Developing Forecasting Models for Unemployment Rate by Gender: Cross Countries Comparison

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Abstract

In this paper the best forecasting model for unemployment rates for each gender in selected European countries are developed using yearly official time series data assuming the socio-economic and other circumstances in the analysed countries in the short time horizon would remain unchanged. Separate forecasting models are developed for male and female unemployment rates. The paper shows cross-country comparison of the forecasting models efficiency for short-term forecasts for both genders. Countries in the focus are: Austria, with the lowest unemployment rates, and several with very high rates, such as Spain, Greece, both with the highest unemployment rates, Croatia, Portugal, Slovenia, the potential EU candidates: Albania, Bosnia and Herzegovina, Montenegro, and the official candidates: the FYR of Macedonia, Serbia and Turkey. Linear trend forecasting using ordinary least squares estimators was the most precise for some countries, while for the others double exponential smoothing forecasting appeared to be the most precise.

Keywords: unemployment rate; regression forecasting models; double exponential smoothing forecasting method; mean absolute percentage error MAPE

1. Introduction

The aim of this paper is to develop the most precise forecasting models for forecasting the future yearly unemployment rates in selected European and several non-European countries. Therefore, several forecasting methods for modelling time series with trend component, were selected, namely: linear trend forecasting and double exponential smoothing. The results of the empirical analysis showed that the optimal model for forecasting unemployment rate in some countries id double exponential smoothing model, but in some countries it is linear or quadratic trend.

According to European Economic Forecast (2014) a more lasting recovery is now taking place in the EU-28 and the euro area after being a double-dip recession noticed since 2008. In the second half of 2014 business indicators show recovery that is gradually gaining strength and spreading across the EU-28. Growth indeed turned positive in a large majority of EU member states over the course of 2013 and the outlook has improved even in the more vulnerable ones. Revisions to the winter 2013 forecast are minor.

2. Literature review

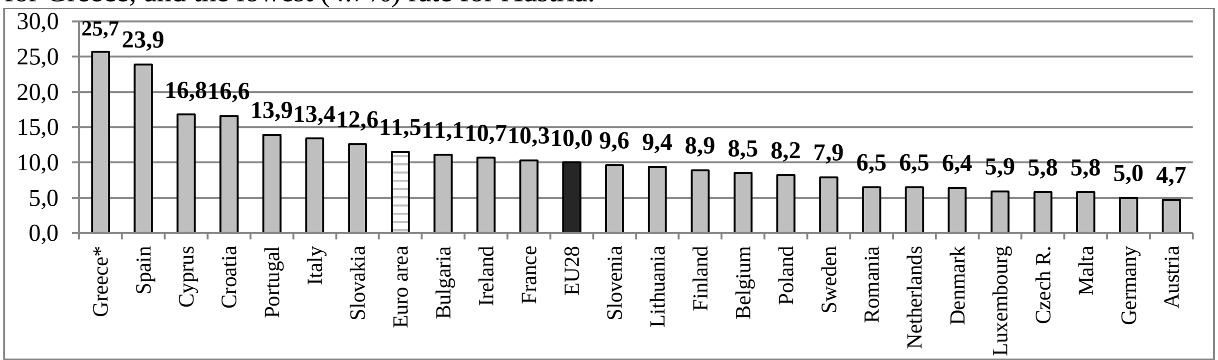
The time series on unemployment are used as an economic indicator interesting for government, social institutions, banks, media and citizens. The unemployment rate is an important indicator with both social and economic dimensions. Rising unemployment results in a loss of income for individuals, influence government spending on social benefits and a reduction in tax revenue.

According to Eurostat «Unemployment statistics» (2015) (http://ec.europa.eu/eurostat/statistics-explained/index.php/Unemployment_statistics#Unemployment_trends), regarding male and female unemployment trends, historically, women have been more affected by unemployment than men. According to Forbes (2014) in US the "official" unemployment rate doesn't count men and women who are discouraged workers who have settled for part-time jobs or have given up looking altogether. Tracking those individuals gives a very different measure of the nation's unemployment rate of 14.3% and not 6.2% in 2014. Dovern and Weisser (2011) analysed accuracy, bias and forecasts efficiency for the following macroeconomic variables: gross domestic product, inflation, industrial production and private consumption in G7 countries. Large discrepancies in the unemployment rates research results are not present only between countries, but also within individual country, Bratu (2013). According to Bratu (2012b), the accuracy of unemployment forecasts is especially relevant in the times of economic crisis in the USA. Furthermore, Simionescu (2013), evaluated forecast accuracy of unemployment rate in Romania. Voineagu et al. (2012) noted an increasing need for high-quality statistics in creating the labour policy. In order to forecast monthly unemployment rate in Romania, they used double exponential smoothing or Holt's linear exponential smoothing model. Further, in the case of the high inflation rate, the unemployment rate and the interest rate in the Czech Republic, Bratu (2012a), shown that exponential smoothing techniques generate better short term forecasts than simple econometric models. For Greece Gounopoulos et al. (2012) came to similar conclusion using exponential smoothing and ARIMA models to forecast tourist arrivals. After the period of increasing unemployment rate which started in 2008, European Commission (2014), *European Economic Forecast: Spring 2014*, forecasted decline of the unemployment rate for the EU in 2014 and 2015. After the Eurostat, in history women have been more affected by unemployment than men. In 2000 the unemployment rate for women in the EU-28 was around 10%, while the rate for men was below 8%. By the end of 2002, this gender gap had narrowed to around 1.5 percentage points and between 2002 and mid-2007 this gap remained more or less constant. Since the first quarter of 2008, when they were at their lowest levels of 6.3 % and 7.4 % respectively, the male and female unemployment rates in the EU-28 were close. By the second quarter of 2009 the male unemployment rate was higher. The decline of the men’s rate during 2010 and the first half of 2011 and the corresponding stability in the women’s rate over the same period brought the male rate below the female one once again. Since then the two rates have risen at the same pace until mid-2013, when they reached their highest value, both at 10.9 %. In the second half of 2013 both the male and the female rates declined, reaching respectively 10.6 % and 10.8 % at the end of the year 2013.

3. Data

An unemployed person is defined by Eurostat, according to the guidelines of the International Labour Organization (ILO), as person aged 15-74 without job during the reference week who is available to start work within the next two weeks and who has actively sought employment at some time during the last four weeks. Unemployment rates represent unemployed persons as a percentage of the labour force. The labour force is the total number of people employed and unemployed. Unemployed persons comprise persons aged 15 to 74 who were: a. without work during the reference week, b. currently available for work, i.e. were available for paid employment or self-employment before the end of the two weeks following the reference week, c. actively seeking work, i.e. had taken specific steps in the four weeks period ending with the reference week to seek paid employment or self-employment or who found a job to start later, i.e. within a period of, at most, three months.

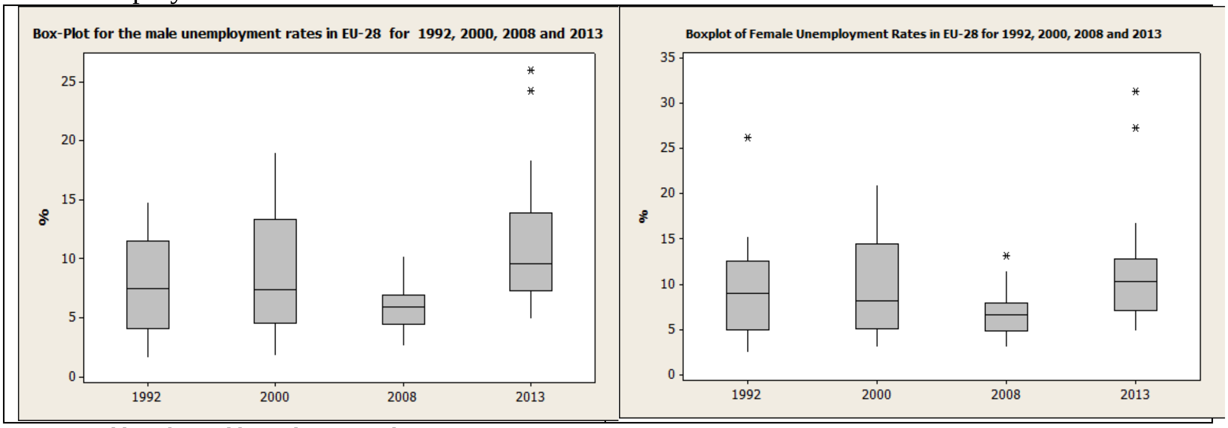
Unemployment might be treated as unused labour capacity, which is important from an economic perspective. The ILO definition of the unemployment rate is the most widely used labour market indicator because of its international comparability and relatively timely availability. Besides the unemployment rate, indicators such as employment and job vacancies also give useful insights into labour market developments. After the ILO survey, the total worldwide unemployment rate in 2015 is forecasted to remain unchanged at the level of 5.9% compared to the previous year, being the highest (12.5%) in the North Africa, and the lowest (3.9%) in South Asia. In figure 1 the bar chart for the total unemployment rates data for EU-28 countries in 2014 is presented, showing the highest rate (25.7%) for Greece, and the lowest (4.7%) rate for Austria.



Note: For Germany, the Netherlands, Austria, Finland and Iceland the trend component is used instead of the more volatile seasonally adjusted data. Source: Author’s creation, Data: Eurostat, www. epp.eurostat.ec.europa.eu

Figure 1 Unemployment rate in EU-28 countries in November 2014 (seasonally adjusted)

Exploration of outliers in unemployment rates in selected years in EU-28 by gender shows that outlier appeared for females and males for Spain and Greece data in 1992 and 2013, as shown in Figure 2. Unemployment rates for females and males for EU-28 countries in 2013 indicate that Spain and Greece compete for bad results in this area having both outliers. So, for females Greece has standardized value for unemployment rate of Z=3.30 and Spain Z=2.65. Spain took advantage with standardized value for male unemployment rate of Z=2.76 and Greece followed it with Z=2.44.



Source: World Bank, World Development Indicators

Figure 2 Multiple Box-Plots for the male and female unemployment rates in EU-28 countries for yearly data for 1992, 2000, 2008 and 2013

Figure 3 shows that female unemployment rates are in 2008 and 2013 higher than for males.

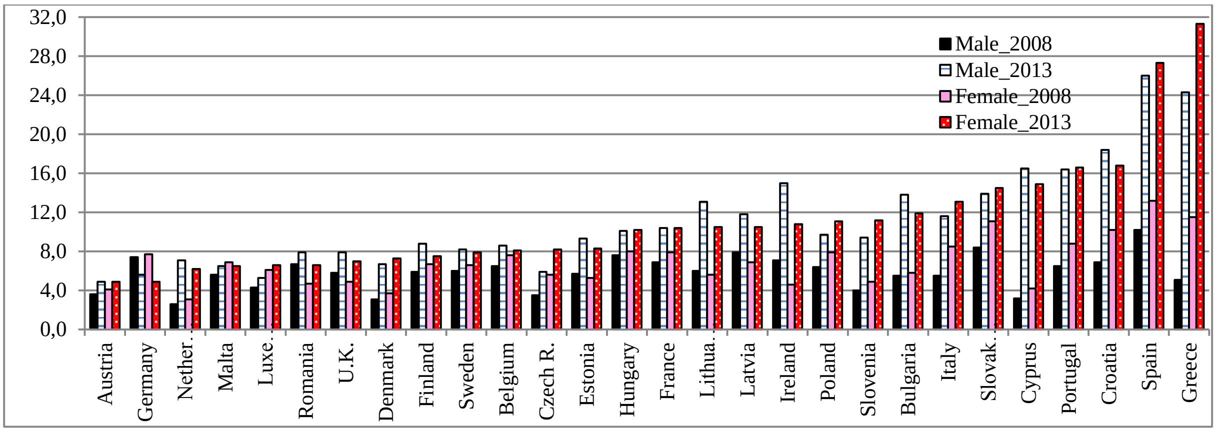


Figure 3 Unemployment rates in EU-28 in 2013 by gender, primarily ranked by females in 2013

The regression models for linear trend with ordinary least squares (OLS) estimators $\hat{y}_t = \hat{\beta}_0 + \hat{\beta}_1 t$, quadratic trend $\hat{y}_t = \hat{\beta}_0 + \hat{\beta}_1 t + \hat{\beta}_2 t^2$ and exponential smoothing methods are developed and applied, Holt (1957). The Holt's forecasting model consists of both an exponentially smoothed permanent (level) component denoted by L_t and a smoothed trend component b_t. The trend component is used in the calculation of the exponentially smoothed value. The following equations show that both L_t and b_t are weighted averages, Makridakis et al. (1998), and alpha coefficient is used for the level, while gamma is used for the trend:

$$L_t = \alpha Y_t + (1-\alpha)(L_{t-1} + b_{t-1})$$
$$b_t = \gamma (L_t - L_{t-1}) + (1-\gamma) b_{t-1} \qquad (1)$$

In order to check the accuracy of the estimated prognostic models, the following accuracy measures were employed: MSD (Mean Square Deviation), which is a measure of the variability in the forecast error, calculated using the expression:

$$MSD = \sum_{t=1}^{n} (Y_t - F_t)^2 \Big/ n \quad , \tag{2}$$

MAD (Mean Absolute Deviation), which measures the average magnitude of the forecast error is:

$$MAD = \sum_{t=1}^{n} |Y_t - F_t| \Big/ n \quad , \tag{3}$$

and MAPE (Mean Absolute Percentage Error), which indicates that on average, the chosen exponential smoothing model produced a forecast that differs from the actual value by calculated percentage:

$$MAPE = \sum_{t=1}^{n} [(Y_t - F_t)/Y_t] \Big/ n \cdot 100 \cdot \tag{4}$$

In the next section, only models with optimal smoothing constants, selected by the optimization algorithm or with the smallest values of MAPE are shown and interpreted.

4. Research results

In this research forecasting future trends of female and male unemployment rate based on past data without considering causal relationship with other variables is applied. In this section, the series of unemployment rate by gender for selected European countries from 1991 to 2013 is forecasted using statistical software MINITAB 14. Only short time horizon for forecasting was used (τ=2), so only forecasts for 2014 and 2015 are given. According to selected criteria of MSD, MAD and MAPE, the most accurate forecasting models for the variable of interest in analysed European countries are presented. Table a shows forecasts for males, and table 2 for females.

Table 1 Males: The most precise forecasting models, measures of forecasting precision and forecasts for 2014 and 2015 for male unemployment rates in12 European countries

Best forecasting models for males unemployment rates (1991-2013 + tau=2)						
Measures of precision	Linear Trend Equation Yt = 3,321 + +0,056t	Linear Trend Equation Yt = 12,332 + +0,146t	Double Exp. Smoothing Alpha 1,210 Gamma 0,714	Double Exp. Smoothing Alpha 1,177 Gamma 0,0581	Quadratic Trend Equation Yt = 6,050 – – 0,670t+ 0,046t^2	Double Exp. Smoothing Alpha 0,947 Gamma 0,043
Country	**AUT**	**ESP**	**GRC**	**HRV**	**PRT**	**SVN**
MAPE	8,714	46,299	11,556	12,604	22,244	21,493
MAD	0,344	5,199	0,928	1,507	1,160	1,346
MSD	0,162	33,780	1,347	4,941	1,998	3,725
F O R E C A S T S						
2014	4,65	15,83	26,68	19,30	16,37	9,70
2015	4,71	15,98	29,71	19,91	17,95	10,04
Best forecasting models for males unemployment rates						
Measures of precision	Linear Trend Equation Yt = 22,941 + +0,146t	Double Exp. Smoothing Alpha 1,484 Gamma 0,076	Double Exp. Smoothing Alpha 1,215 Gamma 0,086	Linear Trend Equation Yt = 12,866 + +0,045t	Double Exp. Smoothing Alpha 1,195 Gamma 0,010	Linear Trend Equation Yt = 19,569 – – 0,045t
Country	**BIH**	**SRB**	**TUR**	**ALB**	**MKD**	**MNE**
MAPE	4,861	10,587	8,973	10,010	4,355	5,124
MAD	1,195	1,475	0,865	1,367	1,422	0,963
MSD	2,707	3,350	1,663	3,346	3,444	1,335
F O R E C A S T S						
2014	26,44	18,94	9,16	13,95	28,58	18,49
2015	26,59	19,41	9,07	14,00	28,63	18,45

In table 1, different models are found to be the most precise in short term forecasting of male unemployment rates in 12 European countries. In evaluating the best models forecasts measured MAPE, MAD and MSD were used. So, the linear trend was the most precise for Austria, Spain, Bosnia and Herzegovina, Albania and Montenegro. The double exponential smoothing was the best for Greece, Croatia, Slovenia, Serbia, Turkey and the FYR of Macedonia, while the quadratic trend was the best for Portugal only.

For the female unemployment rates, based on the minimum values of the forecasting measures of precision MAPE, MAD and MSE, it was found that the linear trend was the best forecasting model compared to other trend or smoothing models in Bosnia and Herzegovina and in Albania only. For all other countries the best fitted models for forecasting females unemployment rates are based on double exponential smoothing with optimal selection of the smoothing constants, as shown in table 2.

Table 2 Females: The most precise forecasting models, measures of forecasting precision and forecasts for 2014 and 2015 for the female unemployment rates in12 European countries

Best forecasting models for females unemployment rates (1991-2013 + tau=2)						
Measures of precision	Double Exp. Smoothing Alpha 0,944 Gamma 0,010	Double Exp. Smoothing Alpha 1,012 Gamma 0,573	Double Exp Smoothing Alpha 1,076 Gamma 0,597	Double Exp. Smoothing Alpha 1,2715 Gamma 0,027	Double Exp. Smoothing Alpha 1,3007 Gamma 0,102	Double Exp. Smoothing Alpha 1,4565 Gamma 0,081
Country	**AUT**	**ESP**	**GRC**	**HRV**	**PRT**	**SVN**
MAPE	8,32	9,05	9,37	7,93	11,21	8,89
MAD	0,36	1,73	1,52	1,16	0,83	0,61
MSD	0,22	4,75	2,97	2,99	1,31	0,63
F O R E C A S T S						
2014	4,90	29,43	35,10	17,28	17,23	12,19
2015	4,93	31,58	39,07	17,72	17,98	12,61

Best forecasting models for female unemployment rates						
Measures of precision	Linear Trend Equation Yt = 26,378 + 0,192*t	Double Exp. Smoothing Alpha 1,494 Gamma 0,076	Double Exp. Smoothing Alpha 0,962 Gamma 0,091	Linear Trend Equation Yt = 17,876 - 0,173*t	Double Exp. Smoothing Alpha 1,023 Gamma 0,060+	Double Exp. Smoothing Alpha 0,345 Gamma 0,109
Country	**BIH**	**SRB**	**TUR**	**ALB**	**MKD**	**MNE**
MAPE	5,39	10,77	12,07	12,87	4,95	3,48
MAD	1,58	2,04	1,06	2,13	1,66	0,71
MSD	4,82	6,60	1,54	10,87	4,13	0,82
F O R E C A S T S						
2014	30,99	25,73	12,03	13,73	28,55	20,25
2015	31,17	26,39	12,20	13,56	28.22	20,22

5. Conclusions

Recent analysis conducted by Eurostat revealed some interesting trends in unemployment rates by gender in European and non-European countries appeared. The authors explored potential forecasting models suitable for predicting the future values of unemployment rates for male and female based on yearly data from 1991 to 2013. Here 12 European countries are studied: a very developed one like Austria, and others less developed, such as, Spain, Greece, both with the highest unemployment rates, Croatia, Portugal, Slovenia, and EU candidates, Bosnia and Herzegovina, Serbia, Turkey, Albania, the FYR of Macedonia and Montenegro. The results of the empirical analysis showed that the optimal model for forecasting unemployment rate is different for different countries. This paper is giving insights in the most appropriate forecasting methods among regression models and smoothing methods for predicting unemployment rate by gender. Even with the best fitted models the real unemployment rates

might be either under- or over-estimated. The future research will give the insight to the quality of the forecasts for both 2014 and 2015.
Only if the economies in the considered countries, as well as the world economy, should improve, the recognized increasing trends of unemployment rates for both genders should not be so hopeless.

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