Simulation scenarios of employment on the Romanian labor market

Madalina E. Andreica, Amalia Cristescu, and Speranta Pirciog

Abstract— In this paper, we have investigated the impact of various macroeconomic variables, such as labor cost, Gross Domestic Product and net investments upon employment in Romania. In order to do that, we first estimated a fixed effects panel data model over the period 2000-2009, for the main Romanian economic activities, leading to a set of results consistent with the empirical evidence. The estimation was then followed by a Monte Carlo simulation which allowed forecasting the total number of employed population in Romania for the horizon 2010-2011.

Keywords— *economic activity, employment, Monte Carlo simulation, panel data model*

I. Introduction

THE aim of this paper consists in quantifying the impact of labor cost, Gross Domestic Product (GDP) and Net Investments upon employment in Romania, in the last decade. In order to do that, we built an econometric model based on panel data series for the period 2000 – 2009. The first step of the analysis consisted in estimating a general employment equation built at national level, when considering 10 of the main Romanian economic activities. Secondly, a Monte Carlo simulation was applied in order to forecast the variations of employment in Romania for the horizon 2010-2011.

The empirical evidence indicates a positive relationship between employment and economic growth [17]. The GDP per capita is often considered an indicator of economic well-being, so we expect that its impact on employment to be a positive and significant one.

In 1995, Boltho and Glyn also found that the employment elasticity with respect to economic growth reaches a level of 0.5 to 0.6 for a set of OECD countries.

Moreover, investments are seen in general as a driver for economic development as it may bring capital, technology, management know-how, jobs and access to new markets. Therefore, policy makers have tended to emphasize the benefits that investments can bring to host economies, particularly in developing countries [11], [19]-[20].

Based on the classical theory, the only negative expected correlation concerns the relationship between the labor costs and the employment.

Among the international studies, some also quantified the determinants of employment upon European developing countries [4]-[5], [15]. The novelty of this paper among the international literature consists, however, in the proposal of applying a Monte Carlo simulation in order to forecast the evolution of employment on the labor market.

The paper is organized as follows: Section II describes the data used in the study, Section III presents the econometric framework of the analysis, whereas Section IV presents the econometric results. In Section V a Monte Carlo simulation is designed in order to forecast the employment in Romania, whereas the last section concludes.

II. Data Description

The variables used in this study are: the number of employed population (*employ*), the Gross Domestic Product (*GDP*), the Net Investments (*inv*) and the labor force cost (*cost*). The nominal GDP, the Net Investments expressed in mil. RON and the labor costs expressed in RON, were deflated by dividing the nominal values to the Consumer Price Index. Next, the natural logarithm was applied to all the variables used in the panel data analysis, in order to ensure higher similarities between measurement units and more comparative values. The main data sources were the Romanian National Institute of Statistics and the Ministry of Labor, Family and Social Protection.

The analysis was conducted over a period of ten years (2000-2009), using macroeconomic data for 10 of the main Romanian economic activities, presented in fig. 1.

Since each of the 10 main Romanian economic activities has distinctive patterns, we decided to start our analysis with a basic data description. In order to see how each of the Romanian economic activities is situated when considering macroeconomic performances, we decided to build a three-dimensional space, based on a three-dimensional Employment - GDP - Labor cost representation of the main Romanian economic activities (see fig.1). The intersection of employment and both the level of the real labor cost and real GDP for the year 2009, highlights several aspects. For instance, *Industry* and *Trade* are the main Romanian economic activities that bring the highest gross added value to the Romanian GDP, *Financial intermediations* registers the

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M. E. Andreica is *Assist.* at The Bucharest Academy of Economic Studies, as well as *Researcher* at the National Scientific Research Institute for Labor and Social Protection. (phone: +40722827889; e-mail: madalina.andreica@gmail.com).

A. Cristescu is also *Assist.* at The Bucharest Academy of Economic Studies, as well as *Researcher* at the National Scientific Research Institute for Labor and Social Protection (e-mail: cristescu_amalia@yahoo.com).

S. Pirciog is scientific director at the National Scientific Research Institute for Labor and Social Protection (e-mail: pirciog@incsmps.ro).

highest labor costs, whereas the *Agriculture, hunting, forestry and pisciculture* has the highest number of employed persons.

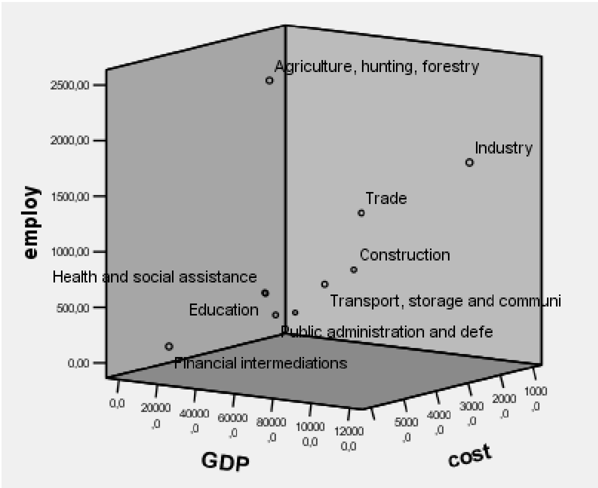

Fig. 1 The three-dimensional Employment – GDP- Labor cost representation of the main Romanian economic activities

III. MODELS AND METHODOLOGIES

The econometric study is based on panel data estimation, using STATA software. A panel data regression has the following general form:

$$y_{it} = \alpha_i + x_{it}'\beta + \varepsilon_{it} \tag{1}$$

where i=1...N, t=1... T.

Most of the panel data applications utilize a one-way error component model for the disturbances with:

$$u_{it} = \alpha_i + \varepsilon_{it} \tag{2}$$

There are several different linear models for panel data. The main distinction between fixed-effects and random-effects models consists in the fact that in the fixed-effects (FE) model the α_i are permitted to be correlated with the regressors x_{it}, while continuing to assume that x_{it} is uncorrelated with the idiosyncratic error ε_{it}. On the other hand, in the random-effects (RE) model, it is assumed that α_i is purely random, which is a stronger assumption implying that α_i is uncorrelated with the regressors [7].

There are several tests based on which we can tell whether a FE or a RE model is more appropriate, out of which the Hausman test is the most common one. The basic idea of this test starts with the hypothesis that the FE estimator is consistent in the RE model as well as in the FE model. In the FE model it is even efficient, whereas in the RE model it has good asymptotic properties. By contrast, the RE–GLS estimator cannot be used in the FE model, since it is efficient by construction in the RE model. The violation of the assumption Eα = 0 for the regression model leads to an inconsistency. Therefore, a rejection of the null is often considered as an adoption of the fixed effects model and nonrejection as an adoption of the random effects model [6].

Out of the variety of FE model estimators, the within estimator, which eliminates the fixed-effect by mean-differencing, is the most commonly used. Actually, according to Cameron and Trivedi it is also consistent under the RE model, but alternative estimators are more efficient [8]-[9]. The fixed-effects α_i can be eliminated by subtraction of the corresponding model for individual means, leading to the within model which can be estimated with the OLS method. The default standard errors assume that after controlling for α_i, the error ε_{it} is independent and identically distributed.

Moreover, when estimating a panel data model, one must check the validity of the assumptions concerning the absence of both heteroskedasticity and serial correlation of the idiosyncratic error term. When heteroskedasticity is present, the standard errors of the estimates will be biased and one should compute robust standard errors correcting for the possible presence of heteroskedasticity. The most common deviation from homoskedastic errors in the context of panel data is likely to be error variances specific to the cross-sectional unit. When the error process is homoskedastic within cross-sectional units, but its variance differs across units, then we have groupwise heteroskedasticity.

Besides, in case the errors are correlated and the estimation does not take it into account, the estimates will be biased [18]. In these cases, one should estimate the regression model using robust standard errors in order to account for these problems [12]-[14].

IV. ECONOMETRIC RESULTS

The general form of the employment equation estimated as a panel data is the following:

$$\ln employ_{it} = \alpha_0 + \alpha_1 * \ln GDP_{it} + \alpha_2 * \ln inv_{it} + \\ + \alpha_3 * \ln cost_{it} + \alpha_i + \varepsilon_{it} \tag{3}$$

where the dependent variable was considered to be the total number of employed population expressed in natural logarithm values (ln*employ*) and the explanatory variables were the natural logarithms of the GDP (ln*GDP*), the net investments (ln*inv*) and the labor cost (ln*cost*). In this equation *i* stands for each of the 10 Romanian economic activities, whereas *t* stands for the years 2000-2009.

We also tested the statistical significance of the first lag of each variable, but they turned out to be insignificant.

When running the Hausman test using STATA software in order to decide whether a RE model is more appropriate than a FE model, the probability was less than 5% (see fig.2). Concluding that we are dealing with fixed-effects, we estimated the model at national level using the within estimator.

	Coefficients (b) f	(B) r	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lngdp	**.3345362**	**.3785297**	**-.0439934**	**.0127489**
lncost	**-.2050732**	**-.2526811**	**.0476079**	**.0136126**

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                 b = consistent under Ho and Ha; obtained from xtreg
  B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test:  Ho:  difference in coefficients not systematic

             chi2(2) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                     =       11.77
           Prob>chi2 =      0.0028
           (V_b-V_B is not positive definite)
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Fig. 2 The Hausman Test

When performing both the modified Wald test for groupwise heteroskedasticity in the FE model, implemented in STATA by Baum and the serial correlation test proposed by Drukker, it resulted that the errors were both autocorrelated and heteroskedastic. That is why, in order to ensure the validity of the statistical results, we had to estimate a robust fixed-effects (within) regression with Driscoll and Kraay standard errors (see fig. 3).

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Regression with Driscoll-Kraay standard errors   Number of obs      =       100
Method: Fixed-effects regression                 Number of groups   =        10
Group variable (i): id                           F(  2,       9)    =     30.74
maximum lag: 2                                   Prob > F           =    0.0001
                                                 within R-squared   =    0.4742
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lnemploy	Coef.	Drisc/Kraay Std. Err.	t	P>|t|	[95% Conf.	Interval]
lngdp	.3345362	.0829303	4.03	0.003	.1469349	.5221375
lncost	-.2050732	.0805744	-2.55	0.031	-.3873452	-.0228012
_cons	4.404016	.2501086	17.61	0.000	3.838232	4.969801

Fig. 3 The Robust FE model

As expected, the labor cost affects employment in a negative way, with a coefficient that indicates a decrease of about 0.205% of the number of employed population in case the labor cost increases with one percent, keeping all the other explanatory variables constant.

The influence of the Gross Domestic Products seems normal, since the growth of the output stimulates employment by the need to create new job entries and the emergence of new economic activities. The estimated coefficient indicates that a 1% increase of GDP leads to a 0.335% increase of employment, keeping all the other explanatory variables constant.

The stimulating effect of the net investments upon employment is however statistically insignificant, highlighting that the variation of the Romanian employment is less dependent on the annual amount of net investments.

A second panel data estimation was then elaborated with the purpose to build individual employment equations for each of the 10 main Romanian economic activities, by assuming that the coefficients of the explanatory variables differ between each economic activity.

The limited number of total observations available for this study forced us, however, to assume that the coefficients of only one explanatory variable can vary between economic activities, while the rest remain constant between them. Since the GDP variable had the highest impact upon employment in the estimated panel data model, we re-estimated the panel model by assuming that the coefficients of the GDP variable vary between economic activities.

The results of the second estimation are summarised in table I. One can tell that, in this case, there is an employment equation for each of the 10 Romanian economic activities, in which the particularity consists in the distinct impact of the real GDP upon the Romanian employment.

TABLE I
ECONOMETRIC MODELS FOR THE MAIN ROMANIAN ECONOMIC ACTIVITIES

No	Economic activity	Econometric model
1	*Agriculture, hunting, forestry and pisciculture*	$\ln employ_{1t} = 0.66 * \ln GDP_{1t} - -0.375*\ln cost_{1t} + 4.06$
2	*Industry*	$\ln employ_{2t} = 0.56 * \ln GDP_{2t} - -0.375* \ln cost_{2t} + 4.06$
3	*Construction*	$\ln employ_{3t} = 0.48 * \ln GDP_{3t} - -0.375* \ln cost_{3t} + 4.06$
4	*Trade*	$\ln employ_{4t} = 0.53 * \ln GDP_{4t} - -0.375*\ln cost_{4t} + 4.06$
5	*Hotels and restaurants*	$\ln employ_{5t} = 0.38 * \ln GDP_{5t} - -0.375*\ln cost_{5t} + 4.06$
6	*Transport, storage and communications*	$\ln employ_{6t} = 0.47 * \ln GDP_{6t} - -0.375*\ln cost_{6t} + 4.06$
7	*Financial intermediations*	$\ln employ_{7t} = 0.4 * \ln GDP_{7t} - -0.375*\ln cost_{7t} + 4.06$
8	*Public administration and defence*	$\ln employ_{8t} = 0.41 * \ln GDP_{8t} - -0.375*\ln cost_{8t} + 4.06$
9	*Education*	$\ln employ_{9t} = 0.52 * \ln GDP_{9t} - -0.375*\ln cost_{9t} + 4.06$
10	*Health and social assistance*	$\ln employ_{10t} = 0.52 * \ln GDP_{10t} - -0.375*\ln cost_{10t} + 4.06$

V. MONTE CARLO SIMULATION

Based on the econometric relations highlighted from the estimated panel data models concerning the impact of GDP and labor costs upon employment, the study further on continued with a simulation of the evolution of these variables in order to predict the total number of employed population for the horizon 2010-2011 in Romania [2]-[3], [16].

A stochastic simulation relies on repeated random sampling to compute the results and it is generally known as a Monte Carlo simulation. In contrast to the deterministic simulation, where the inputs to the model are fixed at known values and a single path is calculated for the output variables, in the stochastic environment uncertainty is incorporated into the model by adding a random element to the coefficients [1].

Therefore, the first step when building the numerical simulation consists in formulating several hypotheses regarding the random variation of the explanatory variables of the panel data models presented in the pervious section [10].

A three-point range: most likely, optimistic, and pessimistic was used for the Monte Carlo simulation. A triangular distribution, shown in fig. 4, was selected for modelling the GDP and labor cost variations during 2010 and 2011.

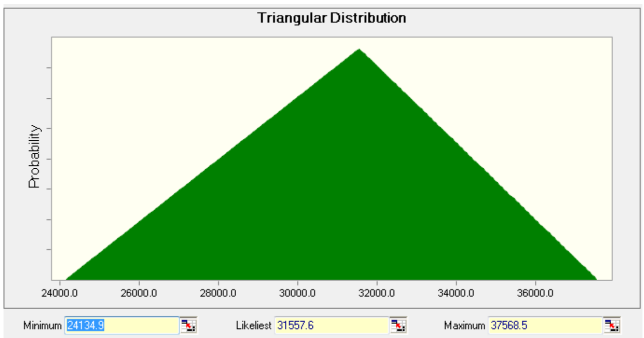

Fig. 4 The description of a Triangular Distribution using Crystal Ball

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Triangular distributions are simple distributions commonly used in similar studies, are easily understood and in most cases, work very well. These distributions use the most likely, optimistic and pessimistic values of a variable.

The triangular distributions for both the GDP and the labor cost variables for each of the 10 main Romanian economic activities are presented in tables II and III.

TABLE II
TRIANGULAR DISTRIBUTION OF GDP VARIATION

	Economic activity	*minim*	*most likely*	*maxim*
1	*Agriculture, hunting, forestry, fishery and pisciculture*	*0.8*	*1.05*	*1.3*
2	*Industry*	*1.1*	*1.13*	*1.3*
3	*Construction*	*0.9*	*1.18*	*1.5*
4	*Trade*	*1.0*	*1.21*	*1.4*
5	*Hotels and restaurants*	*0.9*	*1.15*	*1.4*
6	*Transport, storage and communications*	*0.9*	*1.18*	*1.4*
7	*Financial intermediations*	*0.9*	*1.23*	*1.5*
8	*Public administration and defence*	*1.0*	*1.20*	*1.3*
9	*Education*	*0.8*	*1.00*	*1.1*
10	*Health and social assistance*	*1.1*	*1.12*	*1.2*

The distributions were built by assuming that the most likely, optimistic, and pessimistic levels for each variable are percentage of annual variation of the real levels of the GDP and labor cost of the previous year. In order to forecast the level of GDP and labor cost for the year 2011, the variations were calculated based on the simulated values of the year 2010.

There are several simulation software that can be used in the analysis. For example, Crystal Ball extends the forecasting capability of the Excel spreadsheet model by providing the tools needed to conduct a risk analysis. Using Monte Carlo simulation, the software displays results in a forecast chart that shows the entire range of possible outcomes and the likelihood of achieving each of them. This method moves beyond what-if analysis by providing a statistical picture of the range of possibilities inherent in the assumptions.

TABLE III
TRIANGULAR DISTRIBUTION OF LABOR COST VARIATION

	Economic activity	*minim*	*most likely*	*maxim*
1	*Agriculture, hunting, forestry, fishery and pisciculture*	*1.1*	*1.20*	*1.3*
2	*Industry*	*1.1*	*1.21*	*1.3*
3	*Construction*	*0.9*	*1.15*	*1.4*
4	*Trade*	*1.0*	*1.18*	*1.3*
5	*Hotels and restaurants*	*1.1*	*1.17*	*1.3*
6	*Transport, storage and communications*	*1.1*	*1.25*	*1.4*
7	*Financial intermediations*	*1.0*	*1.22*	*1.4*
8	*Public administration and defence*	*0.9*	*1.20*	*1.4*
9	*Education*	*1.1*	*1.15*	*1.4*
10	*Health and social assistance*	*1.1*	*1.15*	*1.4*

The results of the Monte Carlo simulation computed after 10000 iterations using Crystal Ball software are presented in fig. 5 and 6. The results of the numerical simulation suggests that, based on this scenario, the employed population in Romania is more likely to encounter only slight variations during the simulation horizon, in comparison to the previous years.

In order to plot the results, we first separated the main Romanian activities with high employment level from those with moderate level of employment and then plotted the two groups separately in fig. 5 and 6, respectively.

Three economic activities were identified as having high level of employment (see fig. 5), namely: *Agriculture, hunting, forestry and pisciculture, Industry* and *Trade.* In all three cases, an increase in the number of employed persons is forecasted for the horizon 2010-2011, with the exception of the slight reduction of employment in *Agriculture, hunting, forestry and pisciculture* predicted for the year 2011.

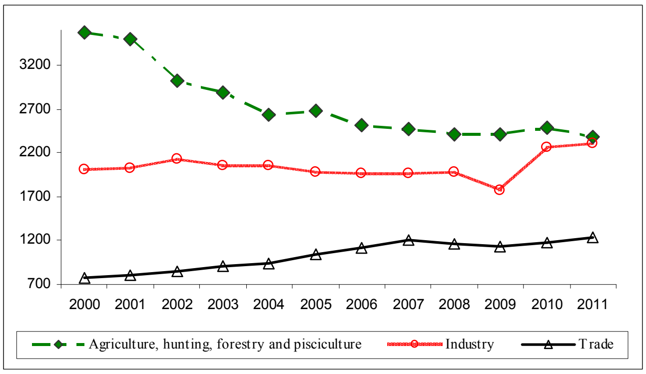

Fig. 5 The employment evolution in the economic activities with higher level of employment

When considering the second group of economic activities presented in fig. 6, we notice that the reductions of the number of employed population is forecasted for the following three activities: *Hotels and restaurants, Transport, storage and communications* and *Public administration and defence*, while at the opposite pole are the activities *Construction* and *Health and social assistance*, having a positive trend.

In the cases of *Financial intermediations* and of *Education*, however, one can notice some alternating fluctuation.

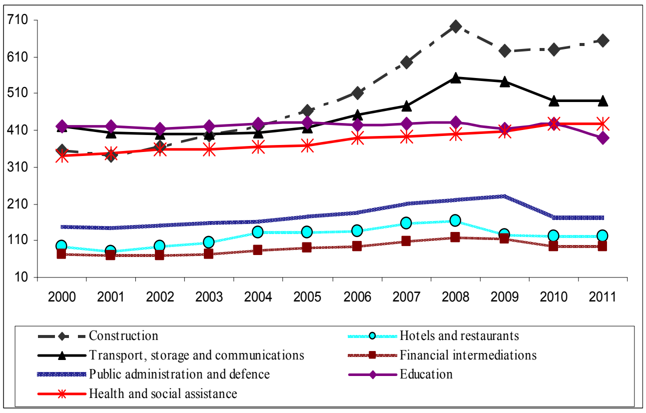

Fig. 6 The employment evolution in the economic activities with lower level of employment

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VI. CONCLUSIONS

In this paper, we have investigated the impact of various macroeconomic variables, such as labor cost, GDP and net investments upon employment in Romania. For that, several econometric models were estimated, based on panel data series for the period 2000 – 2009 for 10 of the main Romanian economic activities.

The first step of the analysis consisted in estimating a general employment equation built at national level, when considering 10 of the main Romanian economic activities.

The main results of the panel data built at national level indicated that the Romanian labor market is showing signs of a normal activity. Thus, the employment is simultaneously affected by both the variations of the GDP and of labor costs.

Secondly, based on the estimated panel data models concerning the impact of GDP and labor costs upon employment, a Monte Carlo simulation was applied in order to forecast the variations of employment in Romania for the horizon 2010-2011. The simulation procedure described in section V, which was based on new-built panel data models, but can be similarly applied for other macroeconomic models as well, represents in fact the novelty of this paper among the international literature.

The simulation analysis will further on be extended in a future study to a multi-scenario approach, in order to better account for the effects of the economic crisis upon the Romanian labor market.

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