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Proposal of New Forecast Measures: M Indicator for Global Accuracy of Forecast Intervals

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Abstract

The objective of this study is to analyse the problem of forecasts accuracy from two aspects: the point predictions and forecast intervals. For the point predictions the classical measures of accuracy were used by adding some new indicators for forecasts of quantitative variables. For forecast intervals, there are no specific measures of accuracy mentioned in the literature. Therefore, this paper proposes different methods for constructing the intervals and some measures of accuracy for this type of forecasts as a novelty in literature. Classical and proposed accuracy measures of predictions were computed for the inflation and unemployment rate forecasts provided for Romania by the European Commission, Institute for Economic Forecasting (IEF) and National Commission of Prognosis (NCP) on the horizon 2010-2012, the best forecasts being proposed by IEF. A novelty in literature is also brought by introducing the methods of building forecast intervals. To the classical interval based on the root mean squared error method, we add the intervals based on the standard deviation and those constructed using bootstrap technique bias-corrected-accelerated (BCA) bootstrap method. Also M indicator was proposed to evaluate the global accuracy of forecast intervals.

Key Words: Point forecasts, forecast intervals, accuracy, U Theil's statistic, Bootstrap technique, M indicator

1. Introduction

The M indicator proposed in this article is a measure of global accuracy

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that takes into account the variation of a value in the interval compared to the real one which can be inside or outside of the forecast intervals.

In this study the new proposed accuracy measures were used to assess the forecasts of inflation and unemployment rate provided by: European Commission (EC), Institute for Economic Forecasting (IEF) and National Commission of Prognosis (NCP). Results based on the new measures of evaluating predictions' accuracy by comparison are different from those based on classical measures of accuracy. Only the best forecast is indicated by the usual measures of accuracy and also by our proposed indicators.

The study is structured in various sections; the introduction is followed by a brief literature review that contains some of the proposed indicators of accuracy for point forecasts. Third section is related to the assessment of point forecasts using the classical and the proposed indicators. The fourth section bring novelties from two points of view: the new method of building forecast intervals using BCA bootstrap technique and the new accuracy measures like, M indicators, number of errors and absolute and average distances between the real value and values like the limits or the intervals' centres.

2. Literature Review

Most international institutions provide their own macroeconomic forecasts. It is interesting that many researchers compare the predictions of those institutions (Melander for European Commission, Vogel for OECD, Timmermann for IMF) with registered values and those of other international organizations, but omit comparison with official predictions of the government.

Abreu (2011) evaluated the performance of macroeconomic forecasts made by IMF, European Commission, OECD and two private institutions (Consensus Economics and The Economist). The author analyzed directional forecast accuracy and the ability of predicting an eventual economic crisis.

Bratu (2012 a) evaluated the accuracy of some macroeconomic predictions for Romania made by the Institute of Economic Forecasting and National Commission of Prognosis. The later institution report more accurate forecasts for inflation, unemployment, GDP deflator, exports and exchange rate on the horizon 2004-2011.

Novotny and Rakova (2012) assessed the accuracy of macroeconomic forecasts made by Consensus for the Czech Republic, observing an improvement in accuracy from one year to another on the horizon of 1994-2009. The authors also proposed a regression for comparing the predictions.

Genrea, Kenny, Meylera and Timmermann (2013) made forecast combinations starting from SPF predictions for ECB and used performance-based weighting, trimmed averages, principal components analysis, Bayesian shrinkage and least squares estimates of optimal weights. Only for the inflation rate there was a strong evidence of improvement in the forecasts accuracy with respect to the equally weighted average predictions.

Thus it can be concluded that there are several accuracy measures for forecasts, the actual trend being the evaluation of predictions provided by official institutions in a country. Therefore, for this study three institutions are selected that provide macroeconomic forecasts for the Romanian economy.

3. The Assessment of Point Forecasts Accuracy

To understand the assessment of point forecasts accuracy, it is usually suggested that if X is the predicted quantitative variable, the forecast error is computed as the difference between the registered and the predicted value: e_x. According to Fildes and Steckler (2000), the frequently used indicators for evaluating the forecasts accuracy, are computed as:

Root Mean Squared Error (RMSE): $RMSE = \sqrt{\frac{1}{n}\sum_{j=1}^{n} e_X^2}$

Mean error (ME): $ME = \frac{1}{n}\sum_{j=1}^{n} e_X$ and

Mean absolute error (MAE): $MAE = \frac{1}{n}\sum_{j=1}^{n} | \ e_X \ |$

These measures of forecast accuracy though often used have some disadvantages. For example, RMSE is affected by outliers. These measures are not independent of the unit of measurement, unless if they are expressed as percentage. If we have two forecasts with the same mean absolute error, RMSE penalizes the one with the biggest errors.

Apart from the above mentioned indicators of forecast accuracy, the U Theil's statistic, used in making comparisons between forecasts is computed in two variants, specified also by the Australian Treasury. The following notations are used:

a- the registered results
p- the predicted results
t- reference time
e- the error (e=a-p)
n- number of time periods

$$U_1 = \frac{\sqrt{\sum_{t=1}^{n}(a_t - p_t)^2}}{\sqrt{\sum_{t=1}^{n} a_t^2} + \sqrt{\sum_{t=1}^{n} p_t^2}} \qquad U_2 = \sqrt{\frac{\sum_{t=1}^{n-1}\left(\frac{p_{t+1} - a_{t+1}}{a_t}\right)^2}{\sum_{t=1}^{n-1}\left(\frac{a_{t+1} - a_t}{a_t}\right)^2}}$$

A value close to zero for U_1 implies a higher accuracy while a U_2 less than one supposes better forecasts than the naïve one.

Given, these indicators of forecast accuracy, this paper proposes the introduction of some new measures of accuracy:

- Mean difference (between the mean of registered values on the forecasting horizon and the mean of forecasted values): $md = \bar{a} - \bar{p}$
- The mean difference between each predicted value and the mean of the effective values on the forecasting horizon: $\bar{d} = mean(p_t - \bar{a})$.
- Radical of order n of the mean squared errors: $$RnMSE = \sqrt[n]{\frac{1}{n}\sum_{j=1}^{n} e_X^2}$$
- For comparisons with the naive forecasts a new indicator is computed: the ratio of radicals of the sum of squared errors i.e. $$(RRSSE) = \frac{\sqrt[n]{\sum_{t=1}^{n} e_t^2}}{\sqrt[n-1]{\sum_{i=2}^{n} (X_i - X_{i-1})^2}}$$

In order to compare two forecasts for different variables, the values of this indicator are compared and a value closer to zero indicates a better accuracy.

Thus, the new indicators proposed by this paper enrich the literature by the fact that the accuracy is seen from a different point of view, taking into account a more emphasized average perspective like md and $\bar{d}$. Moreover, the high importance given to large errors is diminished by computing indicators like RRSSE and RnMSE that use the radical of order n.

The new accuracy measures are computed for the inflation and unemployment rate provided by the Institute for Economic Forecasting (IEF), European Commission (EC) and National Commission of Prognosis (NCP) on the forecasting horizon 2010-2012. Before doing so, Table 1 provides a comparison of first of all some usual accuracy indicators.

Table 1
Classical Measures of Accuracy for the Forecasts by IEF, EC and NCP for Inflation and Unemployment Rates

Accuracy Indicator	IEF-Inflation Rate	IEF- Un employment Rate	NCP-Inflation Rate	NCP-Unemployment Rate	EC-Inflation Rate	EC- Un employment Rate
ME	0.8700	-0.4000	-0.1558	-0.9270	-0.568	-0.8936
MAE	0.9250	1.4000	0.5043	1.1770	0.853	1.275
RMSE	1.1673	1.5732	0.6289	1.3020	1.458	1.476
U1	0.1194	*0.0669*	0.1308	*0.1023*	0.1239	0.1103
U2	1.0082	1.6005	0.8714	1.2268	1.2576	1.0476

Author's computations using Excel

According to U1 indicator IEF unemployment forecasts are the most accurate, while the other indicators (ME, MAE and RMSE) have the lowest values for NCP inflation forecasts. These predictions are also better than the naive ones. The IEF inflation estimations are followed by those of NCP unemployment rate, IEF inflation, EC unemployment rate, EC inflation rate and NCP inflation. Except the IEF forecasts for inflation rate, all the other forecasts are overestimated and shock in the economy are not taken into account.

According to the new accuracy measures, the best forecasts are provided by IEF for the inflation rate, the difference between the mean of registered values and that of the predictions being only of -0.2043. The same value in absolute terms for mean of the deviation of each predicted value from the average of effective values supports the persistence of overestimation of the average value. The hierarchy of predictions regarding accuracy is evaluated

Table 2
New Measures of Forecast Accuracy by IEF and NCP for Inflation and Unemployment Rate

Accuracy Indicator	IEF-Inflation Rate	IEF- Un employment Rate	NCP-Inflation Rate	NCP- Un employment Rate	EC-Inflation Rate	EC- Un employment Rate
RnMSE	0.8079	1.2697	1.1242	1.4470	1.1125	1.325
Md	-0.2043	-0.9693	0.7967	-0.2333	0.386	-0.8576
d	0.2043	0.9693	-0.7967	0.2333	0.386	-0.8576
RRSSE	0.5867	0.7166	0.8164	0.8167	0.779	0.805

Author's computations using Excel

using the RRSSE indicator: forecasts of IEF for inflation and unemployment rate, EC forecasts for inflation and unemployment rate, NCP forecasts for inflation and unemployment respectively. The hierarchy is different from that resulting from applying U_1 or the other classical measures of accuracy.

The U_2 statistic can be modified in order to make the comparisons with other forecasts:

- The filtered naïve forecasts (U_2*);
- The smoothed naïve forecasts (U_2**);
- The new forecasts (U_2***).

The filtered forecasts are obtained using Hodrick-Prescott filter and the smoothed naïve forecasts are obtained using Holt-Winters technique. Whereas the formula for the new U_2 is:

$$U_2 = \sqrt{\frac{\sum_{t=1}^{n-1}\left(\frac{p_{t+1} - a_{t+1}}{a_t}\right)^2}{\sum_{t=1}^{n-1}\left(\frac{a^*_{t+1} - a^*_t}{a^*_t}\right)^2}}$$

a*- transformed actual (effective/real) values (filtered/smothered/ values of new forecasts based on the proposed model).

Table 3
The U_2 Transformed Statistic for the Forecasts Made By IEF, EC and NCP for Inflation and Unemployment Rate

Forecasts	U_2*	U_2**	U_2***
IEF inflation rate	0.6773	0.8230	0.6773
IEF unemployment rate	0.6347	0.8829	0.6347
NCP inflation rate	1.0752	1.3064	1.3064
NCP unemployment rate	0.8935	1.2431	1.2431
EC inflation rate	0.7959	1.0253	1.1377
EC unemployment rate	0.8569	1.2856	1.2767

Source: Author's computations using Excel

The transformed U_2 statistic is computed for the new forecasts of reference. The values of U_2 are displayed in the following table, the indicators are denoted by U_2*, U_2** and U_2***:

U_2* statistic values show that, except the NCP inflation rate, all the other predictions are better than the filtered naïve forecasts based on Hodrick-Prescott filter. The result is justified by the fact that the values of U_2* are less than 1. The indicators forecasted by IEF are more accurate than the smooth naïve ones in Holt-Winters variant and even from the forecasts estimated from the proposed model. For NCP predictions and those of EC, the situation is exactly the opposite compared to smooth naïve forecasts and values of the new forecasts.

4. The Assessment of Forecast Interval Accuracy

In this study some methods of building forecast intervals are proposed.

Firstly, to construct the forecast intervals the predictions provided by NCP in the pessimistic and optimistic versions and those of IEF are taken into account.

As the sample of forecasts has low volume, so the t-Student distribution is used.

$$\overline{infl}(t)-t_{\alpha,n-1}\cdot RMSE*_t<\text{forecasts}<\overline{infl}(t)+t_{\alpha,n-1}\cdot RMSE*_t$$

The average of all the predictions that were proposed by forecasters is computed and the standard deviation corrected with the number of forecasts will be utilized in constructing new forecast intervals:

$$\overline{infl}(t)-t_{\alpha,n-1}\cdot\frac{s_t}{\sqrt{n-1}}<\text{forecasts}<\overline{infl}(t)+t_{\alpha,n-1}\cdot\frac{s_t}{\sqrt{n-1}}$$

Other forecast intervals constructed use the RMSE of the previous year, where the RMSE is computed differently as the root mean square of differences between each prediction of a year made by a certain institution and the real value of the indicator.

$$\overline{infl}(t)-t_{\alpha,n-1}\cdot RMSE_t < \text{forecasts} < \overline{infl}(t)+t_{\alpha,n-1}\cdot RMSE_t$$

A resampling technique is applied to build forecast intervals that consist of replicating the sample of predictions a huge number of times. Basically, a proxy population is made starting only from a sample, which is actually an artificial population.

Table 4
Forecasts Intervals for Unemployment Rate on the Forecasting Horizon 2001-2012

	Forecasts Intervals Based on:					
Year	Bootstrap Technique	BCA Bootstrap Method	Previous Registered Value	Forecasts' Standard Deviation	Real Values	Historical RMSE
2001	8.11-9.90	8.1895-9.9000	5.7750-9.850(	8.547-9.514	8.8	7.416-10.672
2002	7.30-9.20	7.3750-9.2000	6.315-9.2850	7.841-8.808	8.4	6.600-0.990
2003	6.55-8.90	6.7250-8.9000	4.999-10.541	7.212-8.412	7.4	5.733-9.891
2004	6.80-8.60	6.9000-8.2500	4.663- 9.9220	7.354-8.245	6.3	6.256-9.343
2005	6.37-8.40	6.3700-8.2775	1.855-12.225	7.313-8.226	5.9	6.188-9.351
2006	5.92-7.80	5.9200-7.7625	2.575-10.990	6.563-7.728	4.0	5.782-8.802
2007	5.54-7.60	5.5400-6.3800	3.832-10.418	6.563-7.728	4.4	5.389-8.690
2008	5.14-7.40	5.1400-7.3475	3.799-9.166	6.26-7.304	5.8	4.973-8.591
2009	4.71-8.40	4.7100-8.0475	6.534-8.015	6.297-7.952	7.5	4.259-9.990
2010	4.30-7.40	4.9325-7.4000	5.775-9.850	5.778-7.185	6.9	4.048-8.916
2011	6.89-7.50	6.8900-7.4270	6.315-9.285	7.136-7.412	5.3	6.795-7.753
2012	5.20-6.70	5.2000-6.6250	4.999-10.541	8.547-9.514	8.8	4.555-7.269

Source: Author's computations using Excel

The bias-corrected-accelerated interval (BCA) is a complex bootstrap technique used to construct confidence intervals. In this case, Davison and Hinkley (1997) showed that estimates for bias and acceleration are provided using the initial sample and the bootstrap samples.

One accuracy measure for forecast intervals could be the number of intervals in which the real value is placed.

In all 6 out of 11 values of the unemployment rate are placed in the bootstrap intervals and in the historical RMSE intervals, while 7 in the BCA bootstrap intervals and in the intervals based on the standard deviation. The majority values (10 out of 11) are located in the intervals based on the previous registered value.

Other measures of accuracy for forecast intervals can be computed. Differences between the realized value for a specific year and the lower limit of each interval or the upper one and even the interval midpoint could be considered as suitable measures of predictions accuracy. A lower difference implies a better forecast interval.

d1= realized - lower limit
d2= realized - upper limit
d3= realized – interval midpoint

Starting from these deviations we can compute their average or their absolute average on the forecasting horizon.

Table 5
Forecasts Intervals for Inflation Rate (2001-2012)

	Forecast Intervals Based on:					
Year	Bootstrap Technique	BCA Bootstrap Method	Previous Registered Value	Forecasts' Standard Deviation	Real Values	Historical RMSE
2001	33.8-37.2	33.80-36.350	-16.70-87.200	33.832-36.667	34.5	32.158-38.341
2002	26.0-28.3	26.00-27.850	14.36-39.480	25.995-27.854	22.5	23.752-30.097
2003	17.0-19.0	17.00-18.825	11.32-25.320	17.549-19.100	15.3	9.716-26.9330
2004	11.9-14.8	12.3525-14.4	10.30-16.890	12.594-14.610	11.9	7.650-19.5540
2005	09-13.74	09.00-12.607	5.920-14.540	8.3150-12.1590	09.0	6.427-14.0470
2006	07.0-8.60	07.00-08.200	5.250-10.130	7.0200-837400	6.56	3.191-12.2030
2007	05.0-8.14	05.00-07.535	3.580-8.3400	4.7130-7.21600	4.84	3.415-8.51400
2008	03.6-8.50	03.60-07.275	1.657-10.262	3.7150-8.20000	7.85	2.668-9.25100
2009	04.5-8.25	04.50-7.3125	1.386-10.038	4.2570-7.16700	5.59	0.0350-11.460
2010	06.2-8.29	06.20-7.8175	04.347-9.197	5.9360-7.60800	6.09	3.8520-9.6920
2011	03.8-9.11	03.80-7.7825	1.721-9.1840	3.3850-7.52100	5.80	3.338-7.56800
2012	04.9-8.77	05.05-8.0775	3.57-8.81400	4.7250-7.65900	3.60	2.004-10.3800

Source: Own computations using Excel

For the forecast intervals of inflation rate based on bootstrap technique, the lowest value is registered by d2, but when absolute values of deviation are taken into account d2 is the highest.

BCA bootstrap method gave the best results for d1 (0.069), which is the lowest value for all the methods. On average, the deviation between realized and the lower limit is 0.069 percent while the one between the realized and the intervals' midpoint is around 1.23 percent.

d3 registered the lowest value compared to d1 and d2 when the method applied is based on the previous registered value.

When the forecast intervals are based on standard deviation, d1 registers again the best value. It maintains to be the minimum even if the absolute values of the deviations are computed.

According to the values of d1, d2 and d3 and the corresponding values for absolute deviations, the BCA bootstrap technique provide the best intervals for inflation rate.

A negative value but better than d1 and d2 is registered when the historical RMSE is utilized.

For the unemployment rate forecast intervals the best value is registered for d3 when BCA bootstrap method is applied, d1 is a good measure of accuracy for this method, whereas d2 has the lowest value for intervals based on the bootstrap method.

So, the new accuracy measures recommend the forecast intervals based on BCA bootstrap technique for inflation (d1) and for unemployment rate (d3).

However, it is important to compute a measure of global uncertainty or an indicator of global accuracy for all the determined intervals, even if these contain or not the real value. Therefore, a new indicator is proposed, called M indicator, that is computed as a sum of errors for the two cases: when the real value is not in the interval and when the real value is in the forecast interval. For the first case, it is calculated as the root mean square of the deviations between the effective value and the inferior limit (if the real value is lower than the inferior limit) and the difference between the real value and the superior limit (if the real value is greater than the upper limit). This root mean square of the deviations can be considered a modified RMSE, because the reporting is not done according to a certain limit of the intervals (inferior or superior limit), but in a variable way so as to have a minimum distance between the real value and a limit. This indicator was denoted by RMSE*.

In order to get an indicator is coefficient of variation, this RMSE* is divided by the deviations' average (errors average). For the second case, when the effective value is placed in the interval, the root squared average of the deviations using the minimum of the distance between the inferior limit and the real value and the difference between the supeior limit and the real value. This squared mean deviation is denoted by RMSE** and it is divided by the average of minimum distances. Using the previous explanations, the following formula can be utilized in order to compute the indicator M, as a measure of global accuracy of the forecast intervals:

$$M = \frac{RMSE*}{media\ abaterilor\ minime1} + \frac{RMSE**}{media\ abaterilor\ minime2}$$

If the indicator M for intervals on a horizon is less than the value for intervals based on another method, the first procedure gives better results. The M measure is computed for the interval forecasts based on the four proposed methods, mentioned in Table 6.

According to the M indicator the best method of building forecast intervals is that of BCA bootstrap, followed by the bootstrap method, historical RMSE**,** previous registered value and forecasts' standard deviation.

The limit of M indicator proposed is that not all the values in the interval are taken into account to compute it, but only some specific values (the limits or the center of the interval). Actually, there are infinite values in an interval; if worked with the assumption of a normal distribution, the intervals' midpoint can be taken into account, but for this study intervals are not symmetrical and the hypothesis of a normal repartition is not checked.

Table 6
M Indicator for Forecasts Intervals of Inflation Rate (2001-2012)

Forecastin Horizon	Forecasts Intervals Based on:				
2001-2012	Bootstrap Technique	BCA Bootstrap Method	Previous Registered Value	Forecasts' Standard Deviation	Historical RMSE
M Indicator	1.758	1.649	1.957	2.303	1.862

5. Conclusion

This research enlarges the perspective of measuring forecast accuracy, by proposing some new measures for point forecasts and also for forecast intervals. The proposed measures draw attention about different results that may be registered when more predictions are compared. U1 Theil's statistic and the new indicator (ratio of radicals of sum of squared errors) gave different results regarding the hierarchy of forecasts. However, the indicators showed the same forecast as the most accurate forecast. Therefore, the new measure could be used to identify the most accurate forecast. Our indicator reduces the too large weight assigned to large errors.

The BCA bootstrap technique gave the best results for the accuracy measures of the prediction intervals for Romanian inflation and unemployment. The measures of accuracy proposed for forecast intervals are a novelty in this field.

A real innovation is given by the introduction of M indicator as a global measure of accuracy; this measure also indicates the forecast interval, based on BCA bootstrap technique as the best one.

The assessment of forecasts accuracy is really useful in order to select the best prediction that will then be utilized in decisional process or to improve the forecasting method. The ex-post accuracy evaluation is a strong clue that in the future, a certain institution with the highest performance will perform at the same level. It is recommended to accompany each prediction by the evaluation of the degree of accuracy, because not all our forecasts are very good.

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Appendix 1

The New Accuracy Measures for Forecast Intervals of Inflation

Forecasts Based on Bootstrap Technique						
	Accuracy Measures					
Year	d1	d2	d3	ǀd1ǀ	ǀd2ǀ	ǀd3ǀ
2001	0.7	-2.7	-1	0.7	2.7	1
2002	-3.5	-5.8	-4.65	3.5	5.8	4.65
2003	-1.7	-3.7	-2.7	1.7	3.7	2.7
2004	0	-1.81	-0.905	0	1.81	0.905
2005	0	-0.21	-0.105	0	0.21	0.105
2006	-0.44	-1.63	-1.035	0.44	1.63	1.035
2007	-0.16	-3.36	-1.76	0.16	3.36	1.76
2008	4.25	-0.29	1.98	4.25	0.29	1.98
2009	1.09	-2.66	-0.785	1.09	2.66	0.785
2010	-0.11	-2.2	-1.155	0.11	2.2	1.155
2011	2	-3.31	-0.655	2	3.31	0.655
2012	-1.3	-5.17	-3.235	1.3	5.17	3.235
average	-1.33375	1.270833	2.736667	1.66375	2.736667	1.66375

	Forecasts Based on BCA bootstrap Technique					
	Accuracy Measures					
Year	d1	d2	d3	|d1|	|d2|	|d3|
2001	0.7	-1.85	-0.575	0.7	1.85	0.575
2002	-3.5	-5.35	-4.425	3.5	5.35	4.425
2003	-1.7	-3.525	-2.6125	1.7	3.525	2.6125
2004	0	-2.5	-1.25	0	2.5	1.25
2005	0	-3.6075	-1.80375	0	3.6075	1.80375
2006	-0.44	-1.64	-1.04	0.44	1.64	1.04
2007	-0.16	-2.695	-1.4275	0.16	2.695	1.4275
2008	4.25	0.575	2.4125	4.25	0.575	2.4125
2009	1.09	-1.7225	-0.31625	1.09	1.7225	0.31625
2010	-0.11	-1.7275	-0.91875	0.11	1.7275	0.91875
2011	2	-1.9825	0.00875	2	1.9825	0.00875
2012	-1.3	-4.4775	-2.88875	1.3	4.4775	2.88875
average	0.069167	-2.54188	-1.23635	1.270833	2.637708	1.639896

	Forecasts Based on Previous Registered Value					
	Accuracy Measures					
Year	d1	d2	d3	|d1|	|d2|	|d3|
2001	51.2	-52.7	-0.75	51.2	52.7	0.75
2002	8.14	-16.98	-4.42	8.14	16.98	4.42
2003	3.98	-10.02	-3.02	3.98	10.02	3.02
2004	1.6	-4.99	-1.695	1.6	4.99	1.695
2005	3.08	-5.54	-1.23	3.08	5.54	1.23
2006	1.31	-3.57	-1.13	1.31	3.57	1.13
2007	1.26	-3.5	-1.12	1.26	3.5	1.12
2008	6.193	-2.412	1.8905	6.193	2.412	1.8905
2009	4.204	-4.448	-0.122	4.204	4.448	0.122
2010	1.743	-3.107	-0.682	1.743	3.107	0.682
2011	4.079	-3.384	0.3475	4.079	3.384	0.3475
2012	0.03	-5.214	-2.592	0.03	5.214	2.592
average	7.234916667	-9.655416667	-1.21025	7.234916667	9.655416667	1.58325

Forecasts Based on Forecasts' Standard Deviation						
Accuracy Measures						
Year	d1	d2	d3	|d1|	|d2|	|d3|
2001	0.668	-2.167	-0.7495	0.668	2.167	0.7495
2002	-3.495	-5.354	-4.4245	3.495	5.354	4.4245
2003	-2.249	-3.8	-3.0245	2.249	3.8	3.0245
2004	-0.694	-2.71	-1.702	0.694	2.71	1.702
2005	0.685	-3.159	-1.237	0.685	3.159	1.237
2006	-0.46	-1.814	-1.137	0.46	1.814	1.137
2007	0.127	-2.376	-1.1245	0.127	2.376	1.1245
2008	4.135	-0.35	1.8925	4.135	0.35	1.8925
2009	1.333	-1.577	-0.122	1.333	1.577	0.122
2010	0.154	-1.518	-0.682	0.154	1.518	0.682
2011	2.415	-1.721	0.347	2.415	1.721	0.347
2012	-1.125	-4.059	-2.592	1.125	4.059	2.592
average	0.1245	-2.550416667	-1.212958333	1.461666667	2.550416667	1.586208333

Forecasts Based on Historical RMSE						
Accuracy Measures						
Year	d1	d2	d3	|d1|	|d2|	|d3|
2001	2.342	-3.841	-0.7495	2.342	3.841	0.7495
2002	-1.252	-7.597	-4.4245	1.252	7.597	4.4245
2003	5.584	-11.633	-3.0245	5.584	11.633	3.0245
2004	4.25	-7.654	-1.702	4.25	7.654	1.702
2005	2.573	-5.047	-1.237	2.573	5.047	1.237
2006	3.369	-5.643	-1.137	3.369	5.643	1.137
2007	1.426	-3.674	-1.124	1.426	3.674	1.124
2008	5.182	-1.401	1.8905	5.182	1.401	1.8905
2009	5.625	-5.905	-0.14	5.625	5.905	0.14
2010	2.238	-3.602	-0.682	2.238	3.602	0.682
2011	2.462	-1.768	0.347	2.462	1.768	0.347
2012	1.596	-6.78	-2.592	1.596	6.78	2.592
average	2.949583333	-5.37875	-1.214583333	3.15825	5.37875	1.5875

Appendix 2

The New Accuracy Measures for Forecast Intervals of Unemployment

Forecasts Based on Accuracy measures						
Average	d1	d2	d3	|d1|	|d2|	|d3|
Bootstrap method	0.5558	-1.5250	-0.4846	1.4925	1.8750	1.3171
BCA bootstrap method	0.4673	-1.3348	-0.4337	1.4207	1.6973	1.2429
Previous forecast value	1.8387	-3.3823	-0.7718	2.0078	3.3823	1.2457
Forecasts' standard deviation	-0.4926	-1.5440	-1.0183	1.0889	1.5440	1.1632
Historical RMSE	0.9547	-2.4797	-0.7625	1.7137	2.7352	1.3896