMATES

	CPI	LENDIN-IN-GRATES	M2
CPI(-1)	-0.002073 [-2.10656]	0.224139 [2.43630]	9.10E+09 [1.56181]
CPI(-2)	-0.312627 [-1.97393]	0.193312 [0.75072]	-3.50E+09 [-1.19807]
CPI(-3)	0.146839 [2.64908]	-0.183400 [-1.26682]	1.41E+09 [0.85665]
LENDINGRATES(-1)	-0.599187 [-2.54852]	0.952751 [3.51443]	1.64E+10 [2.29226]
LENDINGRATES(-2)	-0.124590 [-2.37982]	0.454639 [0.85247]	-6.94E+09 [-2.14653]
LENDINGRATES(-3)	0.439481 [1.97761]	-0.874559 [-1.89655]	-1.23E+10 [-1.88468]
M2(-1)	5.97E-11 [2.11887]	-2.94E-11 [-2.64274]	0.080036 [2.15412]
M2(-2)	-3.40E-11 [-2.40534]	8.13E-12 [0.20656]	-0.235313 [-2.52712]
M2(-3)	2.45E-11 [1.97260]	8.13E-12 [1.89829]	0.914399 [1.96534]
C	93.91844 (19.3672) [4.84935]	-7.237161 (31.4885) [-0.22983]	-3.28E+11 (3.6E+11) [-0.91752]
R-squared	0.997731	0.950286	0.998603
Adj. R-squared	0.992627	0.838428	0.995459
Sum sq. resids	3.812916	10.07923	1.30E+21
S.E. equation	0.976335	1.587390	1.80E+10
F-statistic	195.4632	8.495502	317.6161
Log likelihood	-10.76050	-17.56508	-341.6911
Akaike AIC	2.965786	3.937868	50.24159
Schwarz SC	3.422255	4.394338	50.69806

VAR model built in each equation has a high explanation and it is seen that most of the coefficients are statistically significant.

If we look upon the impulse responses on this VAR there are seenthat changes in CPI negatively effect on it from lag 1-3 becoming later insignificant.

As for the variables lending rates and M2 shown that changes

in CPI have no impact on them in the lag one, have a friend in lag 2.

but being negative in lag one on CPI variable.

VAR(3) model has residuewith normal distribution, it seems clear based on theJarque-Bera table of statistics values as the following.

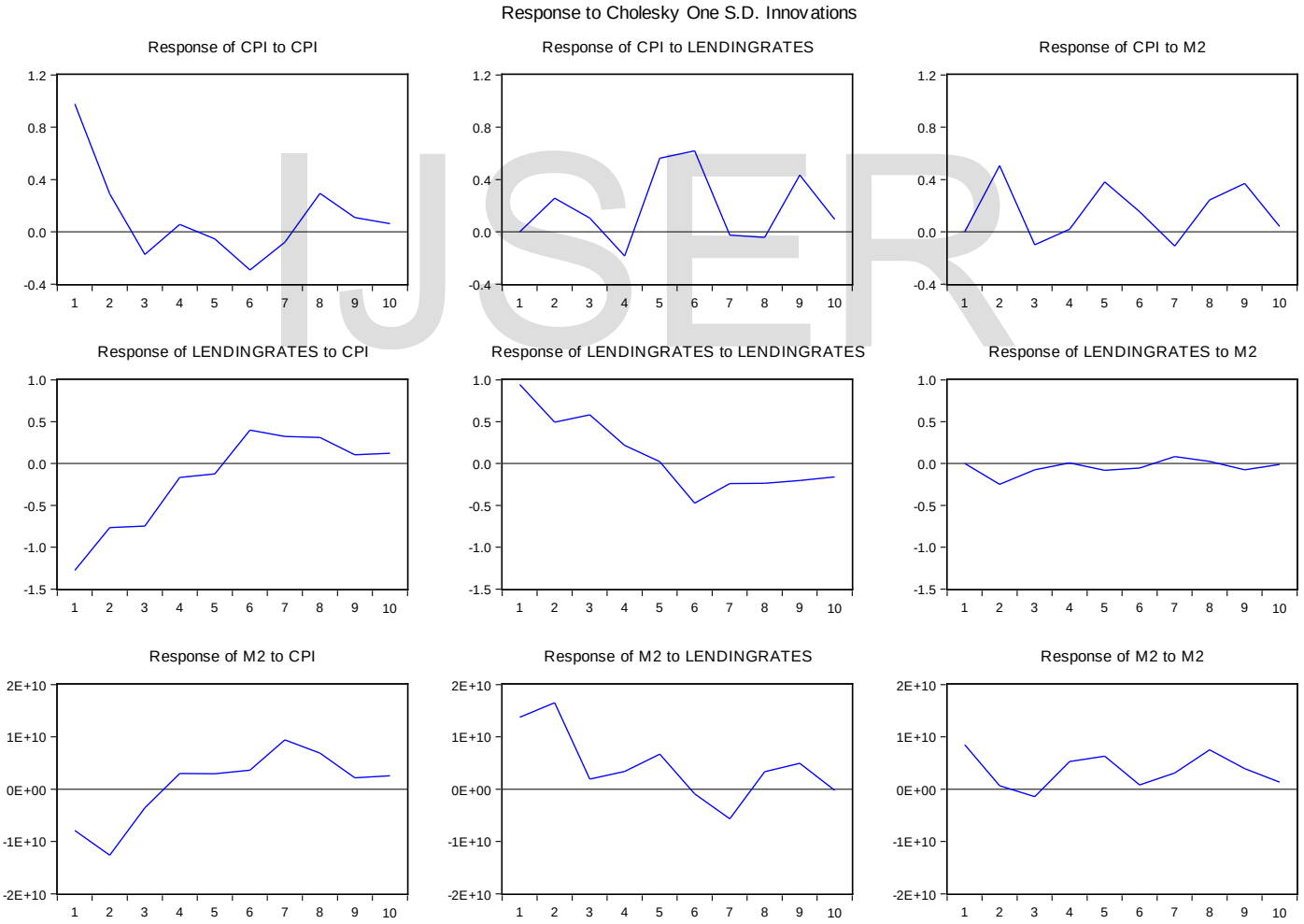
Component	Jarque-Bera	df	Prob.
1	0.239869	2	0.8870
2	0.044483	2	0.9780
3	1.839922	2	0.3985
Joint	2.124274	6	0.9079

It is seen that the values of probabilities accept the basic hypothesis that the remains of each equation have normal distribution and therefore the residual vector VAR (3)itself has three dimensional normal distribution.

Changes in lending rates and M2 continue being reduced

4 RESULTS

To determine the pattern of inflation forecasting in Albania, this paper uses the ARIMA model. The study showed that the CPI series was no stationary series, therefore we used the first difference to turn it stationary. To determine the best model was used AIC criterion of selection of the model, which showed that the best model was ARIMA (3,1,3). Then we evaluate three dimensional VAR model with the same selection criteria, from which the result showed that the best model was VAR (3).



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