An Autoregressive Short-Run Forecasting Model for Unemployment Rates in Romania and the European Union

LIANA SON
GRATIELA GEORGIANA CARICA
Faculty of Economics and Business Administration
West University of Timisoara
Email: liana.son@feaa.uvt.ro
Email: gratiela_carica@yahoo.com
VASILICA CIUCA
DANIELA PAŞNICU
National Scientific Research Institute for Labour and Social Protection Bucharest
Email: silviaciuca@incsmps.ro
Email: danielapasnicu@incsmps.ro

Abstract: - The paper discusses an autoregressive model that captures through a residual analysis the dependence structure of unemployment rates. The model is designed for the analysis and time-forward prediction of spatio-temporal econometric data. Linearity tests are performed for a number of quarterly and monthly, seasonally adjusted, unemployment series from EU-27 countries, focusing on Romania. For a number of series, we found by testing that unemployment rate can be modeled satisfactorily by use of a first-order linear autoregressive model AR(1), but also by a second-order autoregressive model AR(2). The properties of the estimated models, including persistence of the shocks related to them, are illustrated in various ways and discussed within the paper.


1 Introduction - Deterioration of global performance
In 2009 has been registered the worst global performance in terms of real GDP and international trade growth, foreign direct investment dynamics or employment increase. One major objective of many macroeconomic policy makers is to promote economic growth and to reduce employment variability. A short view of the main macroeconomic indicators points out, in a general, but eloquent manner, the deterioration of the socio-economic status, including labour market conditions, both in developed and in developing economies.
In 2009, the global economy expanded with mere 0.9%, e.g. a serious decline in comparison with the consistent growth during few years ago. The decrease of the economic activity was emphasised not only in the developed countries, but also in the European countries. The credit market shouted off, the absence of the financial resources determining a reduction of the productive activity. Also, on the labour market, the unemployment developed unfavourably, affecting a larger share of the population, being constrained to reduce the expenditures and consumption, with implicit effect upon product decreasing [8].
Looking at the economic activity in EU27 countries, we can observe a strong slowdown, both for the major economies and new member states. Except Poland, all EU Member State experienced, in 2009, a negative growth rate.
All countries have taken concerted measures to halt the economic decline, from restricting the budget expenses to stimulating the credit and investment markets. However, banks are still more conservative and restrictive concerning credits, investors are reluctant and amid rising unemployment and reduced incomes, the recovery issues are difficult to overpass.

Current estimations from EUROSTAT for 2010 show a certain recovery, even slightly negative growth for countries like Spain, Greece, Bulgaria, Latvia, Lithuania, Ireland, Hungary or Estonia.

2 Deepening unemployment - general problem of European labor markets

European labor markets are very different in terms of employment, even though unemployment has become an important characteristic for every country between 2008 and 2009. There are great variations in the labour flexibility and security, thus unemployment could therefore be correlated with the degree of "tightness" in the labor market. Starting with 2008 and continuing even in 2009, many economies have experienced an obvious deterioration of the labor market, amid deep current global economic crisis.

Not equally, but with a continuous trend to deepen and amplify, the crisis has affected all countries, threatening vulnerable economies also in 2010. The labor market has received the full shock. Looking over a long period of time, it is obvious that there was a decrease of employment growth rate in 2009 to a half, compared to the beginning of the decade. Thus, if between 2000 and 2007, the average annual growth rate of total employment was 1.9% and for the first time it decreased to 1.4% in 2008 and to 0.7% in 2009. The EU27 experienced a decline of employment growth rates from 1.6% in 2006 to 1.4% in 2007, 0.7% in 2008 and -2.4% in 2009 [9].
The forecasts for 2010 resulted from the following autoregressive model suggests that the European countries need a longer period to a real recovery in order to achieve the best performances obtained over this last decade, based on constant and severe reforms.

The hysteresis hypothesis of NAIRU, which characterizes unemployment as a stationary process, states that cyclical fluctuations in the labour market might affect the unemployment rate permanently and might lead to a long-term persistence [5].

This hypothesis could be relevant for Romania because the raise and variations of unemployment rate in the past decades was bound to affect the natural rate of unemployment due to insiders’ bargaining power. Thus, the evolution of NAIRU in Romania follows an increasing path during 1995 – 2011 also due to a very high and dynamic unemployment rate. Therefore, factors that led to an increased unemployment, including policies aimed at reducing inflation, will generate an extra cost due to unemployment persistence.

The relation between inflation and unemployment in Romania, in October 2008- Mach 2010 period is represented in figure 4. The negative relation between increasing rate of the prices and unemployment rate (Phillips curve) is not functional for the Romanian economy, according to empirical data from October 2008- Mach 2010, probably due to the economic and financial crisis shocks.
In a similar manner with transition period – a period with deeply economic reorganizations – the Romanian economy faces a high inflation and unemployment. The unemployment threat makes difficult the increase or at least the maintenance of the real wage during the given period [4], in conditions in which the labour demand significantly decreased in activity sectors, once very dynamic. A better work of the labour market requires measures for employment increase and mainly for professional re-qualification from an activity sector to another.

The short-run tendency of the unemployment rate is emphasized by a first and second-order autoregressive model, using dynamic data series for the 1999-2010 period.

3 Modelling Unemployment Rate

3.1 The model
We aimed at identifying what type of autoregressive model can be used to model and forecast unemployment rate, using monthly and quarterly, seasonally adjusted, unemployment series from EU 27 countries, focusing on Romania. Thus, we tested to see if a first-order linear autoregressive model AR(1) complies with the requests, so if the dynamics of unemployment rate is correctly described by the following relations:

\[ y_t = \alpha_0 + \alpha_1 y_{t-1} + \epsilon_t \quad |\alpha_1| < 1 \]  
\[ \epsilon_t = \delta \epsilon_{t-1} + \eta_t \quad |\delta| < 1 \]  
\[ \alpha_0 = 1.6367 \alpha_1 = 0.7702 < 1 \]  
\[ \epsilon_t = y_t - \alpha_0 - \alpha_1 y_{t-1} \]  
\[ \sigma^2 = \frac{1}{T-2} \sum_{t=1}^{T} \epsilon_t^2 \]  
\[ \sigma^2 = 0.2387 \]

Thus, we calculated the expected values of mean (4) and variance (5):

\[ \mu = \frac{\alpha_0}{1-\alpha_1} = 7.1227 \]  
\[ \sigma^2 = Var(y_t) = \frac{\sigma_0^2}{1-\alpha_1^2} = 0.6525 \]

We used auto-covariance to test the stationary state of dynamic series. Therefore, we determined the estimators of covariance and correlation:

\[ \gamma_n = E[(y_t - \mu)(y_{t-n} - \mu)] \]  
\[ \gamma_0 = \sigma^2 \gamma_1 = \alpha_0 \sigma^2, \quad \gamma_n = \sigma^2 \]  
\[ n = 1, 2, ..., \alpha_1 = \sigma^2 = 0.5025 \]  
\[ \rho_0 = \frac{\gamma_0}{\sigma^2} \Rightarrow \rho_1 = \frac{\gamma_1}{\gamma_0} = 0.7702 \]

These values mean that current unemployment rate depends largely on its value at the previous moment.

This phenomenon is shown also by the strong correlation \( r = 0.938 \) and dependency between unemployment rate \( y_t \) and \( y_{t-1} \) performed on monthly data (127 observations) for Romania during 1999 – 2009.

We tested to see if the residual value is auto-correlated by using the Durbin Watson test that implies calculating the value:

\[ \delta = \frac{\sum_{t=2}^{T} \epsilon_t \epsilon_{t-1}}{\sum_{t=2}^{T} \epsilon_t^2} = 0.2285 \]  
\[ d = \frac{\sum_{t=2}^{T} (\epsilon_t - \epsilon_{t-1})^2}{\sum_{t=2}^{T} \epsilon_t^2} = 2.016 \]

\[ e_t = \epsilon_t - \delta \epsilon_{t-1} \]

This value indicates that the auto-correlation is zero and therefore the dynamics of unemployment rate is described correctly by a first-order autoregressive model. Using the Durbin Watson Statistic, 5 per cent significance points of \( d \) and \( d_0 \), we determined the limits of \( d \) value \( d_1 = 1.475 \) and \( d_0 = 1.566 \). Thus, we were able to verify the accuracy of the model, due to the fact that our \( d \) value overpasses the upper limit, confirming the initial hypothesis of the model.

Thus we were able to forecast the 2010 quarterly unemployment rates for Romania using AR(1):
We used the same methodology to estimate EU-27 quarterly unemployment rates for 2010:

\[ y_t = 9.2; y_{t+1} = 9.0; y_{t+2} = 8.9; y_{t+3} = 8.8 \]

3.2 Estimating Methodology (AR2); forecasting results

In order to test the statistical estimators, we also used a second-order autoregressive model AR(2) described by the following relations:

\[ y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \epsilon_t \]  
\[ \gamma_0 = \sigma^2 \]  
\[ \gamma_1 = \frac{\alpha_1 \gamma_0}{1 - \alpha_2} \]  
\[ \gamma_2 = \alpha_1 \gamma_1 + \alpha_2 \gamma_0 \]  
\[ \gamma_n = \alpha_1 \gamma_{n-1} + \alpha_2 \gamma_{n-2} \]  
\[ \rho_n = \frac{\gamma_n}{\gamma_0} = \alpha_1 \rho_{n-1} + \alpha_2 \rho_{n-2}, n = 3 + t \]  
\[ \rho_1 = 0.693, \rho_2 = 0.501 \]

To verify if the residual value is auto-correlated and to evaluate if a second-order autoregressive model correctly characterizes the unemployment rate we used Box and Pierce test (11) and Ljung and Box test (12), by calculating the values:

\[ Q_{BP} = T \sum_{n=1}^{T} \rho_n^2 \]  
\[ Q_{LB} = T(T+2) \sum_{n=1}^{T} \frac{\rho_n^2}{T-n}, \rho_n = \frac{E(\epsilon_t \epsilon_{t-n})}{\sigma^2} \]

In order to calculate these values we determined the estimators of the correlation coefficients using the following relations:

\[ \rho_1 = \frac{\sum_{i=2}^{T} \epsilon_i \epsilon_{i-1}}{\sum_{i=2}^{T} \epsilon_i^2 \epsilon_{i-2}} \]  
\[ \rho_2 = \frac{\sum_{i=3}^{T} \epsilon_i \epsilon_{i-2}}{\sum_{i=3}^{T} \epsilon_i^2 \epsilon_{i-2}} \]  
\[ \rho_1 = 0.962, \rho_2 = 0.936 \]

The values obtained for each of these tests \( Q_{BP} = 75.793 \) and \( Q_{LB} = 77.556 \) are over-passing the table value 79.082, meaning that the AR(2) model can be used to model and forecast unemployment rate.

We were thus able to estimate 2010 quarterly unemployment rate for Romania also by using the second-order autoregressive model:

\[ y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \epsilon_t \]  
\[ y_1 = 8.4; y_{t+1} = 7.8; y_{t+2} = 7.4; y_{t+3} = 7.2 \]

We used the same methodology to estimate EU-27 quarterly unemployment rates for 2010:

\[ y_t = 9.5; y_{t+1} = 9.4; y_{t+2} = 9.4; y_{t+3} = 9.3 \]

<table>
<thead>
<tr>
<th>Table 1 Quarterly unemployment rate, 2010 forecasting, %</th>
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<tbody>
<tr>
<td>AR(1)</td>
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<tr>
<td>Q1</td>
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<td>EU-27</td>
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<td>Romania</td>
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Source: own calculations based on Eurostat data

Both autoregressive models describe correctly the evolution of unemployment rate, but taking into consideration the dependency of the unemployment rate to other economic indicators we consider that the second-order autoregressive model describes correctly the evolution of unemployment rate and is better suitable for estimating unemployment.

The graphic representation of the obtained data as a result of applying the autoregressive model, as well as the comparative quarterly unemployment rate in Romania and EU, during 2000-2010, is illustrated by figure 5.
Within the European Union, unemployment registered continuous decreases since the mid-decade, but with a dynamic growth to over 9% during 2008-2009. Towards the end of last year anti-crisis concerted measures were also reflected in slightly positive evolution of employment, indicating a decrease of European unemployment throughout 2010. Nevertheless, the evolution of EU countries, still under the effects of the crisis and economics failures, seems to allow a sharp drop in the number of those who do not find a job, however, indicating an unemployment of about 8.8% (AR1) or even 9.3% (AR2) at end of the year.

In Romania, the entire period after 2000 is "rough" within the meaning of significant changes in a very short period (quarterly) on integration of the fence work. This shows an unstable and underperforming market which can not provide yet more flexible conditions for transition from one sector to another or job security. However, forecasts show that somewhere towards the middle of this year, unemployment will be in continuous decline and even more pronounced than at EU level.

4 Conclusions

2009 was a non-performance year for almost all countries. The EU member states were and will be affected by the current economic and financial crisis. Thus, the general negative evolutions of economic growth, development of goods, services and labour markets directly affected the level of well-being.

In Romania, as in other European States, the unemployment is strictly monitored and assessed. Countries know the necessity of some active measures for the growth of employment. The performed analyse points out that the growth of employment tendency and of the chances to find a workplace require restrictive measure for budgetary expenses or investment stimulation. Thus, the labour market can became more flexible using new instruments of active policies, by adopting fiscal instruments of supporting employment and throughout sustained actions in economic and social field.

References