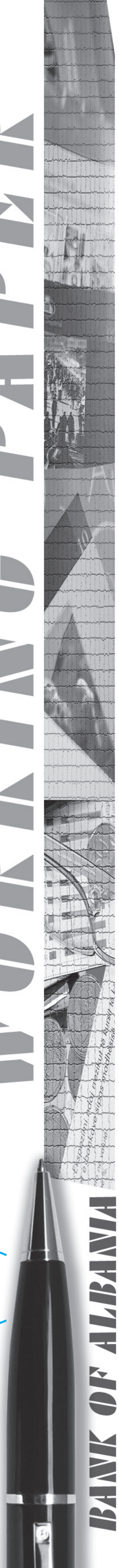
WORKING PAPER



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PERFORMANCE EVALUATION: UNCERTAINTIES IN FORECASTING INFLATION

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CONTENTS

ABSTRACT

This paper aims to present the developments in the inflation forecasting process for the period 2007-2010 and their integration into the monetary policy decision-making at the Bank of Albania (BoA). The history of forecasting at the BoA is still recent compared to earlier experiences in this field, but relatively "mature" compared to the forecasting work at the other institutions and agencies in the country and in the region. Besides our experience in developing forecasts, the reliable and timely statistical information remains a crucial factor in the projection process. In particular, the inflation forecast during 2007-2010 has been developed based on a richer portfolio of models, compared to the previous one (end 2006). From the performance analysis of inflation forecasting, we conclude that this period has been highly charged with uncertainties generated by global conjunctures and factors mainly out of control of the monetary policy. Forecasting performance analysis concludes that the best properties of an accurate forecast are on the 4-6 quarters time horizon, based on the averaging forecasts approach. Models present mixed results in terms of accuracy of forecasting in different time forecast horizons. The sectoral inflation model and the average one represent a higher accuracy compared to the other ones. Meanwhile, core/non-core inflation model results as a better predictor for capturing the correct direction (FD) of inflation for three quarters time horizon. In term of the RMSE and FD, all models have predicted more accurately than the Benchmark one (ARIMA). The combination of all forecasts in a simple mean for the period 2007-2010 was the baseline forecast for calculating the probability of the balance of risks at the end of a four quarters horizon. Testing results on the forecast errors for the average inflation forecast indicate that, overall, the inflation forecast process during 2007-2010 was optimal over four quarters horizon.

Key words: forecasting performance, inflation forecast uncertainties, properties of forecasts.

JEL - Classification: E37, C52, C53.

LIST OF ABBREVIATIONS

Abbreviations	Meaning
Headline	Headline Inflation Model
C_NC	Core/ Non-core Inflation Model
4_C	Four categories Inflation Model
TR_NTRN	Traded/Net Non-traded Inflation Model
Average	Average of results of 1-4 forecasting models
Actual	Actual Inflation/Published
FE	Forecast Error measured as a difference between (Actual – Forecast)
ME	Mean of Forecasting Error
RMSE	Root Mean of Square Error
FD	Forecast direction (correct)
Q	Quarter
h	Horizon

INTRODUCTION

The performance analysis of inflation forecasting is an important step for judging on the accuracy and optimality of BoA's inflation forecasts. The forecasting experience in other central banks (ECB, Sveriges Riksbank, Norges Bank) shows that the starting point regarding performance analyses of the inflation forecast is the evaluation of the short-term forecast obtained from different models. Highlighting problems in short-term forecasts will be helpful for the medium-term forecasts in order to provide better characterization of uncertainty, supporting the decision making process of the central bank monetary policy.

In the first section of the paper, we highlight the role of the main components of inflation projection for the decision making process, especially in an uncertain forecasting time. We describe the gradual integration of three components during 2007-2010: (i) statistical information; (ii) forecasting models; and (iii) experts' judgments. The second section is a quick overview of the quarterly forecasting models in use and the problems encountered in the inflation forecast for 2007-2010. In sections 3 and 4, we carry out a comparative performance analysis based on statistical indicators and specific tests. The paper concludes in Section 5 highlighting the room for improvement in the inflation forecast. The main reference of our study was the practice of analyzing the forecasting performance followed by other central banks, focusing on that of the Sveriges Riksbank as a transparent and contemporary example. The studies conducted by economists of the Riksbank in this relevant field (Andersson, M. K et. al., 2007, 2008) were highly useful in completing our study.

1. INFLATION PROJECTIONS AND MONETARY POLICY DECISION-MAKING PROCESS

Statistical information from the real and financial sectors of the economy, timely and reliable, takes particular importance in the macroeconomic analysis and monetary policy decision-making process at central banks. In highly uncertain times related to the internal and external economic and financial developments, current and future ones, the forecasting and decision-making process becomes even more difficult. Mark Twain's famous remark "…history does not repeat itself, but it often rhymes…"[1] remains always actual. The forecasts are generated from models built on a sufficiently large and long historical data base in order to project the future of the main indicators. Although the historical dimension is essential and useful for predicting the future through the models, lessons of economic developments history are showing that no past experiences occurs again in exactly the same way. The social and economic conditions inevitably change and evolve in ways that cannot be captured precisely by any econometrical model. For this reason, in periods of high economic uncertainties, the forecasts need to be "adjusted" with one of the most important components of economic projection – the judgment. Under these conditions, the accuracy of knowledge of the future in the economy along the reaction horizon of the monetary policy transmission mechanism becomes an increasing function of the three fundamental pillars: statistical information; forecasting models; experts' judgments.

The objective of the monetary policy to maintain price stability is achieved through an optimal decision making process. It consists in projecting future economic conditions under a potential stance of the monetary policy. The aim of the projection process is to assist policy makers for selecting the most beneficial option of the monetary policy to achieve its primary objective. For this reason, the projections are realized in short- and medium-term horizon,

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[1] Cited by Sandra Pianalto - President and CEO, Federal Reserve of Clevenland - "Forecasting in Uncertain Times", in "Economic Club of Pittsburg", Pennsylvania, 18 May 2010.

for the next 4 to 8 quarters. In each forecasting round, information from the three above- mentioned key components are included, depending on the statistics updating degree, the ability of models "to imitate" one or several economic processes and the experts' intuition for making economic judgments.

The database - is the main input for the projection process. The science and art of forecasting aims to develop techniques that take into account extensive and updated databases, increasing the role of the models and their results in the economic decision. In this respect, each forecasting model for inflation or other indicators at the Bank of Albania is intended to contribute to creating the macroeconomic outlook. But, as long as models cannot capture every event and assumptions cannot be fully precise, the forecasting results derived from the models could not and should not be considered as "all-powerful". Under the conditions of increasing information asymmetries and uncertainties for the future, the third pillar – experts' judgments – is nowadays considered to be of particular importance.

One of the crucial issues of the projection process is the combination of the information obtained from history, as captured by forecasting models, with that regarding the current and expected developments, through the economic judgment. Ignoring or overestimating one or another aspect, might lead to wrong projections. Lessons from the recent financial crisis showed that predictions, mainly those for inflation, even for countries under the inflation targeting regime with consolidated and advanced forecasting models and techniques, resulted significantly deviated from the actual development of this indicator.

Turning to the BoA, the inflation forecast process is assessed as set up on the three pillars of the projection framework: updated statistical information; forecasting models; and experts' judgments.

2. FORECASTING INFLATION OVER 2007 - 2010

Inflation forecast, as a regular process at the BoA, began in the first quarter of 2005[2]. During the period of April 2005 - September 2006, the models were assessed regarding their predictive ability and forecasting accuracy over next 12 months or four quarters. As a result of this testing process, the models reflected several changes and improvements, already discussed at the end of 2006 as a consolidated portfolio model for inflation forecasting. They were considered as important input in the monetary policy decision-making at the Bank of Albania and, at the same time, as the result of a work in progress[3]. The comparison of the published inflation rates with those resulting from the forecast models in the course of two years and the respective sensitivity analysis, threw light on a more critical assessment of the existing inflation forecasting models in use by the end of 2006[4].

Based on the previous forecasting experience and the comments of Albers and Allen (2006)[5], the inflation forecast was revised. The essential innovations of this process would consist of: the conception and evaluation of new models for core and non-core inflation components, which were fully implemented after 2007[6]. The permanent exclusion method for measuring the core inflation rate was assessed as the most promising and transparent one to be incorporated in one of the forecasting headline inflation models. Besides modelling core inflation, the forecast models of the non-core components, detailed according to the most representative categories were also evaluated; the new proxy economically appropriate for imported inflation, which improved the simple

[2] Çeliku, E., Shtylla, D., Hashorva, G., Hoxholli, R., (2005): "Inflation forecasting at the Central Bank of Albania", Background Material prepared for the Open Forum "Preconditions for Inflation Targeting in Albania", Tirana, 1-2 December 2005.

[3] Çeliku, E., Shtylla, D., Hashorva, G., Hoxholli, R., Kota, V.,: "The Portofolio of the Econometric Inflation Forecasting Models at the Bank of Albania", Round Table – Inflation Targeting 2, Bank of Albania, Tirana, 7-8 December 2006.

[4] Hashorva, G., Kota, V., Peeters, M., and Çeliku, E., (2006): "Evaluation of the Shadow Run Headline Inflation Forecasts for April 2006-September 2006", Presented at the Round Table – "Inflation Targeting 2", Bank of Albania, Tirana, 7-8 December 2006. Internal Discussion Paper.

[5] Discussions on Inflation Forecasting Process at the Bank of Albania, presented at the Round Table – "Inflation Targeting 2", Bank of Albania, Tirana, 7-8 December 2006.

[6] Çeliku, E., Hoxholli, R., (2008): "New Core Inflation Measures: Their Usage in Forecasts & Analysis", Working Paper (1(02), 2008), Bank of Albania.

Philips Curve inflation forecast equation, was compiled; linear models for short-term forecasts of the main explanatory variables were developed, independently. Their results would help to build the baseline scenario assumptions. Forecast models (for the exchange rate, foreign, oil and seasonal food prices), which have served as satellite models around the main inflation forecast ones, provided them with the respective assumptions for the forecasting horizon.

In 2008, a new model was added to the existing portfolio of models - the three-sectoral forecasting model. The forecasting inflation model of tradable, net nontradable and regulated prices was developed in order to enrich the analysis and forecast with assessments for the potential inflationary pressures in the future from external and domestic sectors of the economy[7].

As of the end of 2010, the Bank of Albania has four forecasting inflation models for each of the frequency (monthly/quarterly). This study will focus on the assessment of the forecasting performance of the four quarterly forecasting models.

As stated above, the inflation forecast is envisaged as a continuous assessment process. It is based on the forecasts performed by the following models: headline inflation; four inflation's categories; core and non-core inflation's components; traded and net non-traded inflation's sectors of the CPI basket.

The inflation forecast results from a simple mean of the forecasting results according to the above-mentioned models. This process is supplied continuously by the economic analysis conclusions. Therefore, the methodologies for computing the proxy variables with a significant explanatory power to the inflationary process in the Albanian economy are compiled and improved. Meanwhile, the results of the historical and satellite models of the explanatory variables are an indispensable input for the respective baseline assumptions.

The following table presents the main features of inflation forecasting models, applied by 2010 Q4, which have supported monetary policy decision-making at the BoA.

[7] For more details, see Appendix 1. Summary of the Internal Memos, Çeliku, E., (2007, 2009): "A sectoral forecasting inflation model for a small and open economy", Monetary Policy Department, Bank of Albania.

Table 1 Properties and variables for the quarterly inflation forecasting models

Models (Name)	Descriptions of the models	Some Statistics' Estimation	Explanatory variables (Sources)
Headline Inflation (Total)*	Philips curve model. It aims to capture the pressures from domestic and external environment. Simple Linear regression (dlog form). OLS method. To forecast the assumption for the exchange rate (euro/lek), a simple satellite model (ARIMA) is used.	R^2_{adj}=0.62; S.E=0.01; DW=2.1	Proxy of imported inflation (BoA, IMF)[1] Unemployment rate (INSTAT). Inertia Terms.
Headline inflation based on 4 inflation categories. (4_C)*	System equations VARX - Method of estimation SUR / OLS. Breakdown of the CPI's basket in four categories according to their economic function: imports regulated, services, others. Regulated CPI is exogenous and the other three categories are endogenous, along with other explanatory variables. Headline inflation is calculated as weighted average inflation of each category. Weights are respective shares to the CPI basket. For the exchange rate (NEER) assumption is used a simple satellite model (ARIMA). For regulated CPI, the assumption based on the information for future developments in corresponding prices.	$R^2_{adj\_Imp.}$=0.64; S.E=0.02; DW=2.3 $R^2_{adj\_Serv.}$=0.83; S.E=0.01; DW=1.9 $R^2_{adj\_others}$=0.86; S.E=0.008; DW=2.1	Exchange rate NEER (BoA); Proxy for imported inflation (BoA); Total fiscal expenditures (MoF); M3 (BoA); Unemployment Rate (INSTAT); Regulated price index (INSTAT, BoA); Inertia and Autoregressive Terms
Headline inflation based on the forecasts for core and non-core inflation components. (C_NC)*	Separate equations: core inflation, measured by the method of permanent exclusion; inflation of oil prices; inflation of high seasonal foods. The information for future inflation of excise and regulated prices are involved as additional information using experts' judgments for the respective assumptions. The forecast of the headline inflation is calculated as a weighted average of core and non-core inflation components, using respective weights in the CPI basket, where core items share is 77%.	$R^2_{adj\_Core.}$=0.93; S.E=0.004; DW=1.9 $R^2_{adj\_Oil}$=0.73; S.E=0.05; DW=1.9 $R^2_{adj\_Seas\_food}$=0.94 S.E=0.02; DW=1.9	Unemployment rate (INSTAT); Exchange rate NEER (BoA); Exchange USD / ALL; M2 (BoA); Oil price in international markets (Reuters and IMF); TB Yield (12-months) (BoA); Inertia and Autoregressive Terms.

	Satellite equations used for exchange rates (NEER & USD/ALL).		
Headline inflation based on forecasts for Traded and Net nontraded inflation. (TR_NTRN)*	System of equations after estimation by a VARX with SUR method. Division of the CPI in 3 economic sectors by source of inflationary pressures (foreign and domestic ones) for traded and net non-traded inflation, respectively. Regulated prices are a completely separate sector, participating in the system as an exogenous variable. Inflations of tradable and net non-tradable are endogenous variables in the system. Headline inflation forecast is calculated as a weighted average of tradable, non-tradable and of regulated inflation. Weights are the respective shares in the CPI basket, 62%, 32.5% and 5.5%, respectively. Satellite equations are used for assumptions related the exchange rate (NEER) and price index of foods in Greece.	$R^2_{adj\_TR}=0.85$; S.E=0.008; DW=1.8 $R^2_{adj\_NTRN}=0.85$; S.E=0.008; DW=2.1	Exchange rate NEER (BoA); Food prices in Greece (National Statistical Institute of Greece and the IMF); House Price Index (BoA) Regulated price index (INSTAT, BoA); Inertia and Autoregressive Terms
Headline Inflation ARIMA*	Benchmark Model.	$R^2_{adj}=0.63$; S.E=0.01; DW=1.9	dlog(IÇK,0,4)=c+[AR(1), MA(2), MA(3)].

[1] Proxy indicator, based on the Internal Memo Hoxholli, R., (2007), "Measuring imported inflation for economic analysis and inflation forecasting". Imported inflation is built combining information on Greece and Italy CPIs, the euro/lek exchange rate (two months lagged) and the share of Albania's imports from respective countries. See Monetary Policy Report, Bank of Albania, sections on imported inflation, http://www.bankofalbania.org/?crd=0,22,18,0,0,5794&ln=Lng1.

Source: Authors and R. Hoxholli (member of the inflation forecasting team, Bank of Albania).

* Note: In parentheses there is an abbreviation notation for each model - which will be kept during this material.

The above models are also used to forecast inflation with risk's scenarios. Designing risk assumptions for variables whose high volatility implies sensitive developments for the future inflation has been part of the forecasting framework. Among these variables are: exchange rate; developments in monetary aggregates mostly influenced by the credit performance, fiscal expenditures, foreign prices, etc.

Analysis and inflation forecast are addressed as a coordinated processes supporting monetary policy making framework at the Bank of Albania. The high persistence of the inflationary process in Albania (Kota, V. 2009) indicates that its past and current values play a significant role in the future and expected inflation developments. The coefficient of the persistent and inertia component and the other economic variables presented in Table 1 are included in the forecasting inflation models.

The progress made in this process is primarily influenced by the increasing demand for forecasting as a crucial step of the monetary policy decision-making process. Contemporary forecasting techniques, reflecting on the problems and issues arising during the analysis, structuring the forecasting work giving more focused actions have supported the forecasting inflation process and its main determinants at the BoA.

Box 1: Highlights of the inflation forecasting framework 2007-2010

The most important developments during the four-year period of inflation forecasting are as following:
- *Forecasting core and non-core inflation, based on a new approach of their measurement;*
- *Enriching the models' portfolio, including the three-sectoral forecasting model;*
- *Compiling a new series for imported inflation incorporating it as an important explanatory variable in the models;*
- *Extending the forecast horizon from four to eight quarters;*
- *Updating the quarterly forecasts through new monthly*

information when actual developments of variables result different from those previously assumed. Economic and technical arguments for changing the baseline assumptions scenario have accompanied the updating of forecasts inflation section;

- *Making baseline assumptions for the explanatory variables transparent according to a standardized format and including it on a regular basis in the projections chapter of the Monetary Policy Reports;*
- *Performing risk scenarios for inflation over the forecasting time horizon. The main risk scenarios have consisted in the performance of the exchange rate, budget deficit, monetary aggregates as well as the other factors assumed to have a high potential risk to inflation. It is aimed to design consistent risk scenarios;*
- *Analyzing the performance of forecasts conducted four quarters / 12 months before and examining the deviations diagnostic results;*
- *Decomposing the deviation according to the main factors for 2009-2010;*
- *Involving the Fan-Chart as a transparent, contemporary and simple presentation for the risks surrounding the central baseline forecast for the four quarters ahead.*
- *Estimating a reference model (Benchmark) in an ARIMA structure, for assessing the forecasting performance for comparison purposes among the different models.*

3. DEVIATIONS IN ONE-YEAR FORECAST HORIZON

The pursuit of the probability distribution of the “deviations” or “forecast’s errors”[8] series is the gateway to study the out-of-sample forecasting performance. The deviations may be small or large, biased in one direction or randomly distributed, serially correlated or not. A condition should be intact in the sufficiently long deviation series; its probability distribution must respect a Normal Distribution $\sim N(0; 1)$[9]. For the period 2006M3-2010M12, the deviation series by monthly and quarterly frequencies calculated as a difference between published annual inflation rate and the forecasted one 12 months and four quarters before, consist of 60 and 20 observations, respectively. As long as the forecasting horizon over one to two years plays an important role in decision making, it should be first of all reliable. Forecasting errors investigation aims to detect their causes according to the main sources. The latter ones may consist of: wrong assumptions, unexpected shocks, missing information at the time of forecast; different models, frequencies and time horizons of the forecasts.

A careful assessment of the causes of deviations makes the forecasting process more transparent and accountable in the eyes of the policymakers. On one hand, it contributes to the improvement of the models and the forecast process. On the other hand, it encourages scientific debate on modelling, reinforces the requirements for reliable statistical information in real time. They both help in designing more consistent baseline assumption scenarios from the technical staff and monetary policy decision makers.

Since autumn 2007, projections worldwide have experienced a high degree of uncertainty. By early 2009, the world economy faced the phenomenon of sharp *Aginflation*[10] and high price volatility of

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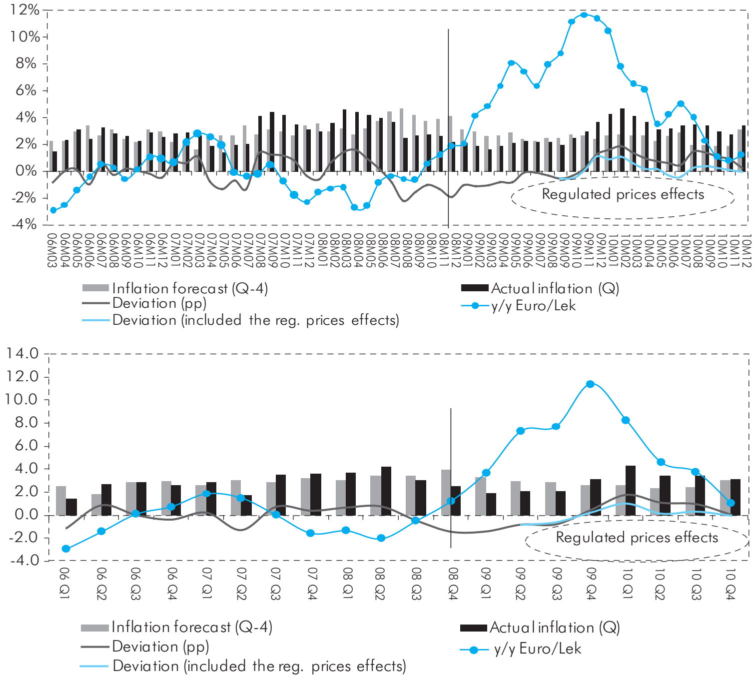
[8] Calculated as a difference between the published annual inflation rate (Actual) and the forecasted one.

[9] N(0,1) - Standard Normal Distribution, with the Expectation 0 and Standard Deviation 1.

[10] The inflation caused by the increase of the world prices of agricultural production.

Chart 1 Annual inflation rate: forecasts one year earlier vs. actual inflation rate, monthly and quarterly*



*Presented at the Boa's Monetary Policy Report (4rth quarter 2010).
Source: Authors' estimates

other commodities (oil and fuels, gas, energy, etc). This uncertainty was reflected in significant deviations from inflation projections conducted months, quarters and years earlier. Among the most important central banks in the world under the inflation targeting regime, only the Central Bank of Brazil was able to be successful[11]. In addition, the world financial crisis, increased uncertainties in macroeconomic projections. Structural dynamic models of general equilibrium (DSGE) were seriously shocked. Reformatting them in terms of new equilibriums for the main macroeconomic indicators was considered by the economists as a primary process. The downward trajectory of inflation in 2009 triggered the debate on the disinflation risk, which actually did not turn out as such. This

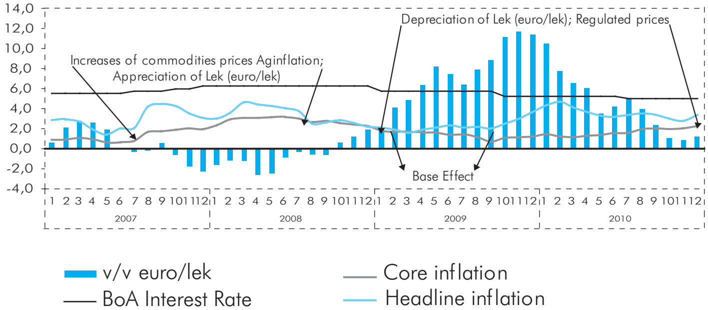
[11] National Bank of Serbia, Box: "(Non) achievements of inflation targets across the world", Inflation Report, August 2008, pg. 15-18.

tendency was caused by the high base effect of the previous year. The above-listed developments did not remain out of the inflationary process in Albania. Supply shocks, originating from the domestic and external economy, led to considerable deviations from the previous forecasts. Despite these developments, the distribution of the deviations series resulted ~ N (0, 1), supporting the presence of non-systematic errors in forecasting inflation.

Box 2: Profile of inflationary pressures during 2007 - 2010

During 2007-2010, the annual inflation rate in average terms resulted at 3%, in line with the Bank of Albania's objective. This inflation supported the economic growth rates by 5.3% in average real terms under the 5.7 % policy interest rate for ALL. The year-on-year exchange rate of the domestic currency against the euro for the period under review resulted in a slight depreciation, 2.8%, mainly due to exchange rate developments during 2009-2010. The performance of the above-mentioned indicators has contributed to maintaining a relative macroeconomic stability. Nevertheless, difficulties generated by external demand shocks as a result of the recent financial crisis have been present in the Albanian economy, increasing economic uncertainties.

Chart 2 BoA policy interest rate, annual changes of the CPI and exchange rate (in %)



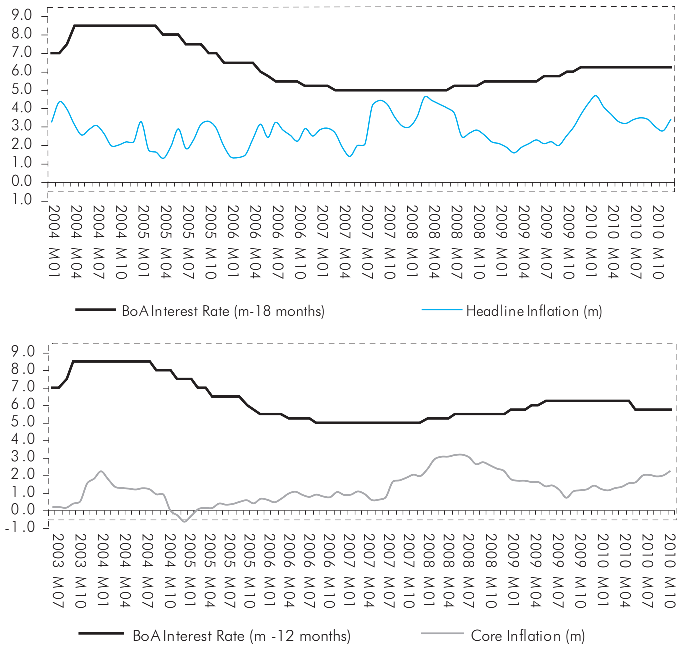
Source: INSTAT and BoA

In this framework, the primary objective of the monetary policy to maintain price stability in the medium term, 3%, has been achieved. The forward-looking monetary policy decision-making has played an important role supporting the future developments on the consumer prices, markets and aggregate demand in the economy. Inflation expectations of the public and those of the main market agents have been anchored close to the Bank of Albania's objective. Regular inflation forecasts have also supported the monetary policy decision-making. Their role over time in assessing inflationary pressures for different forecasting horizons has increased. Furthermore, as the aim of the monetary policy is to move towards the inflation targeting regime, the interest and reliance on them has been and remains still high. The period 2007-2010 recorded several shocks for the world economic equilibriums associated by high volatility of the consumer and commodity prices. Their pass-through in the Albanian CPI was reflected in increased inflationary pressures mainly from external supply side, from the autumn of 2007 to the end of 2008. In the same period, the domestic currency was appreciated, easing significantly inflationary pressures. But, by the end of 2008, the exchange rate demonstrated a depreciating behaviour. Its impact on inflation over the first nine months of 2009 was offset by the profound inflation base effect[1]. Consequently, the base effect can be considered neither as a "shock" to inflation nor as a disinflation process. The latter, was reflected in a strongly declining trend and low historical values of the annual headline and core inflation rates during the above-stated period, supporting the weakening of inflationary pressures in the economy. In the absence of this statistical factor, the inflationary pressures would have been higher, due to the depreciation of the domestic currency against the euro. The last quarter of 2009 and the year 2010 were marked by a significant increase of inflationary pressures as a result of the combination of accumulated aforementioned factors effects and the continuing depreciation trend of the lek against the euro. In the same period, some tariffs for the regulated prices of different goods and services rose. These effects, in combination with the lower base of comparison of 2009, shifted the inflation trend upward, with a similar profile to that of the second half of 2008. On the other side, inflationary pressures in this period were eased

[1] Bank of Albania, Monetary Policy Report, 2010 Q1, Box 1: "Base effect and its impact on inflation rate".

by the relative weakened aggregate demand, expressed in the presence of the negative output gap.
Inflation rate volatility has been smoothed over time, due to: (i) the monetary policy decisions for BoA's policy rates; (ii) the impact generated from the implementation of the correcting measures under new domestic and external economic balances in the macroeconomic development programmes of the country. Under the conditions of an appropriate efficiency of the monetary policy transmission mechanism, inflation was kept in under control, in line with the BoA's medium term objective, 3%[2]*.*

Chart 3 BoA policy rate with time lags and headline (on the top) & core inflation (below)



Source: INSTAT, BoA and Authors' estimates

[2] There is a negative correlation between the BoA's policy rate (with a time lag no higher than 18 months) and headline and core inflation rates. The linear correlation coefficients between core inflation and policy interest rate ranges from (-0.4) to (-0.7); and between the headline inflation and the policy interest rate the correlation is weaker ranging in a lower band (-0.21) to (-0.4).

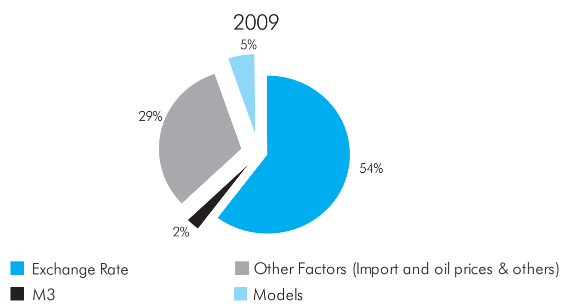
3.1 FORECAST'S DEVIATIONS VERSUS ASSUMPTIONS

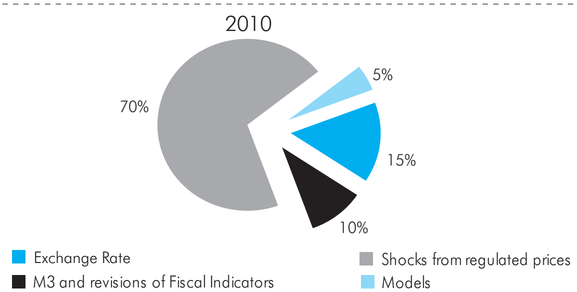
The deviation's decomposition analysis during the forecasting period 2009-2010, indicates that the main factors of the deviations were as follows:

- For the year 2009, long depreciation period of the lek, mainly against the euro;
- For the year 2010, repetitive shocks from regulated prices.

The baseline scenarios conducted during 2008 for the exchange rate variable have captured its performance based on the history, failing to signal in advance the depreciation of the domestic currency. The depreciating behaviour became more obvious in December 2008 reaching the peak during the second half of

Chart 4 Deviation's decomposition according the main factors (2009 and 2010)*





*Bank of Albania, Monetary Policy Reports, 3rd quarter 2010, Box 1: "Projections and the role of their components in the decision-making process".
Source: Authors' estimates

2009. To carry out a careful assessment of the exchange rate situation and its implication for the inflation rate, the risk scenario results were a helpful support for the policy makers at the BoA. Based on these scenarios, quarterly inflation projections during 2009 were verified by the official inflation data for horizons lower than four quarters. In average terms for 2009, approximately 54% of the deviation is caused by the exchange rate shocks.

Inflation forecasts for 2010 conducted during 2009, "suffered" the lack of information at the time of the forecasts for the increases from time to time of the regulated prices (electricity, water and some important medical and hospital services). It is estimated that about 70% of the total deviation, in average terms, resulted from the lack of information for the time and the size of the regulated prices increases.

3.2 FORECAST'S DEVIATIONS VERSUS FREQUENCIES' MODELS

Due to higher frequency, monthly models produce more forecasts than the quarterly ones. Their usefulness consists in terms of updating forecasts between two quarters with the most recent monthly information. At the same time, they enable the extension of the deviation time series in order to examine its distribution function parameters. Because monthly and quarterly models are different in time structure aspects, including time-lag variables, in some cases in their forms as well, the deviations in the monthly models are less smooth than in the quarterly ones. Notwithstanding this consideration, the series of deviations in both cases has maintained the normal distribution properties. In quarterly models, the deviation series reached the minimum length for normal distribution assessment (20 observations).

The results from quarterly models represent an important tool for the monetary policy decision-making. In the contemporary philosophy of forecasting, these results are used as raw material in projections by structural models[12].

[12] During November '10 - October '11, first tests were realized to perform projections and simulations through the Gap Model, by "supplying" the latter with the results of quarterly inflation forecasting models and the short-term GDP ones.

4. PERFORMANCE ANALYSIS OF INFLATION FORECASTS

Forecasting performance analysis will be realized by the presentations of charts, specific statistical indicators and empirical test results for the forecast errors series (Appendix 2). The mission of this analysis consists in assessing the performance of short to medium term inflation forecasts by each quarterly model over time. As a consequence, it will aim to characterize more accurately the probability of the confidence for the inflation forecast.

To fulfil this mission, the study will focus on specialised statistical indicators and econometric practices, widely encountered in the evaluation experience framework[13]. The series of forecast errors[14] will be examined in three comparative dimensions: (i) across inflation forecasting models, (ii) across model results and those of the benchmark model, (iii) across the forecasting horizons.

Analyses based on the respective indicators according to the time dimension are realized by focusing on the forecasting horizon from 1 to 4 quarters ahead. Despite this fact, the analyses try to extend to a longer term (up to 6 quarters), aiming to include the potential horizon of monetary policy reaction[15]. The evaluation of forecasting performance in the medium term is still in a preliminary stage, because of the short forecasting history beyond four quarters (since 2008 Q3). Forecasts in this horizon are addressed to present a rough picture to the policymakers on the inflationary pressures trends; meanwhile the final decision is focused on the forecasted value four quarters ahead. As a result of the statistical elaboration of quarterly forecast errors, a Fan chart is realized, in order to illustrate the balance of risks for the inflation after one year (Appendix 3).

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13 Andersson, M.K. et. al., (2007); Andersson, M.K., (2000); Andersson, M. K. & M. Lof (2007); Stock, J. & M. Watson (2008); Mukherjee, D. and D. Kemme (2008); Sveriges Riksbank (2009 and 2010); Bjonland, H. C. et. al. (2010); Lars E.O. Svensson (2009); Stock, J. H., M. W. Watson (2002, 2007); Timmermann, A. (2005).

14 Measured as a difference between published inflation (INSTAT) and the forecasted one in different time horizons (h=1,....,8).

15 This horizon is considered to be 18 months / 6 quarters, “Monetary Policy Document 2009-2011”, Bank of Albania June 2010.

Given that the forecast errors series is positively/negatively different from zero for one/more quarters ahead, despite the condition that it must converge to zero on average terms for a long time series, there are some basic principles that should be checked for measuring the performance of forecasting models concluding to the identification of the best or more accurate model:

- Firstly, the forecasting accuracy in terms of the average size of the deviation/error. The main statistical indicators in conducting this analysis are: Mean Error (ME); Mean of the Absolute Error (MAE); Root of the Mean Squared Error (RMSE); Normalized Root Mean of Squared Error (NRMSE); and Coefficient of Variance of the Root of the Mean Squared Error (CVRMSE). The lower the values of the above indicators, the more accurate the forecasts and, as a consequence, the more reliable the model is[16];
- Secondly, it is necessary to establish a comparative indicator. Usually the RMSE of each model / combination of some or all models should be compared to that resulting from the benchmark model (in general an ARIMA structure model). As a result of comparison a relative RMSE indicator (RRMSE) is calculated. The value of this ratio should be smaller than 1 unit, indicating that the models perform with smaller forecast errors than those resulting from an ARIMA one. If the opposite happens, predicting by the benchmark model would be recommended.
- Thirdly, it is also necessary examining the consistency of the forecasts direction. Analysing whether the forecasted values are in the correct direction (or not) of the annual inflation fluctuations (increase/decrease/ unchanged, compared to the previous quarter/year). The indicator used in this assessment is the direction of the forecast (DF);
- Fourthly, through the tests suggested by Nordhaus (1987), Mincer & Zarnowitz (1969) and Andersson. M.K. *et. al*. (2007), the efficiency of forecasting and the optimality of forecasts for different horizons are assessed.

[16] In this respect the combination of some/all forecasts from the different models is not excluded.

Box 3: Indicators of the comparative assessment of the forecasting performance

If T - number of forecast periods, t- moment at which prediction is conducted, A - the actual value of inflation, F - the estimated value of inflation, the indicators for the performance assessment would be:

1. ME- Mean Error examines the presence and direction of the forecast errors. Its positive/negative values indicate that, in average terms, it is forecasted below/above the published value, signalling under/overestimation during the forecasting process. The calculation formula is as follows:

$$ME = \frac{1}{T}\sum_{t=1}^{T}\left(A_t - F_t\right)$$

2. MAE- Mean Absolute Error measures the size of forecast errors, neglecting their sign (direction). This indicator assumes that the value of a forecast error varies in proportion to the size of the MAE. This means that a 2% error is 2 times worse than a 1% error. MAE's formula is as follows:

$$\mathrm{MAE} = \frac{1}{\mathrm{T}}\sum_{\mathrm{t}=1}^{\mathrm{T}}\left|\mathrm{A}_{\mathrm{t}} - \mathrm{F}_{\mathrm{t}}\right|$$

3. RMSE – Root Means Square Error is one of the most encountered indicators in literature and practice for assessing the forecast quality in terms of comparability among different models and forecasting horizons. RMSE is used to measure the average size of the forecast error. In terms of comparability, a lower value indicates a better accuracy of the prediction. It is computed by the following formula:

$$\mathrm{RMSE} = \sqrt{\left(\frac{1}{\mathrm{T}}\sum_{\mathrm{t}=1}^{\mathrm{T}}\left(\mathrm{A}_{\mathrm{t}} - \mathrm{F}_{\mathrm{t}}\right)^2\right)}$$

4. NRMSE – Normalized Root Means Square Error is another form of expressing the magnitude of the error. It shows the value of the RMSE per unit of amplitude of the actual series inflation variance. It should be as small as possible, showing less relative fluctuations of the residuals. It may be expressed in % and is useful for comparability purposes (different models / different forecast horizons). It is measured by the following formula:

$$NRMSE = \left(\frac{RMSE}{A_{max} - A_{min}} \right)$$

A_{max} and A_{min} are respectively the maximum and minimum values of the actual inflation series (for the forecasting horizon).

5. CVRMSE - Coefficient of Variation of the Root Mean Square Error. It is very similar to the previous indicator, but it examines the volatility of RMSE (error), compared to the average actual inflation according the forecasting horizon. It is measured by the following formula:

$$CVRMSE = \left(\frac{RMSE}{A_{mesatar}} \right)$$

6. DF – Direction of Forecast. Besides measuring the accuracy of forecasting (the measure), it may be useful to analyse if the forecast is or not in the right direction for different forecast horizons, or how much the forecasted values have captured correctly the increases / decreases / no changes of inflation. This ratio may be important especially for the short-term forecasts of some indicators. According to Andersons, M.K. et. al, 2007, by DF can be judged whether the GDP in the coming quarters will increase / decrease, taking preliminary signals on the expansion / contraction or the turning point of the business cycle (economic activity) or if the exchange rate may be appreciated/ depreciated in the near future compared to the current level. The same information from the DF may be used to analyse inflation if there will be an increasing/weakening of inflationary pressures in the short term. This indicator is expressed in percentage according to the formula:

$$DF = 100^* \frac{1}{T} \sum_{t=1}^{T} I\left\{\hat{D}_{t+i} = D_{t+i}\right\},$$

where I is a function or an indicator that rises by 1 unit when the hypothesis (increase / decrease / same) is verified and 0 if otherwise, i.e. if it is forecasted that in the quarter (t +1) inflation will rise and according to official sources the increase is verified, I = 1, otherwise, I = 0. And if in moment (t +1) is forecasted to decline and this event is verified officially then I = 1, otherwise I = 0. The higher the value of I at the end of the hypothesis control, the more the model is able to correctly forecast direction of the future inflation.

7. RRMSE – Relative Root Means Square Error is measured as the ratio of RMSE of each model (Mi) to the RMSE resulting from the benchmark model.

If RRMSE(i) <1, then model (Mi) forecasts better than the benchmark one.

If RRMSE(i) > 1, then the benchmark model forecasts better than (Mi) model.

If RRMSE(i)=1, then the benchmark model predicts as well as (Mi). If the result verifies the latter two cases, it is better to predict by the benchmark model, usually ARIMA models.

8. RDF – Relative Direction Forecast is an indicator built on the same logic as RRMSE, but with its opposite interpretation, since DF should be as high as possible. If RDF(i)>1, Mi model forecasts the direction better than the benchmark one.

The performance analysis in the forecasting process, in general, depends significantly on the length/number of observations of the deviations/errors series. For a given period of analysis, its length reduces with the extent of the forecast horizon. If the series of errors has 20 observations on the one-quarter horizon, on the four-quarter horizon it would have only 17 ones. The average forecast error may increase considerably for high forecast horizons. It is important to take into consideration that this phenomenon can be caused partially or substantially by reducing the sample size. Statistical inference, other statistics and tests used in the whole assessment of the forecast performance are highly "vulnerable" by the length of the sample size. Andersson M.K. et. al. (2007), evaluating the performance of forecasts from different agencies and institutions, including Sweden's Central Bank, emphasizes that, in some cases, the forecasting accuracy seems to improve significantly over long-time horizons. Still, the interpretation of these facts should be done with extreme caution from the statistical point of view, because of the reduction of the sample size. It is difficult and risky for the whole process to draw conclusions from small samples, because coincidentally the RMSE or ME may result lower.

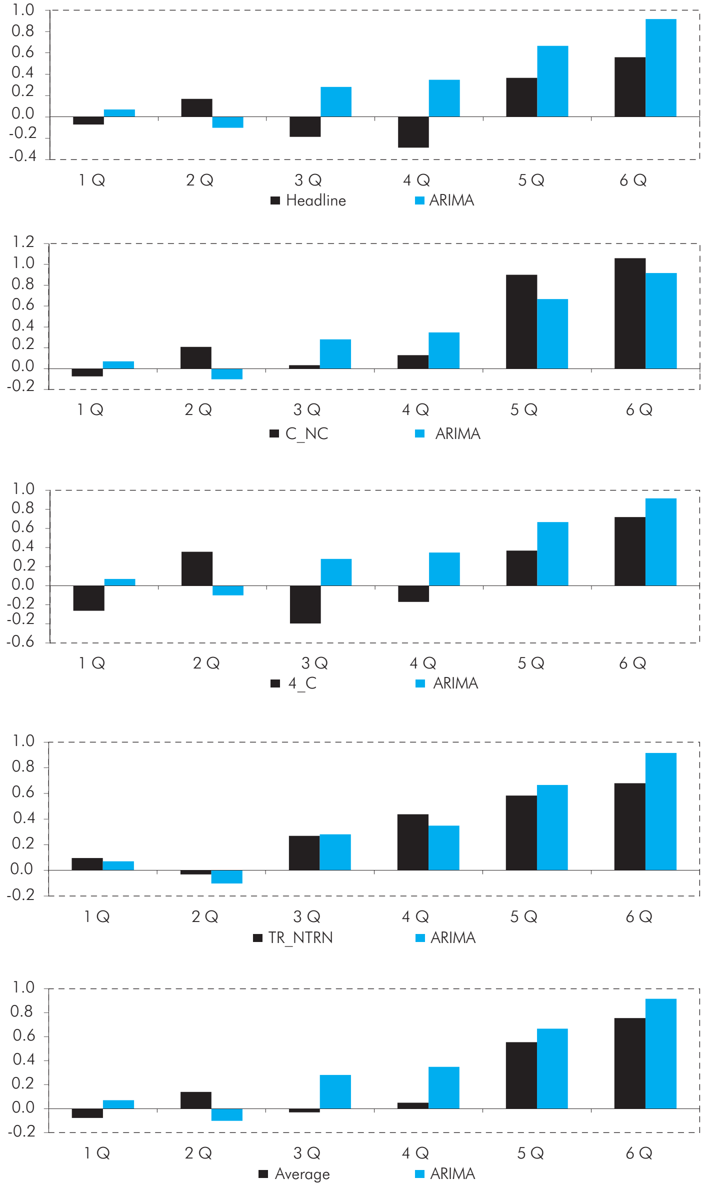
Taking into consideration the above conclusion and, based on the gained experience on the inflation forecast at the BoA, we will try to analyse the performance of the annual inflation rate extending the forecast horizons from four quarters (Hashorva, G. et. al., 2006) to six quarters. The forecasting process up to eight-quarter horizon has started in 2008 Q3. As a result, only 3 observations of the deviations series at the end of 2010 Q4, for the next eight quarters, are insufficient for the further analysis. In this respect, the values of performance indicators, even for the five- and six-quarter horizon, should be considered with extreme caution. On one hand, the length of the deviation series is still short, representing a relevant statistical factor. On the other hand, the models are not evaluated based on long-term equilibrium relations. Both aspects represent inherent statistical factors for vulnerability of the performance indicators up to four-quarter horizons. This issue is quite controversial in the periods of high uncertainty for future economic events hampering the setup of the assumptions for the explanatory variables. The debate raised about such models and even the structural ones consists in their limitations to reflect the structural changes in the developing economies in general and in the Albanian economy in particular.

4.1. COMPARATIVE ANALYSIS OF FORECAST ACCURACY AMONG MODELS

The ME, RMSE and FD indicators are treated specifically in this section, presented in the group-charts 5, 6 and 7[17]. The results indicate that, for more than four quarters forecast horizons, the deviation in average terms is increasing. Also, for all models it is positive, implying lower prediction of annual inflation rate than the actual one under the period in review. For 1 - 4 quarters forecasting horizons no systematic errors have been identified. The model with the lowest ME/MEA is the one that combines the forecast results of four separate models by a simple mean. Combined forecast indicates that the size of the forecast error is smaller than in the other models, even than the ARIMA one, for 1- 6 quarters forecast horizons.

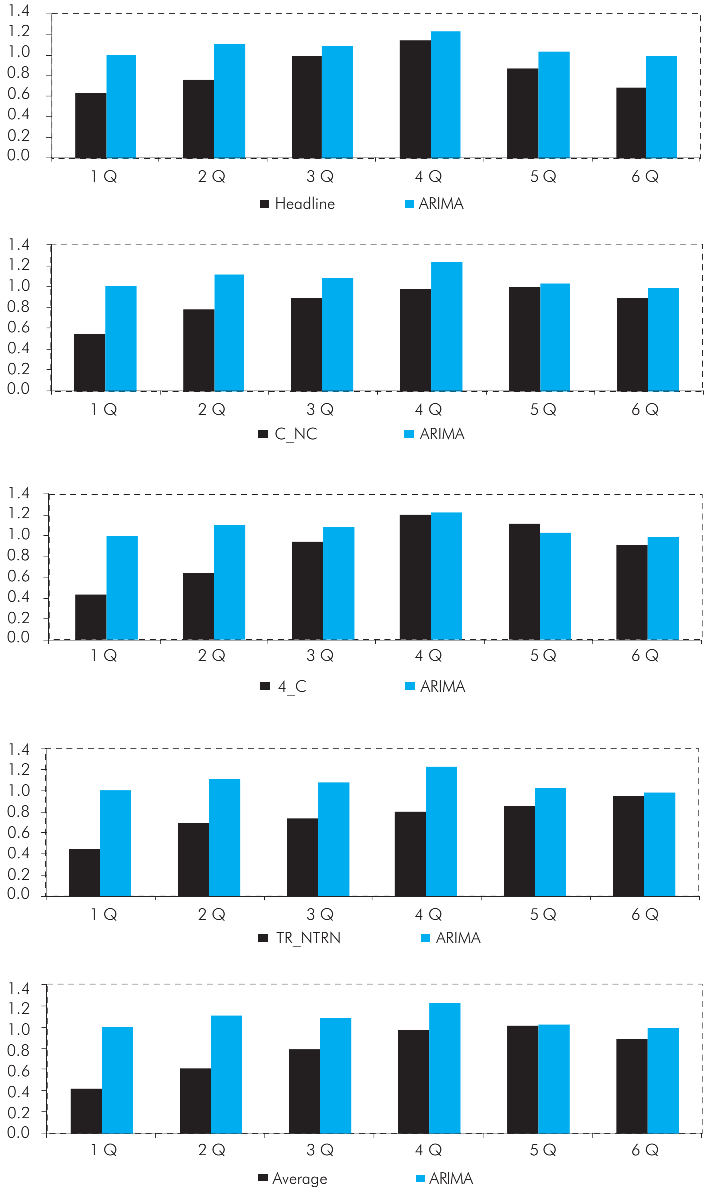
[17] The results of other indicators are presented in the Appendix 2. They can be interpreted based on the information provided in Box 2. For this section see charts 1, 2, 3 and tables 1 and 2.

Chart 5 ME for 1-6 quarters horizons: forecast models vs. the benchmark one



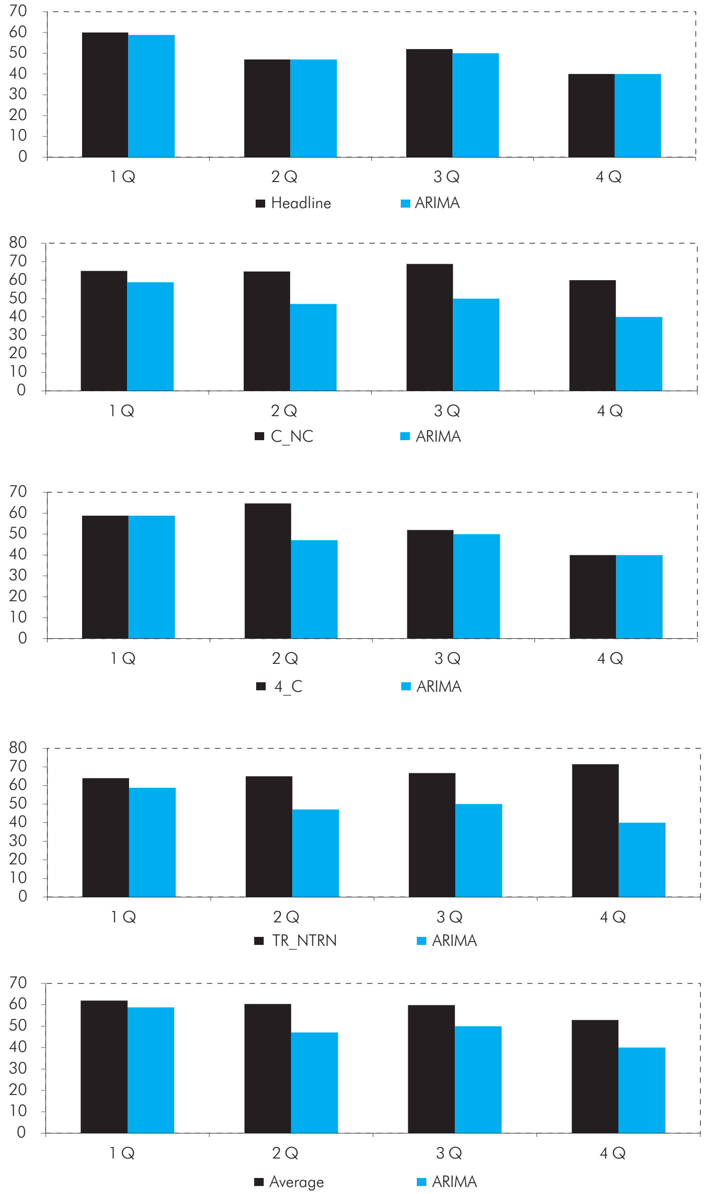
Source: Authors' estimates

Chart 6 RMSE for 1-6 quarters horizon: forecast models vs. the benchmark one



Source: Authors' estimates

Chart 7 FD for 1-6 quarters horizon: forecast models vs. the benchmark one



Source: Authors' estimates

RMSE results suggest that the model with the most accurate forecasts for 1-4 quarters horizons is the TR_NTR one. The 4_G model, presents a high RMSE for the four-quarter horizon, almost equal to that of the ARIMA. Nevertheless, the RMSE sizes support the average forecasts or the combined one. For all models, the RMSE increases with the extension of the forecasting horizon (1-4 quarters). This phenomenon is explained by the lack of information mainly regarding the foreign and regulated prices and other factors at the forecasting time. In relative terms, forecasting with individual models is more accurate than forecasting with ARIMA.

In terms of the FD, the most correct direction is found in a relatively higher degree from TR_NTRN and C_NC models. Over the period in analysis, both models forecast in the right direction, up to three quarters horizon, approximately on 70% of cases. Other models, including the average one, predict the forecast direction correctly at a range of 60%-65% of cases over the horizon of 1-2 quarters. The latter one is considered as a more appropriate horizon for interpreting the information given by the FD's indicator (Andersson, M. K., 2007).

All models in use represent a higher FD size than that of the ARIMA though comparable to it. This derives from the autoregressive nature of inflation, captured by all models. Meanwhile, as the ARIMA model is particularly concerned with this feature, other models include also additional information from other economic variables. FD results suggest that, in our case, the additional information has contributed to the improvement of this indicator.

4.2. PROPERTIES OF THE AVERAGE FORECAST

Practice and literature suggest that there is not a model and consequently a prediction that may be considered as "absolutely the best". Different models try revealing inflation developments in different forms and aspects. They signal the main trends of inflation indicating the relevance of factors affecting it and those that are expected to generate inflationary pressures in the future. Combining the results of certain projections in an average one, remains one of the most highly suggested methods, in order to avoid the over

/ underestimation of one or another forecasting model. When the forecasting experience is recent, applying a simple average is suggested. Different central banks and other institutions with a rich experience in the forecasting process, in most cases, apply average forecasts in the weighted version (Bjonland, H.C. et. al., 2010, Timmermann, A., 2005). Models with a small size of RMSE were given a higher weight in calculating the average forecast, because they supply a high accuracy over time horizons. The weighting size is determined based on the inverse of the variance of the forecast errors for each model.

As it was concluded from the comparative analysis of the inflation forecasting performance according to different models, the approach that averages all the forecast results, in our case, represents a more appropriate forecast, compared to individual models along the forecasting horizon. Based on this series, the Fan-Chart was designed in mid-2009. In the following, we analyze the optimality and efficiency of the forecasts according the above approach. To address these hypotheses, the approach employed is the forecasting performance analysis by Andersson. M.K. et. al. (2007), Bank of England and Deutsche Bundesbank (2009)[18], will be applied in the current section. The framework established by Nordhaus (1987), Mincer & Zarnowitz (1969), is used to test the optimality and efficiency of the inflation forecast in average terms.

Box 4: Properties of the optimal forecasts.

When a forecast series is optimal? In order to investigate this question the series of forecast errors should have several properties and testing the presence of optimality it needs long time series of the forecast errors.

The forecast errors series, FE (h), where (h) is the forecast horizon must be unbiased, which means that an optimal forecast in (t + h) horizon would be equal to the published value of inflation, in average terms. If the above condition is not fulfilled, the verification of other properties is not necessary to be done.

[18] Background Materials on the Deutsche Bundesbank's Workshop "Modelling and forecasting at the Central Banks", March 2010.

Optimal forecasts generate forecast errors FE (h), whose series should respect a MA process of an order lower than (h), then a MA (q) process, where q <h. For h = 1, the forecast error series follows a white noise process.

Optimal forecasts in (t + h) horizon generate an error series with non-increasing variance over the horizon (h), which converges to an unconditional variance process, therefore the errors are homoscedastic.

The forecast error series, FE (h) should be unpredictable using the information available at the forecast moment.

a. Is the average forecast unbiased? In order to examine the fulfilment of this essential property, a regression between the forecast errors series and a constant term for 1, 2, 3 and 4 quarters horizon was developed[19]. Then the result of the "t-test" for the constant term is analysed. If the null hypothesis, H0: " const = 0", is rejected, then the forecast errors will not be zero on average, therefore, they are systematic and the prediction was biased over time. The results (Appendix 2, Table 3) show that the H0 is not rejected with a convincing probability for all horizons. Hence, the average inflation forecast has been unbiased, with no systematic errors during the period in analysis. The fulfilment of this requirement is promising that in the long-term, inflation forecasts will converge to the actual inflation rates according the different forecasting horizons.

b. Does the average forecast generate forecast errors series that respect an MA (q) process, where q <h, therefore MA of order (q>= h) should have been insignificant? The test results (Appendix 2, Table 4) indicate that this condition is verified for h = 1 and 2, and partially for h = 3 and 4. Reducing the sample size may be one of the essential reasons that cause this "anomaly". Thus, the results support the optimality of the average forecast in the short term; meanwhile, for longer horizons it is not completely true.

[19] The regression for longer time horizons cannot give reliable results, because of the shortening of the forecast errors series.

c. Is the forecast suffering from the heteroscedasticity? Answering negatively to this question, the third condition for forecast optimality is satisfied. Therefore, the variance of errors does not increase in time. Forecasts made with individual models satisfy the condition of the homoscedasticity. Nonetheless, does the error of the average forecast suffer from heteroscedasticity? Is the error series of the average forecast a linear combination of the forecast errors derived from each model? In order to answer these questions, a simple regression model has been estimated. Forecast error series are examined about the presence of the trend component at h=1,2,3,4, given that const. = 0 in average terms (from a). Results of regression at h=1,2,3,4 significantly reject the presence of trend component (@ trend) and the increase of errors in time (Appendix 2, Table 5) as well as the presence of the heteroscedasticity based on the ARCH test results (Appendix 2, Table 6). This means that, although the deviations regarding the horizons during the given period rise, it is statistically rejected that this phenomenon is caused from the increased variance of errors in time.

d. Are the forecasting errors unpredictable? This property is difficult to be verified mainly due to the limitation from the short-time series. Nevertheless, for h=1,2 an attempt is made in order to investigate the following relationship:

$$FEt(h)_{,t} = a_0 + a_1 * Info(h)_{,t} + u_t \qquad (1),$$

where $FE_t(h)$ forecast error at the time (t) for horizon (h); Info. $(h)_{,t}$, the information until (t) time (third month of the current quarter), related to the inflation and other monthly variables; u_t – residuals/error term. This is a condition that forecasters take into consideration during the updating forecasts based on the most recent/new information. It is used to test whether the indicators published in a preliminary version (i.e. GDP), influence or not the forecast of errors. Errors must be independent of this fact, hence, unpredictable according to a functional relationship. They might be reduced, but not dependent on the amount of information until the forecast time. Given that there is no preliminary publication of inflation in Albania, we transformed this exercise assuming two monthly inflation figures within a quarter as preliminary figures for the quarterly inflation rate. This and new information coming in up to the moment of the quarterly forecast are incorporated to perform a new forecast round (update). According to the “t - test” in regression (1), the coefficients a_0 and a_1, must result insignificant. The results of the above regression are mixed. They are not convincing to conclude that the errors are completely unpredictable in updating inflation forecasts. The forecasting inflation process in Albania, based on the nature and amount of information collected in between the forecasting rounds, is not an appropriate case to perform this testing procedure.

5. CONCLUSIONS

The forecast performance analysis of the forecasting models at the Bank of Albania is considered as an integral part of the forecasting process in order to support an appropriate decision-making process of the monetary policy. Forecasting of one-year-ahead inflation, during 2007-2010, was not be able to capture the global shocks mainly from: (i) world price conjunctures (2007-2008); (ii) exchange rate (2009); and (iii) administered prices (2010). The lack of timely information, mainly for regulated prices, is identified as an essential factor in increasing the size of forecast errors during 2010.

Meanwhile, the risk scenarios for the exchange rate and foreign prices have contributed to the decision-making process with more accurate information for the inflation forecasts at shorter time horizons (less than four quarters). Updating inflation forecasts, based on the short-term models and the increased role of expert judgment was very supportive for the policy makers especially during uncertain time periods.

Forecasting based on different models is considered useful, because it captures different developments in the consumer price trends. All models perform better than the benchmark one, in terms of both accuracy - the smaller errors – and capturing the correct inflation direction particularly for the short-run horizon.

Combining and averaging the results of forecasts from each model has produced an optimal prediction with an acceptable statistical accuracy for building the risks balance of inflation up to four quarters horizon.

Information efficiency remains a hypothesis to be verified, as long as test results do not provide convincing answers in this regard.

A more accurate forecast for the exchange rate would help to increase the accuracy of inflation forecasting. The analysis of the average forecast performance shows that the results of inflation forecasting models should be considered in a horizon of no longer than six quarters, with particular emphasis on the horizon of four quarters from the time - forecast. The updating process of the forecasts turns out to be dependent on the monthly values of inflation and exchange rate developments within a quarter.

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APPENDIX 1

A SECTORAL MODEL FOR A SMALL AND OPEN ECONOMY

THEORETICAL FRAMEWORK

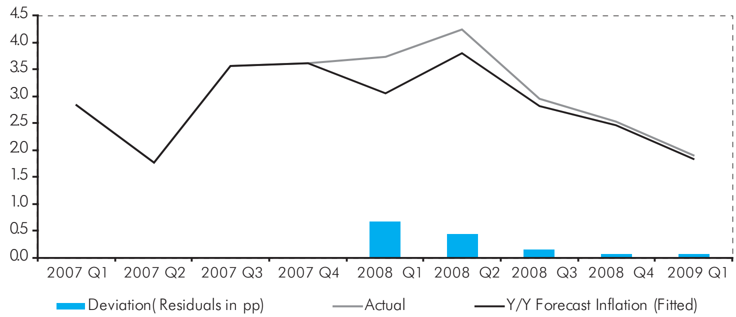
In a small and open economy, like the Albanian economy, inflation pressures are 'produced' by foreign and domestic developments, or through tradable and non-tradable sectors of the CPI basket, respectively. The first sector of the prices of goods is more exposed to developments in international markets facing directly the competition. This means that prices in this sector are mainly determined by the global conjuncture or the economic conjunctures in Albania's main trading partners. While the non-tradable sector prices are mainly determined by domestic factors/ demand. Therefore, inflationary process, for a small and open economy, can be modelled as a two-sectoral model.

SECTORAL MODEL AND VARIABLES

The dependent variables - price index for tradable and non-tradable (excluding regulated prices) - were tested for: stationarity (ADF - test); causality (Granger Causality) in the relationship with other potential explanatory variables. The SUR method is applied in the Weighted Least Squares (WLS) method and is used to model the simultaneous changes affecting price changes in both sectors of the CPI basket. The volatility of prices in one sector can be influenced by those that have occurred or are occurring in the other one. To correct the detected heteroscedasticity of errors, the Least Squares method is applied in its weighted version (WLS). Other variables participating in this model are: NEER, Food Prices Index in Greece, Regulated Prices Index, lagged variables of TR and NTRN inflations, the yield of the Treasury Bills for 12 months, and House Price Index (HPI) as a proxy for asset prices. The lagged TR inflation is also one of the variables that explain a part of the movements in the NTRN prices, trying to capture the pass-through from cost changes due to the pressures from commodity prices to those of services – mostly represented by NTRN sector of the CPI basket.

Variables in the model are included with reasonable lags. They are annual changes at quarterly frequencies (dlog (variable), 0, 4). Signs of variables are in line with the economic theory, while providing a reliable statistical significance (almost 95%). The adjusted determination coefficients, respectively for both equations in the model, result 0.73 and 0.83, suggesting a satisfactory fit of the estimated values with actual ones.

Chart 1 Actual Values, Forecasts and Deviations - Sectoral Model



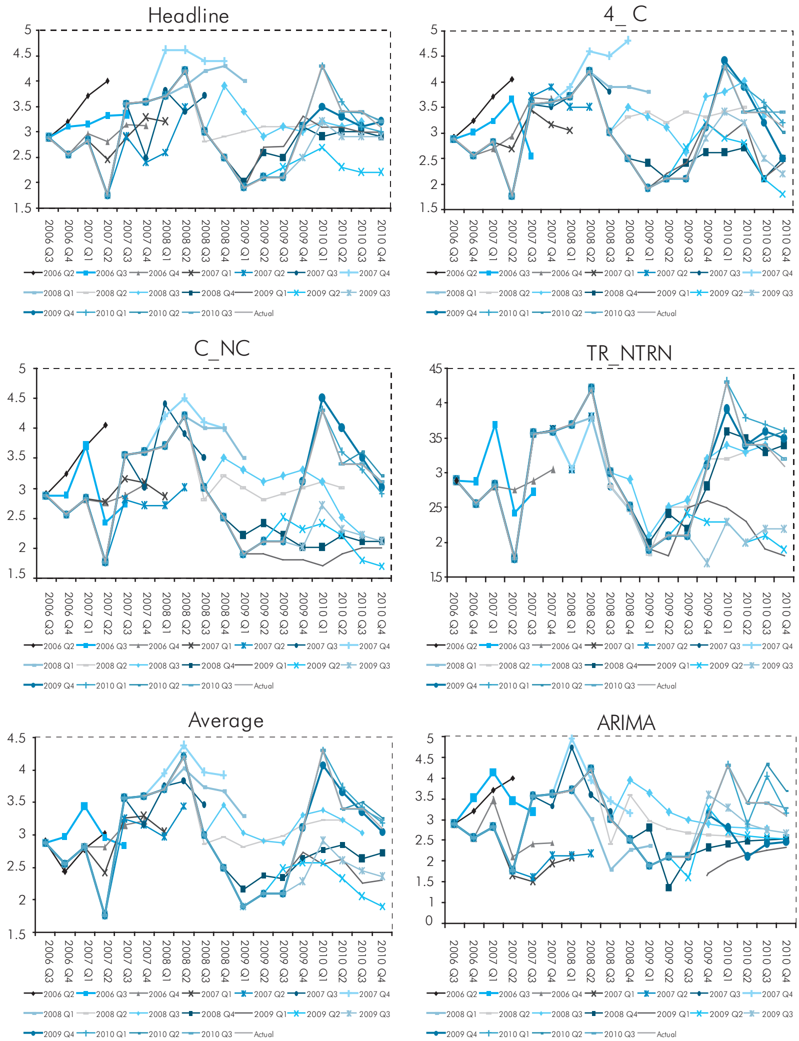
Source: E. Çeliku, Forecasting Unit, Monetary Policy Department, Bank of Albania

The deviation series presented in this chart are considered as moderate, although the out of sample forecasts coincide with a period of high economic uncertainty (2008-2009).

APPENDIX 2

ADDITIONAL RESULTS: CHARTS AND TABLES

Chart 1 Annual Actual and Forecast Inflation, quarterly, over 2006 Q2-2010 Q4



Source: Authors'estimates

Table 1 Other indicators for evaluating forecast accuracy according to different models and forecast horizons

Indicators	Horizons (h)					
MAE	1 Q	2 Q	3 Q	4 Q	5 Q	6 Q
Headline	0.50	0.64	0.83	0.92	0.70	0.56
4_C	0.31	0.49	0.70	1.02	1.00	0.80
C_NC	0.41	0.69	0.84	1.16	1.23	1.06
TR_NTRN	0.30	0.48	0.52	0.62	0.75	0.76
Average	0.33	0.47	0.63	0.86	0.91	0.78
ARIMA	0.86	0.99	0.93	1.03	0.86	0.92
RMSEN	1 Q	2 Q	3 Q	4 Q	5 Q	6 Q
Headline	0.24	0.35	0.52	0.54	0.97	0.68
4_C	0.20	0.25	0.45	0.53	0.70	0.46
C_NC	0.21	0.30	0.42	0.56	0.93	0.83
TR_NTRN	0.20	0.41	0.38	0.41	0.57	0.59
Average	0.22	0.27	0.48	0.50	0.81	0.60
ARIMA	0.24	0.29	0.54	0.61	1.44	1.78
CVRMSE	1 Q	2 Q	3 Q	4 Q	5 Q	6 Q
Headline	0.21	0.24	0.31	0.34	0.30	0.24
4_C	0.13	0.19	0.27	0.38	0.39	0.33
C_NC	0.18	0.25	0.33	0.45	0.60	0.49
TR_NTRN	0.15	0.23	0.27	0.30	0.32	0.34
Average	0.14	0.19	0.26	0.32	0.38	0.33
ARIMA	0.34	0.38	0.39	0.45	0.40	0.39

Source: Authors' calculations.

Table 2 RRMSE: RMSE of each model relative to the ARIMA one

R RMSE	Horizon (h)					
	1 Q	2Q	3Q	4 Q	5 Q	6 Q
Headline	0.63	0.69	0.91	0.93	0.85	0.69
4_C	0.43	0.57	0.87	0.99	1.09	0.92
C_NC	0.54	0.70	0.82	0.80	0.97	0.90
TR_NTRN	0.44	0.62	0.68	0.65	0.83	0.96
Average	0.42	0.55	0.73	0.79	0.98	0.90

Source: Authors' calculations.

*Table 3 Test for constant term**

Horizon (h)	n. obs.	constant (c)	t-Statistic	Prob.
1	20	-0.08	-0.77	0.45
2	19	-0.14	-0.95	0.36
3	18	-0.03	-0.16	0.88
4	17	0.05	0.18	0.86

Note:*H0: c=0. Unbiased

Source: Authors' calculations.

*Table 4 Test for MA(q) process for FE**

Horizon (h)	MA(q)	t-Statistic	Prob.
1 Verified White noise process	MA(1)	-2.02	0.07
	MA(2)	-1.33	0.21
	MA(3)	-0.73	0.48
	MA(4)	-1.87	0.09
2 Verified	MA(1)	-2.81	0.05
	MA(2)	-0.24	0.45
	MA(3)	-1.02	0.33
	MA(4)	-1.38	0.19
3 Verified	MA(1)	7.37	0.00
	MA(2)	-4.67	0.00
	MA(3)	0.26	0.80
	MA(4)	-0.48	0.36
4 Verified	MA(1)	4.10	0.00
	MA(2)	-2.06	0.06
	MA(3)	-2.74	0.02
	MA(4)	-0.67	0.48

Note:* MA (q<h), must be significant; MA (q>=h), no significant.
Source: Authors' calculations.

Table 5 Regress Results for the Trend of FE(h): FE(h) dependent variable

Horizon (h)	Variable	Coefficient	Std. Error	t-Statistic	Prob.
1	@TREND	-0.005	0.009	-0.552	0.589
2	@TREND	-0.006	0.013	-0.486	0.633
3	@TREND	0.003	0.016	0.183	0.858
4	@TREND	0.011	0.020	0.532	0.603

Source: Authors' calculations.

Table 6 ARCH test for heteroscedasticity

Horizon (h)	Variable	Coefficient	Std. Error	t-Statistic	Prob.
1	RESID^2(-1)	-0.196	0.266	-0.736	0.474
2	RESID^2(-1)	-0.124	0.266	-0.469	0.647
3	RESID^2(-1)	-0.097	0.276	-0.350	0.732
4	RESID^2(-1)	0.108	0.288	0.374	0.715

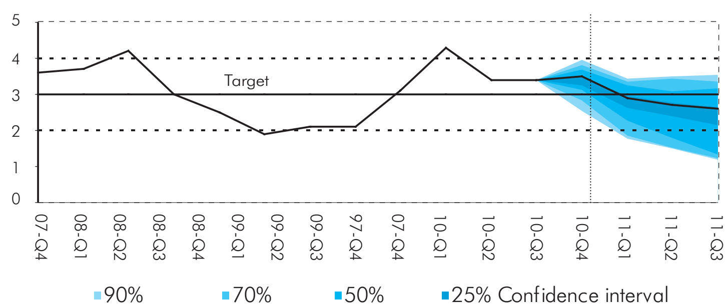
Source: Authors' calculations.

APPENDIX 3

FAN-CHART

Although efforts to reduce the forecast errors in the future through improvements in modelling, forecast errors will always remain, originating in several sources of uncertainty. There are limitations to the ability of any forecast model. One source of uncertainty pertains to the assumptions framework versus the actual developments of exogenous variables. Another one is related to the errors of the econometric models in use. The average forecast, used by the BoA, actually tries to eliminate, considerably, errors generated by uncertainties that would exist if it relied only on a single model. The greatest concern of point estimates relates to the drawback that these predictions focus on one forecast value without assessing the degree of uncertainty surrounding it. Fan chart is a simple way to introduce the assessment of forecast error, otherwise known as "risk assessment" in the forecast inflation. The gradually spreading fan, during the forecast period, depicts the increase of uncertainties around the central projection. It highlights the fact that the degree of uncertainty or forecast error grows over time. A lighter shade is given to the highest and lowest percentiles reflecting the amount of confidence in these forecasting values. There are four degrees of shading confidence: 25%; 50%; 75%;

Grafik 1. Fan Chart presented in 2010 Q3 from the Monetary Policy Department, BoA



Source: G. Hashorva, Forecasting Unit, Monetary Policy Department, Bank of Albania and 90%. Inflation forecast value falling in the ranges of the darkest shade has a 25% probability to occur. Further up, the values found in the area with lighter tonalities have a 90% probability to occur.

The fan-chart presentation below shows that risks are in downside, supporting the non-increasing risks for inflationary pressures at the end of the forecast horizon (after four quarters).

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