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AUTOREGRESSIVE MODELS USED IN THE STUDY OF LABOR MARKET

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Abstract: *The macroeconomic management implies the knowledge of correlations between the macroeconomic indicators and their influence factors. An objective of macroeconomic management is the efficient use of labour force. The paper analyses significant aspects of increasing efficiency of labour force use by emphasising some timing correlations between different macroeconomic indicators, relevant for the labour market. The analysed indicators are participation rate, unemployment rate and activity rate. The econometric analysis supposes elaboration of an autoregressive model, estimation of parameters, studying of Granger causality, stationarity testing, analysis impulse/response, determination of lag length and other operations. The analysed period is 1990-2013.*

Keywords*: labour market, participation rate, autoregressive model, econometric model*

1. INTRODUCTION

On short term the economic activity depends on the demand. At microeconomic level, to maximise the profit, the economic agents are concerned to satisfy better possible the demand, as a premise of their financial stability. Also, an important concern is the promotion of products to increase demand and attract new customers.

At the macroeconomic level, aggregate demand increases real GDP and the economy moves toward expansion. Aggregate demand growth is considering its most important component: private consumption of goods and services.

The mood of the population, monetary policy, fiscal policy and the state of the global economy are among the factors that can influence private consumption.

Private consumption depends primarily on disposable income. In general, an increase in disposable income determines the movement to the right of aggregate demand curve, and as a result, causes a stimulation of overall economic activity.

In this context, income from jobs, salaries and income of people operating on their own play a fundamental role, being the largest part of the disposable income. The size of this type of income depends on how the labour market works. Labour market status is an important indicator of the state of the economy.

An increase in unemployment and a decrease in labour income is a sign of worsening state of the economy, as the reduction of unemployment and labour income growth is a sign of its recovery.

Careful monitoring of the state of the labour market, necessary and possible, may

provide the driving factors in a short time, the information needed for decision making of economic policy.

In the medium and long term, attention must focus equally also on the terms of the offer. Job creation through investment, modernization of manufacturing technologies, development of distribution networks, production management improvement activities are capable to ensure a better possible employment of labour resources.

2. THEORETICAL BASES

Theoretical foundation of this work is the neoclassical model of the labor market. Theoretical aspects of the neoclassical model of the labor market are analyzed by Abel, AB, Bernanke, BS (2001) "Macroeconomics" Blanchard O. (2006), "Macroeconomics" Mankiw NG (1994), "Macroeconomis" and others.

The way to form the occupation, how wages are determined, the conditions giving the existence of a permanent unemployment, how the state finances unemployment benefits, factors affecting supply and demand for labour are neoclasic model features of the labour market.

The classical labor market theory is the foundation of many other econometric analyses of the labor market: Dobrescu E. (2006), *Macromodels of the Romanian Market Economy*, Albu, LL (2004), *Dynamics of the natural rate of unemployment in the transition period*, Stockhammer, E. (2002), *Explaining European Unemployment: Testing the NAIRU Theory and a Keynesian Approach*, and others.

3. RESEARCH METHOD

The research method used is the econometric analysis. Autoregressive econometric model allows the analysis of correlations between macroeconomic measurements, with a certain lag.

For example, theoretically, the unemployment rate is countercyclical variable and delayed (Abel 2001). This means that there is a lag between changes in unemployment and overall business development. Using macroeconomic data available (published by INS), the parameters of different models were estimated and also there were calculated all statistics to validate them. The software used is Eviews 7.1.

4. STUDY OF LABOUR FORCE PARTICIPATION RATE

The used model is:

rp 1 1 *rp poc*(-1) where:

rp is the participation rate, calculated as ratio between the labour force (civil active population) and the population of and over 15 years; *rp* is also an explanatory variable, as lagged variable with one time unit.

poc is the civil occupied population. In the model *poc* is lagged with two time units.

The participation rate dependency on the occupied population is illustrated in Figure 1. It can be seen that the ratio of these two quantities has a high stability. Also, there is a tendency for stabilization of both the participation rate, as well as the occupied population.

Two independent variables were included in the model, the first being rp with one lag time, the latter being poc with two lag periods. This reflects the high inertia of the labor market. The model contains no free term.

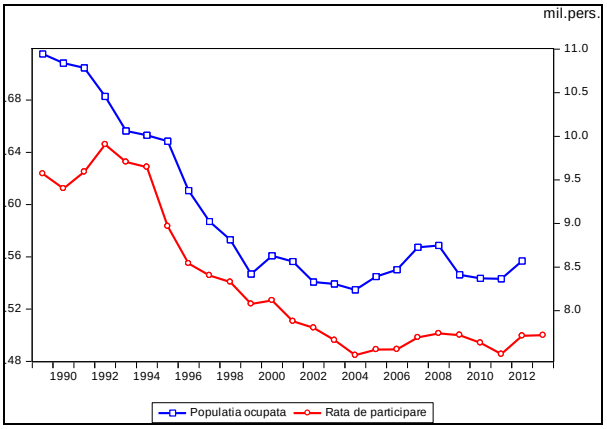

Figure 1. Evolution of *rp* and *poc* in 1990-2012

The estimation results are:

$rp_t = 0.36021 \cdot rp_{t-1} + 3.72E\text{-}08 \cdot poc_{t-2}$

(0.0349) (0.0007)

[2.2561] [3.9476]

(·) = probability threshold

[·] = t-Statistic

Both variables are significant. It is important to check if the variables are Granger causes, one for the other. The results of Granger test are presented in Table 1. It can be seen that *poc* is a Granger cause of *rp* for each of the three lags. But there is kept poc_{t-2} for which the probability of rejecting the null hypothesis is the greatest value.

According to Dobrescu E.[6] on long-term, the stabilization of the civil active population determines the participation rate to stabilize itself at a level equal to:

(pop(-2)* 3.72E-08) / (1 – 0.36021).

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/14/14 Time: 19:09
Sample: 1989 2013
Included observations: 23

Lags: 1		
Null Hypothesis:	F-Statistic	Prob.
poc does not Granger Cause *rp*	11.8139	0.0026
rp does not Granger Cause *poc*	2.85491	0.1066
Lags: 2		
Null Hypothesis:	F-Statistic	Prob.
poc does not Granger Cause *rp*	9.95626	0.0014
rp does not Granger Cause *poc*	1.19033	0.3282
Lags: 3		
Null Hypothesis:	F-Statistic	Prob.
poc does not Granger Cause *rp*	4.10550	0.0277
rp does not Granger Cause *poc*	0.70436	0.5651

Table 1. Granger causality between *rp* and *poc*

The graph of the roots of characteristic equation, shown in Figure 2 highlights the stationary character of the explanatory variables. It notices that all roots of the characteristic equation are less than the 1, which means that the autoregressive model is stationary.

Functions impulse/response highlight how a shock propagates to one of the explanatory variables. A shock not only directly affects the variable on which works, but it is transmitted to other variables through the dynamic structure of the model.

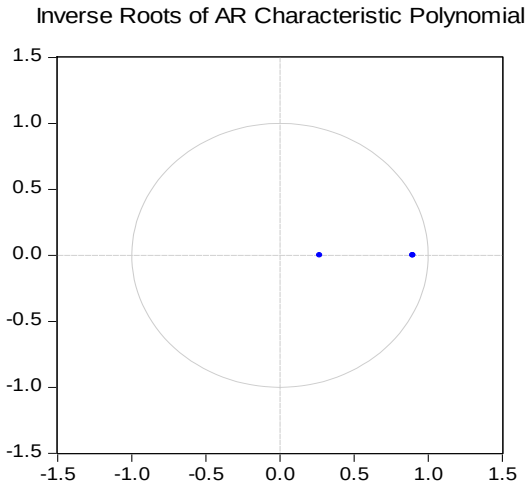

Figure 2. The roots of the characteristic equation

In Figure 3 is presented the chart of response function of the variable *rp* to a shock suffered by *poc*. It can be noticed that in the first three periods from the moment of the shock on *poc*, *rp* answers with a deep decreasing.

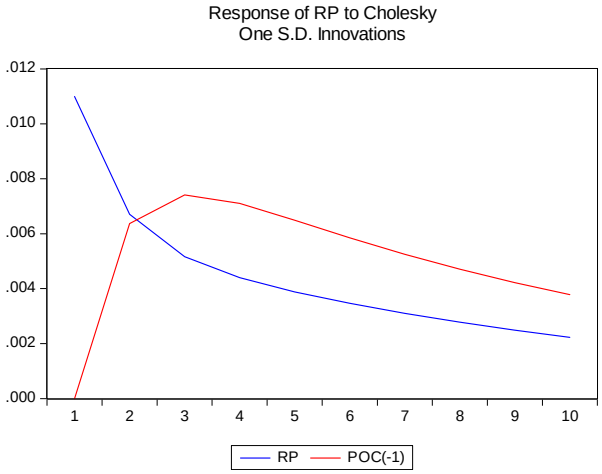

Figure 3. Response function of *rp*

As the shock effect is diminishing on *poc*, *rp* continues to decrease, but the decrease is much slower. After the first three periods,

there is a remarkable stability between the two series, the decrease was strongly correlated with decreased one another.

Forecasting the evolution of participation rate is presented graphically in Figure 4 and it highlights the interval [0.46, 0.52] in which it will be in the coming years.

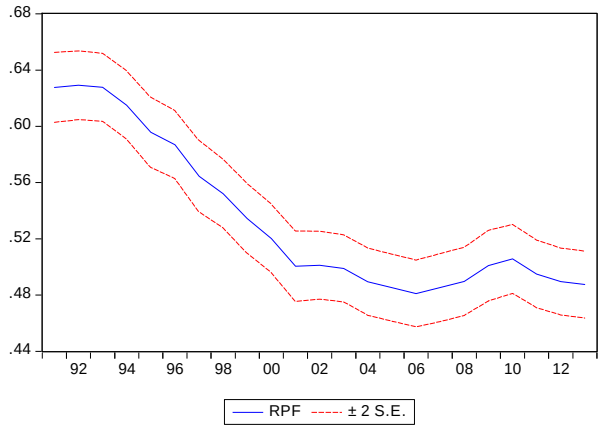

Figure 4. Probable future values of *rp*

It is noticed the evolution tendency towards stability.

5. STUDY OF UNEMPLOYMENT RATE

The unemployment rate, *rs*, is the second analysed variable. According the Bureau of Labor Statistics (BLS), the unemployment rate is calculating as a ratio between the number of unemployed, *sbim* and the civil active population (labour force), *pac*.

$$rs = sbim / pac * 100, \text{ where:}$$

rs is unemployment rate;
sbim is the number of unemployed BLS;
pac is the labour force.

According [3] unemployment rate is significantly correlated with the labour cost, respectively with the unitary wage, *su*. The model used for studying the unemployment rate is:

$$rs\ 1\ 1\ rs\ su(1), \text{ where:}$$

rs is unemployment rate; *rs* appears between the explanatory variables, lagged with one lag;
su is the unitary wage.

To estimate the model, there were used the data from INS, of yearly nominal net average wage, corrected with Consumers Prices Index (CPI). The chart of evolution of yearly real net average wage is presented in Figure 5.

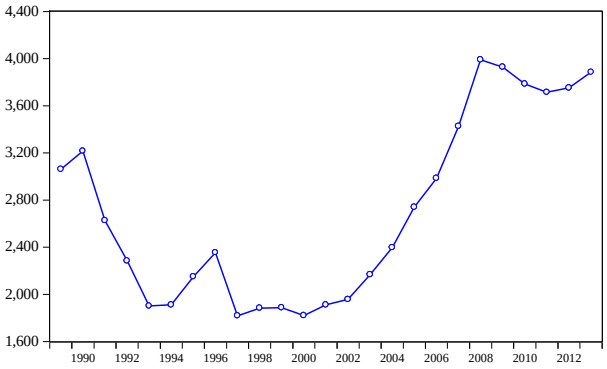

Figure 5. Evolution of real net average wage

The results of estimation of model parameters are:

$$rs_t = 0.82031 \cdot rs_{t-1} + 0.00055 \cdot su_t$$
$$(0.10640) \qquad (0.0003)$$
$$[7.7100] \qquad [1.8646]$$

(·) = probability threshold
[·] = t-Statistic

In this formulation, the variable rs_{t-1} is significant at a significance threshold greater than 10.6%. The analysis of Granger causality based on the data from Table 2, emphasises the fact that only for the lag of order 1 it exists a Granger causality between *rs* and *su*.

VAR Granger Causality/Block Exog. Wald Tests
Date: 05/15/14 Time: 09:29
Sample: 1989 2013
Included observations: 23

Lags: 1		
Null Hypothesis:	F-Statistic	Prob.
su does not Granger Cause *rs*	0.94309	0.3431
rs does not Granger Cause *su*	10.6887	0.0038
Lags: 2		
Null Hypothesis:	F-Statistic	Prob.
su does not Granger Cause *rs*	0.87285	0.4257
rs does not Granger Cause *su*	1.11762	0.3499
Lags: 3		
Null Hypothesis:	F-Statistic	Prob.
su does not Granger Cause *rs*	0.44140	0.7270
rs does not Granger Cause *su*	1.23290	0.3347

Table 2. Granger causality between *su* and *rs*

From this reason, influences of *su* over *rs* were not considered with lags, in the model. In fact, the unemployment rate is powerfully correlated with current *su*. The explanatory

variable rs_{t-1} was included in the model ro reflect te high degree of inertia of labour market.

Response function of *rs* at a shock on *su*, presented in Figure 6, shows that *rs* decreases when *su* increases, that is corresponding to the theoretical fundamentals.

It can be noticed that the shock of increasing *su*, even it slowly diminishes, influences *rs* a long period (at least 5 succesive periods). Is is accepted that an increasing of *su* will change the expectations, these becoming more optimistic.

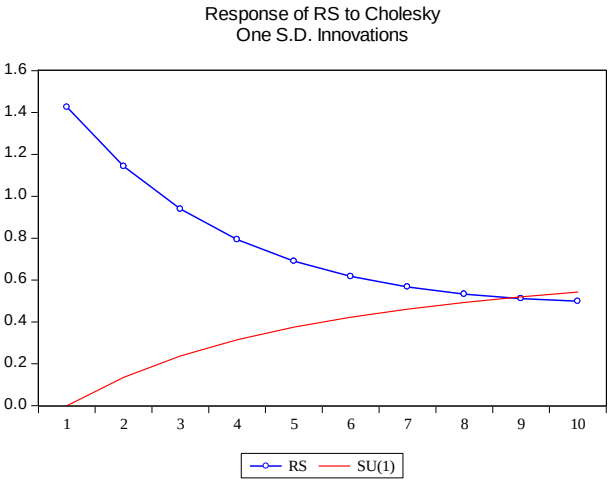

Figure 6. Response function of rs

The unitary wages are correlated with the labor productivity.

6. CONCLUSIONS

In correlation with the research objective, autoregressive models used to study the evolution of labor market indicators, highlight the correlations between these and other macroeconomic variables.

Thus, the participation rate, which is intrinsically linked to demographic evolution of population, is strongly correlated with occupied population. Influence of occupied population on labor participation rate occurs mainly with a lag of two years.

Current participation rate is itself influenced by the rate of participation in the previous year. An increase in the participation rate by 1% increases the participation rate of about 0.36% next year.

It can be seen inertial character of the labor market suggested by theoretical works that underlie the study of the labor market.

On the other hand, the unemployment rate is strongly correlated with real unitary wage. In the conducted research, using real net average salary, calculated on the basis of INS data, deflated with CPI. Average net real wage from 1989 decreased persistently during 1990-2000.

The level in 1989 was exceeded only in 2004, increasing thereafter. Real net average wage is not only the main factor that determines the size of private consumption, but the main factor influencing the unemployment rate.

Note that the current real net average wage is one that has a significant influence on the unemployment rate. The constant growth of real net average wage is likely to change expectations, resulting in a sequential increase in consumption and a gradual reduction in the unemployment rate.

Years	*rp*	*poc*	*popover15*
1989	0.62	10,946,000	17,552,215
1990	0.61	10,839,500	17,702,916

1991	0.63	10,786,000	17,796,308
1992	0.65	10,458,000	17,628,133
1993	0.63	10,062,000	17,748,687
1994	0.63	10,011,600	17,870,437
1995	0.58	9,493,000	17,981,825
1996	0.56	9,379,000	18,082,636
1997	0.55	9,022,700	18,146,764
1998	0.54	8,812,600	18,190,185
1999	0.52	8,419,600	18,226,785
2000	0.53	8,629,300	18,295,918
2001	0.51	8,562,500	18,383,003
2002	0.51	8,329,000	17,976,508
2003	0.50	8,305,500	18,064,890
2004	0.48	8,238,300	18,145,035
2005	0.49	8,390,400	18,221,714
2006	0.49	8,469,300	18,250,418
2007	0.50	8,725,900	18,246,731
2008	0.50	8,747,000	18,249,385
2009	0.50	8,410,700	18,234,744
2010	0.49	8,371,300	18,210,068
2011	0.49	8,365,500	18,174,982
2012	0.50	8,569,600	18,144,412
2013	0.50	9,057,625	18,115,350

Source: INS

Years	*rs*	*sbim*	*su*
1989	NA	NA	3,063
1990	1.1	123,000	3,217
1991	3.0	337,400	2,627
1992	8.2	929,000	2,285
1993	8.5	952,000	1,902
1994	8.6	971,000	1,911
1995	9.2	968,000	2,150
1996	7.5	748,057	2,354
1997	6.7	664,686	1,818
1998	7.0	688,400	1,884
1999	7.8	745,526	1,888
2000	8.0	775,465	1,821
2001	7.6	711,299	1,911
2002	9.3	845,273	1,957
2003	7.7	691,755	2,168
2004	9.1	799,526	2,397
2005	7.9	704,462	2,740
2006	8.2	728,837	2,985
2007	7.0	640,942	3,426
2008	6.3	575,547	3,991
2009	7.5	680,683	3,929
2010	8.1	725,150	3,786
2011	8.3	730,217	3,715
2012	7.7	701,210	3,752
2013	7.3	730,131	3,885

Source: INS

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