CAUSALITY BETWEEN STOCK PRICE AND GDP IN TURKEY: AN ARDL BOUNDS TESTING APPROACH

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LIKELYHOOD ESTIMATION OF THE SYSTEMIC POISON-INDUCED MORBIDITY IN AN ADULT NORTH EASTERN ROMANIAN POPULATION
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Causality between stock price and GDP in Turkey: An ARDL Bounds Testing Approach

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ABSTRACT

The study investigates the dynamic relationship between stock prices and GDP in Turkey using quarterly data from 1989Q2-2014Q2. The study investigated the interrelationship between the variables via auto regressive distributive lag (ARDL) framework and ECM to analyse the existence of a long-run equilibrium relationship between gross domestic product and stock prices. The results provide strong evidence that both the stock prices and GDP are strongly cointegrated in the long-run. The empirical estimation indicated a significantly positive relationship between GDP and stock prices. The robustness of the ARDL model was confirmed by using Johansen and Juselius’s cointegration test (1990). The Granger causality test results indicate a long-run bidirectional causality between stock prices and GDP, and also a uni-directional causality from GDP to stock prices in the short-run. Both the stock prices and the economic growth are directly linked with each other. The reliability and validity of our estimations are confirmed by the diagnostics and the CUSUM test.

Key Words: ARDL Model, Granger Causality, GDP, Stock price.

JEL Classification: C22, G10

INTRODUCTION

There is a vast amount of theoretical and empirical literature available on the relationship between financial markets and economic development. Schumpeter (1912) argued that well designed and well-functioning financial markets enable investors and entrepreneurs to post higher profits, which promotes economic development. The relationship between stock prices and economic growth has been an important subject in the literature. This debate in the literature is supported by the fact that stock price movements may influence economic growth. This leads to the question of whether a long-run or short-run relationship exists between stock prices and economic growth.
or if a causal relationship exists between economic growth and financial development (Deb and Mukherjee, 2008). The stock market helps to mobilize savings by providing incentives to the savers to create portfolios that consist of attractive securities, which have maximum return and minimal variance.

Financial markets are characterized by the trading of different securities that depend on their period of maturity. The concept of fund raising has been a burning issue in the field of finance and its relationship with economic growth is also an important topic. The investor plays a pivotal role in improving the stock prices of a company in a given country by investing in its particular stocks. The investor invests in a company by purchasing shares, which are issued by the company to finance itself. There are several modes that can be used as a better source to attract the investors to buy the stocks. If the investment opportunity seems to be an attractive proposition for the investors, they will buy stocks in order to achieve maximum return at the lowest possible risk. This results in an overall increase of stock prices, which is a positive sign for a country to attract more investors to improve its economic growth on one side, and the profitability for the stock issuing company on the other. Conversely, the investor will not invest in those stocks that promise little or no return with maximum risk, which results in a decrease in the price of stocks. Pearce’s (1983) study suggested that the stock prices indicate the prospect of economic growth, with rising stock prices increasing the domestic expenditures, which can in turn lead to an improved GDP. The stock prices and GDP relationship can vary and has drawn the attention of researchers, economists and experts in finance. For example, Gupta and Hartley (2013) studied the relationship in South Africa between growth and stock prices. However, no mutual consensus has been derived in the literature regarding a causal relationship between economic growth and stock prices. Ritter (2005) conducted a study on stock prices and GDP, and the empirical estimations confirmed that stock prices and economic growth have a negative relationship at the company level. A positive relationship was identified between stock prices and economic growth by Kim and In (2003), Cole et al. (2008) Beck and Levine (2004), and Zhou et al. (2012).

The linkage between macroeconomic variables and stock market prices has been widely studied in the literature. Some studies have analysed the stock market indexes and some of them have analysed the stock return. However, most of the studies do not consider the bivariate relationship between stock market prices and economic growth. This study investigates and analyses the interaction between economic growth and stock prices in Turkey. Specifically, a bivariate form of co-integration is used to analyse the relationship between the two variables. The main goal of the study is to identify the direction (uni-
direction or bi-direction) or causation between economic growth and stock prices in Turkey. This study aims to investigate whether, in the case of Turkey, both the real GDP and stock prices may have any long-run relationship by applying the auto regressive distributed lag model (ARDL). This study can also be useful in identifying the direction of causality for short-run and long-run dynamics for stock prices and economic growth by applying an error correction model (ECM). The rest of the article is organized as follows. Section 2 explains the literature review. Section 3 describes the data, model specification and econometric methodology. Section 4 analyses the empirical results and discussion and Section 5 explains the conclusion of the study.

LITERATURE REVIEW

Hassapis and Kalysitis (2002) studied the causative relationship between real growth and stock prices for the period 1949 to 1998 in the G7 countries by employing the VAR model. The results of the VAR model show that a strong association exists between economic growth and stock returns. Binswanger (2004) also investigated the relationship between the growth of real economic activity and stock returns between 1960 and 1999 in the G7 countries by analysing the quarterly data. The VECM model was employed and demonstrated a strong correlation between stock return and GDP.

Mauro (2003) analysed the correlation between real interest rates, GDP, money growth and stock returns in emerging market countries, which included Argentina, Mexico, Korea, India, Greece, Chile, Thailand and Zimbabwe as well as developed countries that included Austria, Switzerland, Australia, Canada, Denmark, France, Belgium, Italy, Germany, Netherlands, Norway, Japan, Singapore, United Kingdom, Sweden, USA and Spain for the period from 1971 to 1988. The study employed panel regression and the results indicated a strong correlation between economic growth and stock returns in both emerging market countries and developed countries. The asset price was determined as a strong predictor for GDP in both emerging market countries and developed countries.

Siliverstovs and Duong (2006) investigated the relationship among the stock market, GDP and interest rates in five European countries including Germany, France, Italy, the Netherlands and UK by taking the quarterly data from the period ranging 1985 Q1-2004 Q4. The VAR model was used to investigate the relationship between the above-mentioned variables. The results indicated a positive correlation between stock prices and GDP in those five countries. In addition, share prices demonstrated a significant relationship with GDP.

Mun et al. (2008) examined the interrelationship between economic growth and stock prices for the period 1977 to 2006 in Malaysia. Both VAR
and Granger causality were employed and the results indicated a uni-causal relationship between two variables, which means the stock prices affected/caused the economic growth in Malaysia.

Enisan and Olufisayo (2009) examined the long-term association between stock markets and economic growth in Egypt and South Africa for the period 1980 to 2004. The newly developed autoregressive distributed lag (ARDL) model was employed to find the relationship. The study found that economic growth and the stock market were positively affecting each other in Egypt and South Africa.

Olweny and Kimani (2011) employed the VAR model and Granger Causality to study the causal relationship between the stock market and economic growth in Kenya for the period 2001-2010. The result showed a uni-causal relationship between economic growth and stock prices, i.e. economic growth Granger causes stock prices.

Budden et al. (2010) investigated the effect of stock prices on inflation in Brazil as well as the currency exchange and deficit spending by the government on GDP for the quarterly period from 1996Q3-2009Q3, by employing multiple regression techniques. The study determined that stock prices, Government spendings positively affect GDP. However, inflation negatively affects the GDP.

Ikoku (2010) investigated a causal relationship between the stock prices index and GDP by using the quarterly data for the period 1984Q1-2008Q4 in Nigeria. The study analysed the long-run relationship by using the co-integration test on both stock prices and GDP. The VECM model and Granger causality showed a causal relationship exists between stock prices and GDP. The study also found that the share prices have a positive and significant relationship with GDP.

Taiwo et al. (2012) investigated the effect of all stock prices, interest rates and exchange rates on the Nigerian economy for the period 1980 to 2010. The VECM model that was applied indicated that oil prices, stock prices, exchange rates and interest rates affect the economic growth of a country. Omowunmi and Oluseye (2011) examined the effect of economic growth on the stock market in Nigeria for the period 1985 to 2009 by applying the multiple regression model. The results showed that the stock market significantly affected the economic growth. Various studies examining different countries have been conducted to find the direction of causality, but the problem has still been unresolved. The fundamental valuation model argues the dependence of the stock price based on the expectations of the future economy. In this case any expected changes in the real income in an economy may cause the stock price to change. While wealth effect on other hand, argues that it is
because of the stock price that causes variations in the economy. This study
is undertaken with the aim of determining whether both the stock prices and
GDP are cointegrated followed by Granger causality test under the framework
of ECM for the period 1989Q2-2014Q2.

METHODOLOGY OF THE STUDY

Data
The bivariate framework includes gross domestic product and stock
prices. For empirical analysis, the quarterly data for GDP and stock market
indices from the second quarter of 1989 to the second quarter of 2014 is
employed. The data was collected from the IMF international financial
statistics. Seasonally adjustment was applied in order to remove the seasonal
component, by taking out the irregular components and trend-cycle.

Model Specification
Various studies have been conducted to find the relationship between
GDP and stock prices by using different econometric models. Many authors
have utilized different econometric models for different countries. However,
to the extent of our knowledge, no study has been conducted on the long-term
and causal relationship between GDP and stock prices for Turkey by using
the ARDL bounds testing approach. Turkey was selected on the basis of its
tremendous growth over the last 12 years, including its foreign trade and gross
domestic product. The study will be very beneficial and a valuable literature
resource. As discussed in the literature review, the estimated Equation in
logarithm1 form will be:

\[ lnGDP = \alpha_0 + \alpha_1 lnSP + \epsilon_t \] (1)

Where GDP is the gross domestic product, and SP is the stock
price. According to the literature and theory, is expected to be positive.
For estimation, the newly econometric ARDL bounds testing approach was
applied, as suggested by Pesaran et al. (2001).

3.3. Unit root
The unit root is used to examine the stationarity of the data; however,
selecting the appropriate unit root test is very difficult when it comes to
estimation. To improve the robustness of the selected variables, (gross domestic

---

1. The data is converted to log lessen the effect of heteroscedasticity and eliminate variation in
time series data.
product and stock prices), several unit root tests can be applied. Enders (1995) argued in his study that it is beneficial to perform more than one unit root test at the same time, i.e. the Augmented Dickey and Fuller (1981) and Phillips-Perron (PP) tests (1988). If both the unit root tests give the same results then we are certain about the order of integration of series. The Augmented Dickey Fuller and Phillips-Perron (PP) tests are the two most widely used unit root tests for stationarity of data in literature.

3.4. Bounds test of cointegration

The ARDL bounds testing approach used in this article have been developed by Pesaran et al. (2001). The ARDL bounds testing is a new approach for cointegration. The test can be performed by using the F-statistics or Wald test to check the significance of the lagged co-efficient in the unrestricted correction model (UECM). The ARDL model can act efficiently for small sample sizes in time series data. The ARDL bounds test approach consists of three main steps. The first step is to determine the long-run cointegration among the variables in the equation. The F test or Wald test can be used to determine this long-run relationship among the variables. The Wald test or joint significance test is performed by equating all the coefficients of the lag variables to zero, as shown in Equation 2 (Tang, 2003).

$$
\Delta \ln GDP_t = \beta_0 + \sum_{i=1}^{n_1} \beta_{1i} \Delta \ln GDP_{t-i} + \sum_{i=1}^{n_2} \beta_{2i} \Delta \ln SP_{t-i} + \lambda_1 \ln GDP_{t-1} + \lambda_2 \ln SP_{t-1} + \nu_t \tag{2}
$$

Where “$\nu_t$“ is an error term and $\Delta$ represents the first difference. The estimated F statistic is then compared with the bounds critical values in the table created by Pesaran et al. (2001) at significance levels of 1%, 5% and 10%. The Pesaran et al. (2001) critical values are comprised of the upper and the lower bounds values. If the calculated F statistics value is greater than both the upper and lower bounds critical values, then the null hypothesis of no co-integration can be rejected. This means that the variables in the model do have long-term co-integration. If the calculated F statistics value lies between the upper and lower bounds critical values, then the decision is inconclusive. If the calculated F statistics lies below the upper and lower bounds critical values, then it suggests the evidence of no cointegration among the estimated variables in the model.

The next step is to estimate the elasticity of the long-run relationship and short-run relationship to determine their impact on the dependent variable. The estimation of the elasticity of the long-run relationship depends on the first step after predicting a long-run relationship among the variables in the series.
\[ \ln(GDP)_t = \alpha_0 + \sum_{i=1}^{p} \beta_1 \ln(GDP)_{t-i} + \sum_{i=0}^{p} \beta_1 \ln(SP)_{t-j} + \mu_t \]  
(3)

\[ \Delta \ln(GDP)_t = \alpha_0 + \sum_{i=1}^{k} \theta_1 \Delta \ln(GDP)_{t-i} + \sum_{i=0}^{l} \beta_1 \Delta \ln(SP)_{t-j} + \psi ECT_{t-1} + \delta t \]  
(4)

The short-run elasticity is estimated from the short-run coefficients of the differenced variables by using Equation 4. When there is more than one short-run coefficient, then the Wald test can be used for the joint significance of the short-run coefficients toward the long-run, where \( \psi \) represents the coefficient of error correction term in Equation 4. The sign of coefficient of the error correction term should be negative and significant, and the value should be between 0 and 1, showing the convergence of the system of equations to the long-run equilibrium after a short-run shock.

The robustness of the ARDL bounds test of cointegration can be confirmed by using the Johansen and Juselius (1990) maximum livelihood estimation to test for sensitivity. The series is integrated of the first order, which is a pre-requisite to employ the Johansen and Juselius test to examine the presence of cointegration. The Johansen procedure is carried out under the unrestricted vector auto regressive (VAR) in which the restrictions are imposed on the coefficients by cointegration in the unrestricted VAR system.

### 3.5. ECM Granger causality test

After the confirmation of cointegration by the Johansen and Juselius (1990) test in the unrestricted VAR, a long-run relationship was indicated amongst the dynamic regressors. The existence of cointegration among the variables suggests that there must be Granger causality among the variables in at least one direction. We employ ECM Granger causality to find out the direction of causality between GDP and stock price. Sargan introduced ECM in 1964, but when it was later modified by Engle and Granger (1987), it became more popular. The ECM is used to correct the disequilibrium for testing the causality in the cointegrated variable for the short and long-run.

\[ \Delta \ln(GDP) = \delta_0 + \sum_{i=1}^{p} \lambda_{1i} \Delta \ln(GDP)_{t-i} + \sum_{i=1}^{q} \lambda_{1i} \Delta \ln(SP)_{t-i} + \varphi_1 ECT_{t-1} + e_{1t} \]  
(5)

\[ \Delta \ln(SP) = \delta_0 + \sum_{i=1}^{q} \lambda_{2i} \Delta \ln(SP)_{t-i} + \sum_{i=1}^{p} \lambda_{2i} \Delta \ln(GDP)_{t-i} + \varphi_2 ECT_{t-1} + e_{2t} \]  
(6)

Where \( ECT_{t-1} \) represents the lagged error correction term and represents the first difference to capture the short-run disturbances. Also, \( e_{1t} \) and \( e_{2t} \) represents the error term that should be white noise and serially uncorrelated. An ECM distinguishes between both the short-run and long-run Granger causality. The statistical significance of the short-run is tested by using
the individual coefficients of the lagged terms. The statistical significance of
the coefficient of the $ECT_{t-1}$ indicates the long-run causality. The value of the
ECT must be between 0 and 1 with a negative sign indicating the convergence
of the system back to equilibrium. The joint causation of both long-run and
short-run can be tested to check for joint significance.

To check the reliability and validity of the estimation of the ARDL
model, several diagnostic and model stability tests are performed. The
diagnostic test examines serial correlation, heteroscedasticity and serial
correlation. The structural stability of the model can be examined via CUSUM
Test, proposed by Brown et al. (1975).

**EMPIRICAL RESULTS AND ANALYSIS**

**4.1. Unit Root Test for Stationarity**

It is not important to perform a unit root test in the ARDL model
because ARDL bounds testing can be applied to any series, irrespective of
their order of cointegration. The regressors can be $I(0)$, $I(1)$ or mutually co-
integrated but none of the variables must be $I(2)$. Enders (1995) suggested
using both the Augmented Dickey Fuller (1981) and Phillips-Perron (PP) unit
root tests (1988). The unit root tests were estimated both at level and first
difference with intercept and trend. The lag selection was carried out by using
the Schwarz information criterion, as recommended by (Pesaran and Shin,
1997). Table 1 specifies the summary of the ADF unit root test, in which both
LSP and LGDP at level are non-stationary, and become stationary after the
first difference at 1% level of significance. The PP Test confirms the results,
given by ADF, as shown in Table 2.

**Augmented Dickey Fuller Unit Root test**

<table>
<thead>
<tr>
<th>Country (Sample Period)</th>
<th>ADF (Level)</th>
<th>ADF (First Difference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkey (1989Q2,2014Q2)</td>
<td>0.2709 (0)</td>
<td>-9.1358***(1)</td>
</tr>
<tr>
<td>LGDP</td>
<td>-0.6941(4)</td>
<td>-7.0869***(3)</td>
</tr>
<tr>
<td>LSP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: (i) E-Views 9 has been used for performing the unit root tests. (ii) The Augmented Dickey Fuller unit root test was performed both at level and first differenced (the trend and intercept) (iii) The figure in the parenthesis represents the lag selection by using the Schwarz info criteria (SIC). (iv) *, **, *** represents significance at 1%, 5%, and 10%. 

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Philips Perron (PP) Unit Root test

Table 2

<table>
<thead>
<tr>
<th>Country (Sample Period)</th>
<th>PP</th>
<th>PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkey (1989Q2,2014Q2)</td>
<td>Level</td>
<td>First Difference</td>
</tr>
<tr>
<td>LGDP</td>
<td>0.0543 (5)</td>
<td>-9.4236*** (5)</td>
</tr>
<tr>
<td>LSP</td>
<td>-1.7364 (3)</td>
<td>-6.7824*** (4)</td>
</tr>
</tbody>
</table>

Note: (i) E-Views 9 has been used for performing the unit root tests with Newey-West using Bartlett Kernel.. (ii) The Phillips-Perron unit root test was performed both at level and first differenced (trend and intercept) (iii) The figure in the parenthesis represents the lag selection by using the Schwarz info criteria (SIC). (iv) *, **, *** represents significance at 1%, 5%, and 10%.

A summary of the ADF and PP Tests is given in Tables 1 and 2, which concludes that none of the variables is I(2), so the long-run relationship can be predicted by using the bounds test or F test proposed by Pesaran et al. (2001).

Results of Bounds test of Co-integration

Table 3

<table>
<thead>
<tr>
<th>Estimated Model</th>
<th>$F_{LnGDP} (LnGDP/LnSP)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimal Lag Length (AIC)</td>
<td>(3,0)</td>
</tr>
<tr>
<td>$F$-Statistics (Bounds Test)</td>
<td>7.0584***</td>
</tr>
</tbody>
</table>

Critical Values

<table>
<thead>
<tr>
<th>Lower Bounds I(0)</th>
<th>1 Percent</th>
<th>2.5 Percent</th>
<th>5 Percent</th>
<th>10 Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.94</td>
<td>4.18</td>
<td>3.62</td>
<td>3.02</td>
<td></td>
</tr>
<tr>
<td>Upper Bounds I(1)</td>
<td>5.58</td>
<td>4.79</td>
<td>4.16</td>
<td>3.51</td>
</tr>
</tbody>
</table>

NOTE: *** represents 10% significance level. The above table shows the different F-statistics values for Turkey by using AIC. The CV’s are taken from Pesaran et al. (2001).

Table 3 illustrates the results of the computed F statistics value, which is compared with the F lower and F upper critical values and strongly suggests the existence of the long-run relationship among the variables in the estimated model. The computed F statistics value suggests that the gross domestic product and the stock prices have a long-run co-integration, where both the variables move together.

After the confirmation of the long-run relationship, the next step is to estimate the confirmation of the error correction term, which must be smaller than the unity in absolute term and should be negative and statistically significant. This condition is satisfied and the error correction term exists and is

1. The ARDL model is estimated by using restricted intercept and no trend.
significant as well. This means that divergence from the long-run equilibrium is corrected in the short-run, depending on the speed of adjustment. The coefficient of the error correction term in Turkey is -0.0384. This suggests that 3.84% of the disequilibria from the previous quarter is converged and corrected back to the long-run equilibrium in the current quarter. In this case, the findings indicate that the speed of adjustment is very slow and it will take time for the system to get back to the long-run equilibrium after a short-run shock. The next step is to estimate the long-run coefficient by using AIC\(^1\) criterion to select the optimum lag.

**ARDL Long-run and short-run results**

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Dependent Variable: LnGDP&lt;sub&gt;t&lt;/sub&gt;</th>
<th>ARDL(3,0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-run results</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable</td>
<td>Coefficient</td>
<td>Standard Error</td>
</tr>
<tr>
<td>Constant</td>
<td>23.7540</td>
<td>1.0336</td>
</tr>
<tr>
<td>LnSP</td>
<td>0.7392</td>
<td>0.1614</td>
</tr>
<tr>
<td>R(^2)</td>
<td>0.99</td>
<td>Adjusted R(^2)</td>
</tr>
<tr>
<td>F-Statistics</td>
<td>50036.22***</td>
<td>DW</td>
</tr>
<tr>
<td>Sum Squared resid</td>
<td>0.3300</td>
<td>S.E of regression.</td>
</tr>
</tbody>
</table>

| Short-run results | |
| Variable | Coefficient | Standard Error | t-Statistics |
| Constant | 0.7986 | 0.4276 | 1.8673* |
| D(lnSP) | 0.0329 | 0.0346 | 0.5902 |
| ECM\(_{t-1}\) | -0.0384 | 0.0082 | -4.6587*** |
| R\(^2\) | 0.46 | Adjusted R\(^2\) | 0.44 |
| F-Statistics | 19.9045*** | DW | 2.07 |
| Sum Squared resid. | 0.3328 | S.E of regression. | 0.0598 |

Note: *, ** and *** represents significance level at 1%, 5%, and 10% level respectively.

Table 4 represents the estimated long-run coefficient of the independent variable. Table 4 shows that an increase in the stock prices contributes to an increase in the gross domestic product. More precisely, a 1% increase in the stock prices leads to a 0.7392% increase in gross domestic product. The sign of the stock price is positive and in accordance with the theory. This means that there is a positive long-run relationship between GDP and stock prices, which is also confirmed by the studies of Kim and In (2003), Cole et al. (2008), Beck and Levine (2004), and Zhou et al. (2012).

1. The AIC criterion was selected because, as W. Ender (1995) suggested, the AIC performs better in small samples then in SBC, as the AIC is biased in selecting the over parameterized model.
The validity and reliability of our estimation results are confirmed by the diagnostic tests. The diagnostics tests include the Breusch-Godfrey serial correlation LM test, the Arch Test and the White test for heteroscedasticity. The results of all the diagnostics tests are displayed in Table 5.

### Diagnostic Tests (Long-run)

<table>
<thead>
<tr>
<th>Diagnostic Test</th>
<th>$\chi^2_{sc}$</th>
<th>$\chi^2_w$</th>
<th>$\chi^2_{AR}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkey</td>
<td>3.1933</td>
<td>16.6707</td>
<td>0.2611</td>
</tr>
<tr>
<td></td>
<td>(0.2026)</td>
<td>(0.1180)</td>
<td>(0.6093)</td>
</tr>
</tbody>
</table>

NOTE: $\chi^2_{sc}$, $\chi^2_w$, and $\chi^2_{AR}$ are the Lagrange multiplier value for serial correlation, White test and Arch tests for heteroscedasticity based on the regression of squared residuals on squared fitted values respectively. The numbers in the brackets are the P-Values.

From the results of the diagnostic tests, it is clear that there is no serial correlation among the residuals as we check the second order correlation in the ARDL model. The Arch test and White test for heteroscedasticity in our estimation confirm that the residuals are homoscedastic. The diagnostics tests further strengthen and confirm the reliability and validity of our estimation results. To check the stability of the long-run of the coefficient of the estimated variables in the model, the cumulative sum (CUSUM) tests are used. The CUSUM are plotted against the plotted lines at 5% level of significance. If the plot of the CUSUM lies inside the critical bounds at 5% level of significance, this indicates that the regression model is stable.

### Plots of cumulative sum of recursive residuals

![Figure 1](image_url)
Note: The straight line is in between the critical bounds at 5% significance level, indicating the stability of the model.

As seen in the figures for the CUSUM, the estimated CUSUM lines within the critical bounds at 5% level of significance, suggesting that the estimated model is stable.

The robustness of the ARDL model can be tested by using Johansen and Juselius’s (1990) maximum likelihood cointegration approach as showed in Table 6. Both the variables at level were estimated in the unrestricted VAR for the optimum lag and found lag 5, selected on the basis AIC, FPE, LR and HQ criterions. The same lag length is checked for serial correlation by performing the serial correlation LM test, which found that the residuals are white noise at lag 5. Table 6 shows that a cointegrating relationship exists between GDP and stock a price, which confirms the results of the Pesaran et al. (2001) cointegrating approach. The normalized cointegrating equation has been revealed in Table 6 and the sign is positive, confirming a positive relationship between GDP and stock prices, as we expected.
Johansen and Juselius’s maximum likelihood cointegration results.
(intercept and no trend)

Table 6

<table>
<thead>
<tr>
<th>Hypothesized No. of cointegrating vectors</th>
<th>H₀</th>
<th>Trace statistics</th>
<th>Critical Values</th>
<th>Max Eigen</th>
<th>Critical Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>5%</td>
<td>1%</td>
<td>5%</td>
</tr>
<tr>
<td>None</td>
<td>R=0</td>
<td>20.4496***</td>
<td>15.41</td>
<td>20.04</td>
<td>13.0284</td>
</tr>
<tr>
<td>At most one</td>
<td>R≤1</td>
<td>7.4211***</td>
<td>3.84</td>
<td>6.65</td>
<td>7.4211***</td>
</tr>
</tbody>
</table>

Normalized cointegrating equation: GDP = 21.89+ 0.9722 Stock price

Note: 4 The trace statistics is the λ₁ value. *** show the significance at 1% level. The lag length was selected by using the Lag criteria. The Autocorrelation LM tests was performed and found no serial correlation problems.

4.2 Results of the Granger causality

Table 7 reveals the results of the causality test. Several tests have been performed for Granger causality: (1) Short-run causality - this includes the sum of the lagged coefficients of each independent variable by joint $F$ test; (2) The long-run causality can be investigated by taking the t-test into account to examine the significance of the error correction term; (3) The joint significance of the sum of the lagged terms of each independent variable and the error correction term (ECT) by joint $F$ test for analysing the short-run adjustment to rebuild the long-run equilibrium.

As the estimations in the table reveal that the lagged error correction term is statistically significant indicating a long-run causality that runs via the error correction term from stock prices to GDP, which confirms the results of the bounds test. In addition, there is another long-run Granger causality, which runs interactively via the error correction term from GDP to stock prices. Therefore, bidirectional causality exists in the long-run. This indicates that both the variables can come back to the long-run equilibrium after a short-run shock that confirms the system stability. The convergence back to equilibrium position depends on the speed of adjustment. However, short-run causality is only found from the GDP to stock price, and not vice versa. That means there is a short-run uni-directional Granger causality, which implies that economic growth contributes to the development of stock market. Consequently, the stock market develops as the economy of Turkey develops in the short-run. This further implies that growth is a good indicator for predicting stock returns in the short-run proving the validity of adaptive expectation model that utilize the past values of GDP to explain the future stock prices. However, a bi-directional causality has been confirmed in the long-run, as well in joint (short-run and long-run) which suggests that stock market development and

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economic growth are causing each other in the long-run as well as in joint Short-run and long-run. This indicates that the stock markets play an important role in explaining the predictions about an economy, assisting the investors in making accurate expectations about the future economy. Furthermore, the growth also is a good indicator that predicts stock prices implying the validity of adaptive expectation model. Both the stock market (stock prices) and the economic growth are directly linked with each other. Our estimated results are in line with the study conducted by Comincioli (1995) and show that the stock prices can be used as a sign of prospective economic growth. The results of the Joint (short-run and long-run causalities) are shown in Table 7.

**Results of Granger Causality**

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>F-Statistics (Probability)</th>
<th>Long-run</th>
<th>Joint (Short-run and long-run)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔLGDP</td>
<td>1.6039 (0.1681)</td>
<td></td>
<td>2.1973 (0.0512)*</td>
</tr>
<tr>
<td>ΔLSP</td>
<td>5.8989 (0.0001)***</td>
<td>-0.16 [-2.5789]***</td>
<td>6.4546(0.000)***</td>
</tr>
</tbody>
</table>

Note: *, *** represents the significance level at 1% and 10%, respectively.

F-Statistics probabilities and t-ratios are given in parenthesis and square brackets, respectively. The optimal lag chosen is lag 5, based on the lag criteria (AIC, LR, FPE and HQ) estimated under the unrestricted-VAR. The residuals are white noise at lag 5 estimated via VAR residual serial correlation LM test. The Godfrey LM tests have been applied and the estimation confirms the absence of serial correlation in the ECM.

**CONCLUSION**

The study aim was to investigate the dynamic relationship between stock prices and GDP for Turkey using the quarterly data from 1989Q2 - 2014Q2. The empirical method implied in the study was the recently developed bounds testing approach to cointegration developed within the auto-regressive distributive lag (ARDL) framework and ECM to examine the existence of a long-run equilibrium relationship between gross domestic product and stock prices. The results provide strong evidence that both stock prices and GDP are strongly cointegrated and have a long-run relationship. The empirical estimation suggests that there is a significantly dynamic and positive relationship between GDP and stock prices. This means that if the stock prices increase (fall) the GDP of turkey will also rise (fall), which is also confirmed.
by Kim and In (2003), Cole et al. (2008), Beck and Levine (2004), and Zhou et al. (2012) in their studies. When the elasticity of the stock prices in Turkey rise by 1%, then the GDP will also rise by 0.73%. The parameter of the error correction term (-0.0384) is smaller than unity in absolute term and negative, indicating the existence of a long-run relationship among the variables in the estimated model. This suggests that if the level of GDP is above or below the equilibrium level, it adjusts by 3.84% per quarter. The parameter of ECT shows the speed of adjustment, which is very slow in countering the short-run shock and converges back to the long-run equilibrium, indicating the stability of the system.

The Granger causality test result indicates a long-run and as well in Joint (short-run and long-run) bidirectional causality between stock prices and GDP, suggesting the importance of both growth (Fundamental valuation model) and stock price (wealth effect) helps in predicting and accurate forecasting to preclude the economy from confronting the crises in future. Both fundamental valuation model and wealth effect explains that stock market usefulness in predicting the economy. A short-run uni-directional causality running from GDP to stock price, was found suggesting that growth is a good indicator for predicting stock returns in the short-run proving the validity of adaptive expectation hypothesis that utilize the past values of GDP to explain the future stock prices that has been ignored in most of the studies undertaken. The estimation based on the stock prices represents the real economic activity of any country. Both the stock prices and the economic growth are directly linked with each other. This indicates that policy makers can use stock market information and past values of economic growth by making accurate predictions about potential crises by formulating efficient policies to offset and prevent them. However, future studies can be conducted by including exchange rates, inflation and other relevant micro-economic variables.

Acknowledgements

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References


5. Comincioli, B., 1995, The stock market as a leading economic indicator: An application of Granger causality. Digital Commons @IWU, Economics Department of Illinois Wesleyan University.


Internationalization of the Higher Education in Romania and EU Countries

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ABSTRACT

Internationalization of higher education has become a part of the globalization process. In this paper we analyze the internationalization of the higher education in Romania and EU countries, identifying the forms of the internationalization, the main statistical indicators available to measure the process of internationalization. The figures presented in this article show that although Romania took some measures to support the internationalization and the number of foreign students started to increase especially after 2007, it has one of the lowest rates of student mobility among EU countries. The asymmetry ratio of students’ mobility shows that Romania is not currently an attractive country for tertiary education. Only medicine seems to attract foreign students mainly because the tuition fee is much lower than in other European countries. The determinants of the student mobility were investigated through some simple regression models which showed that the GDP per capita and the ratio between the number of students and professors influence the decision to study abroad.

Keywords: higher education, internationalization, mobility, statistics of education

JEL Codes: I23, I21

1. INTRODUCTION

Internationalization of higher education has become a part of the globalization process (Scott, 2000). While 20-25 years ago internationalization was regarded exclusively through the student mobility, today there is another vision of the internationalization of the higher education (Dragoescu 2015). Internationalization of higher education is an evolving concept which includes
all practices of the higher education institutions to face the new global academic environment as well as the policies at national, regional or international level developed to promote student or academic staff exchange. Internationalization of higher education is based on a set of underlying values and principles such as intercultural learning and mutual respect, academic integrity, equitable access and quality.

At this moment there is no well-defined conceptual framework for defining the internationalization of higher education but there are efforts to develop such a framework, some of them being presented in (Qiang, 2003). One of the current definitions used for internationalization is given by Knight (2003) and Knight (2008) who states that the internationalization is an integration process of the international, global and intercultural dimensions of the purpose and mission of post-secondary education. The process of internationalization can be seen on two levels: internationalization within the national educational system and internationalization across the national borders. The first level refers to the strategies adopted by higher education institutions for students to understand the benefits of internationalization and intercultural skills and the second level regards the mobility of students, teachers and researchers. The motivations for internationalization are presented in Altbach (2007), the evolution of the higher education internationalization is presented in (Gao et al. 2015) and (Altbach et al., 2009) while an overview of the European experiences in internationalization is presented in Teichler (2009) who describes the efforts made during the implementation of the Bologna process towards the internationalization in higher education.

The development of internationalization needs that higher education institutions have a strategy and allocate a special budget for these activities. While in over 60% of the EHEA countries more than half of higher education institutions have adopted strategies on internationalization (European Commission/EACEA/Eurydice, 2015) in Romania fewer than 25% of higher education institutions have adopted such an internationalization strategy.

The development of joint programs by universities from different countries is another aspect of internationalization. Belgium, France, Germany, the Czech Republic and Portugal have more than 10% of universities with at least one study program developed jointly with a university from another country (European Commission/EACEA/Eurydice, 2015). Currently, there are certain barriers to the development of such programs, especially related to national legislation that is either ambiguous or not yet allowing universities to offer degrees by such programs. Financing the joint programs is a key factor for their success. In the recent years most of these programs were financed either by European funds such as Erasmus Mundus programme (European Commission/EACEA/Eurydice, 2015).
Commission, 2016) either by the universities that have priorities in this field. Only a few countries such as Finland, Italy, Lithuania, Norway, Germany, Romania or Spain have mechanisms for additional financing the joint programs.

Distance learning can be viewed as a mean of internationalization of tertiary education because Internet access has become ubiquitous and very cheap in most of the European countries. Online courses are means by which students who do not move to another country to study can participate to international study programs. The term commonly used for the online courses that universities offer to students around the globe is MOOC (Massive Open Online Courses) and was used for the first time since 2008 (Cormier, 2008). This form of education has virtually exploded in the U.S. after 2012 where edX (www.edx.org), Coursera (www.coursera.org), and Udacity (www.udacity.com) led to massive development of online courses. MOOC is now regarded as a major innovation that takes place in higher education (Par, 2013; Watters, 2012) threatening the classic form of education due to much lower costs and high accessibility.

The purpose of this paper is two-fold: first we provide a descriptive view of the internationalization of the higher education and second we analyze the determinants of the students’ mobility by the means of linear regression models.

The rest of the paper is organized as follows: the next section presents the data used to analyze the internationalization of higher education and the main methodological approaches, in section 3 we discuss students’ and academic staff mobility issues in Romania and EU countries, in section 4 we try to identify the main determinants of the students’ mobility using a series of linear regression models and in the final section we present the conclusions of our study.

2. DATA AND METHODOLOGY

Data series about higher education statistics are available from multiple sources: UNESCO database, Eurostat database or World Bank database. In our study, we used data series regarding the number of foreign students enrolled in Romanian universities retrieved from UNESCO database, the decomposition of this number by the region of origin retrieved from Eurostat database as well as the number of foreign students by the field of study in Romania also retrieved from Eurostat database. The internationalization of the higher education in EU countries was analyzed using the inbound and outbound students’ mobility rates and the asymmetry ratio, all the necessary
data series being retrieved from Eurostat database for 2012, the last year with complete data in Eurostat database.

We tried to identify the determinants of the students’ mobility in EU28 countries using a number of economic as well as non-economic data series presented in table 1. The economic variables considered in our models were the GDP per capita, the social protection expenditures, the employment rate and the mean income for higher education graduates. We chose these economic variables as a measure of the economic attractiveness of a country for foreign students.

The non-economic variables we used in our models are a measure of the quality of the tertiary education in a country: the students-professors ratio and the number of universities in Top 500. Although there are other quality indicators for higher education systems such as the student services, the laboratory equipment, training materials, etc. the lack of data availability at EU level prevented us from using them. Table 2 shows some descriptive statistics of the selected variables. All the data series were for 2012, the most recent year Eurostat has complete data for all EU28 countries.

The variables used in the regression models

<table>
<thead>
<tr>
<th>Variable</th>
<th>Meaning</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOREIGN_STUD</td>
<td>The percentage of foreign students in the total number of students from a country</td>
<td>Eurostat</td>
</tr>
<tr>
<td>GDP_PER_CAPITA</td>
<td>GDP per capita (EUR)</td>
<td>Eurostat</td>
</tr>
<tr>
<td>SOCIAL_PROTECTION_EXP</td>
<td>Social protection expenditure per capita (EUR)</td>
<td>Eurostat</td>
</tr>
<tr>
<td>EMPLOYMENT_RATE</td>
<td>Employability rate for higher education graduates</td>
<td>Eurostat</td>
</tr>
<tr>
<td>MEAN_INCOME</td>
<td>Equivalized net income</td>
<td>Eurostat - SILC</td>
</tr>
<tr>
<td>TS_RATIO</td>
<td>The ratio between the number of students and the number of professors</td>
<td>Eurostat</td>
</tr>
<tr>
<td>NO_TOP500</td>
<td>Number of TOP 500 universities from a country</td>
<td><a href="http://www.shanghairanking.com/ARWU-Statistics-2012.html#2">http://www.shanghairanking.com/ARWU-Statistics-2012.html#2</a></td>
</tr>
</tbody>
</table>
Descriptive statistics of the variables used in the regression models

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>Maximum</th>
<th>Minimum</th>
<th>St.Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOREIGN_STUD</td>
<td>5.2297</td>
<td>2.6854</td>
<td>40.9836</td>
<td>0.1907</td>
<td>7.8647</td>
</tr>
<tr>
<td>GDP_PER_CAPITA</td>
<td>23,978</td>
<td>19,500</td>
<td>75,900</td>
<td>5,200</td>
<td>15,363</td>
</tr>
<tr>
<td>SOCIAL_PROTECTION_EXP</td>
<td>6,666</td>
<td>5,087.6</td>
<td>18,862.1</td>
<td>951.6</td>
<td>4,938.1</td>
</tr>
<tr>
<td>EMPLOYMENT_RATE</td>
<td>81.67</td>
<td>81.95</td>
<td>87.7</td>
<td>70.3</td>
<td>4.36</td>
</tr>
<tr>
<td>MEAN_INCOME</td>
<td>20,916.7</td>
<td>20,956</td>
<td>51,755</td>
<td>4,171</td>
<td>11,775</td>
</tr>
<tr>
<td>TS_RATIO</td>
<td>15.99</td>
<td>14.69</td>
<td>44.5</td>
<td>3.75</td>
<td>7.48</td>
</tr>
<tr>
<td>NO_TOP500</td>
<td>6.71</td>
<td>2</td>
<td>38</td>
<td>0</td>
<td>10.42</td>
</tr>
</tbody>
</table>

We employed a number of linear regression models were the endogenous variable was the percentage of foreign students in the total number of students from a country (which is the inbound mobility rate) and the exogenous variables were the economic and non-economic variables described above.

Since we considered six regressors, the total number of combinations between them is considerably high. Therefore, in order to select the best regression models we used the best subset selection procedure described in detail in (James et al., 2013) to choose among the possible models. We applied this procedure using the leaps library of the R software system. The criteria used to select the best models were the RSS but using adjusted R² or BIC one can obtain the similar results. Considering p regressors, the best subset selection procedure chooses the best model with 1, 2, ..., p regressors iteratively, adding a new regressor to the previous model in each iteration. Finally, the best model is chosen according to the criteria set by the user. Since our purpose is not to find a single model to predict the mobility but to analyze the determinants of the mobility we presented the estimations for all p models (in our case, p=6). Besides these six models we also considered two more models including two of the economic variables identified to have a significant influence on the students’ mobility and the students-professors ratio. All the regression models were estimated using the ordinary least squares method with the R software system.

3. STUDENTS AND ACADEMIC STAFF MOBILITY IN ROMANIA AND EU COUNTRIES

Students mobility

Figure 1 presents the evolution of the number of foreign students enrolled at a university in Romania for undergraduate studies during 1970-2014 while the number of foreign students in the academic year 2014-2015 is presented by the continent of origin in Table 3. It can be observed that 66.3%
from the total number of 23,559 foreign students who studied in Romania during 2014-2015 academic year came from European countries. The share of foreign students in the total number of students during the academic year 2014-2015 in Romania was 4.07% and the share of students from European countries was 2.69%, which places Romania among the countries with the lowest rates of mobility at European level.

The number of foreign students who studied in Romania in 2014-2015

<table>
<thead>
<tr>
<th>Region</th>
<th>Europe</th>
<th>Asia</th>
<th>Africa</th>
<th>North America</th>
<th>South and Central America</th>
<th>Oceania</th>
<th>Other countries</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15,611</td>
<td>4,646</td>
<td>2,849</td>
<td>310</td>
<td>115</td>
<td>17</td>
<td>11</td>
<td>23,559</td>
</tr>
</tbody>
</table>

* data source: Eurostat

The number of foreign students in Romanian universities

![Figure 1](image)

* data source: UNESCO database

Although since 2004, and especially after 2007 when Romania joined the EU, the number of foreign students studying in Romania has an upward trend, their share in the total number of students is very low: the highest value was 8.9% in 1982, especially due to the overall small number of students, not just to the large number of foreign students. During the period after 1990, the highest percentage was recorded in 2014-2015 when 4.07% of the total number of students in Romania was from foreign countries.

The number of foreign students in Romania by the field of study is presented in Table 4 where one can observe a great inequality between the
fields of study. It appears that the most attractive areas for foreign students are health and welfare (especially medicine) and social sciences, business and law. On the opposite side are the programs that prepare teachers for the educational system or programs in science, mathematics and computing. The Romanian medicine schools attract a relative large number of foreign students mainly because of the low tuition fee comparing with other countries. In Romania the tuition fee is around 2000 EUR per year while in other European countries this fee is very large: in the Czech Republic it is 60,000 EUR for the entire six-year program (Centre for International Cooperation in Education, 2016), in Hungary 20,000 EUR (Educations.com, 2016), in Poland around 50,000 EUR (Medical Study Guide, 2016) while in the UK it is around 36,000 £ (QS Top Universities, 2016) per year of study.

The number of foreign students in Romania by the field of study

<table>
<thead>
<tr>
<th>Study field</th>
<th>2008</th>
<th>2010</th>
<th>2012</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>36</td>
<td>56</td>
<td>51</td>
<td>39</td>
</tr>
<tr>
<td>Humanities and arts</td>
<td>1,357</td>
<td>1,451</td>
<td>1,541</td>
<td>1,818</td>
</tr>
<tr>
<td>Social sciences, business and law</td>
<td>4,263</td>
<td>4,471</td>
<td>4,272</td>
<td>4,290</td>
</tr>
<tr>
<td>Science, mathematics and computing</td>
<td>469</td>
<td>598</td>
<td>527</td>
<td>677</td>
</tr>
<tr>
<td>Engineering, manufacturing and construction</td>
<td>2,024</td>
<td>2,030</td>
<td>2,582</td>
<td>2,892</td>
</tr>
<tr>
<td>Agriculture and veterinary medicine</td>
<td>249</td>
<td>290</td>
<td>317</td>
<td>3,150</td>
</tr>
<tr>
<td>Health and welfare</td>
<td>5,262</td>
<td>8,225</td>
<td>10,461</td>
<td>10,008</td>
</tr>
<tr>
<td>Services</td>
<td>197</td>
<td>266</td>
<td>486</td>
<td>685</td>
</tr>
</tbody>
</table>

* data source: Eurostat

One of the priorities of the Bologna Process is to increase the mobility of students, researchers and professors because it generates academic and cultural benefits, helps to increase employability and labor market access of young people (European Commission/EACEA/Eurydice, 2015). At the Conference of Education Ministers of the EU countries in 2012 mobility was defined regarding two aspects: obtaining credits of study in another country (at least 15 ECTS) and full graduation of study programs in another country, i.e. obtaining a diploma, but yet there are no statistics at international level to evaluate separately the two types of mobility.

At the meeting of EU education ministers during 28-29 April 2009 in Leuven / Louvain-la-Neuve where they reviewed the progress of implementation of the Bologna Process, they set a target for 2020 that at least 20% of university graduates in the EHEA countries should have had a period of mobility. There are a number of countries that proposed even higher targets for student mobility (EHEA, 2012a). For example, Germany, Austria and Denmark have proposed this target to be 50%.
Student mobility rates in the EU countries in 2012 are shown in Figure 2. The mobility rate of the students is measured using two statistical indicators: inbound mobility rate and outbound mobility rate. The inbound mobility rate computed by Eurostat is given by the percentage of the foreign students that come to a host country for studies while the outbound mobility rate is given by the percentage of the national students who go to study abroad. Only EEA and candidate countries were considered when measuring these indicators. The average inbound mobility rate for EU28 countries was 3.6% and that of the outbound mobility was 3.5%.

**Inbound and outbound students’ mobility rates (%) in EU28 countries during 2012**

*data source: Eurostat*

Although these percentages are still very low compared to the targets set for 2020, there is a wide inequality among EU member states: the inbound mobility rate varies from 41.9% for Luxembourg to 0.2% for Lithuania and the outbound mobility rate varies from 72.5% for Luxembourg to 0.9% for the UK. Most of the students in Cyprus and Luxembourg are going to study in other countries probably due to the low educational supply in their countries. Among the countries with a high outbound mobility rate one can note the Eastern European countries that also recorded a very low inbound mobility rate. For 11 EU countries the ratio of students who go to study abroad is below 3% with the lowest values recorded for UK with 0.9% and Spain with 1.6%. Countries
that receive most of the foreign students are the UK, Austria, Luxembourg, Denmark, and Belgium. At European level, the UK had the largest number of foreign students – 150,133 in 2012, which is 2 times greater than Germany.

Generally, the inbound mobility is a recognition of the attractiveness of higher education institutions of a country in terms of learning provision, quality of education or financial capacity while the outbound mobility can be the result of either encouraging the students to follow at least a part of a study program in another country, the poor quality of higher education provision in the native country, or of the difficulties encountered by the graduates on the labor market in their native country.

In the statement of the Education Ministers in Bucharest (EHEA, 2012b) it is noted that a goal for the coming years is to achieve a more balanced mobility of students. Asymmetry mobility which is another indicator of the inequality of the students’ mobility and it can be quantitatively assessed by the ratio of the number of foreign students coming to study in a country and that of its students who go to study abroad. We computed the values for the asymmetry mobility for 2012 and the results are shown in Figure 3. If the values of this ratio are greater than one this means that the country “imports” students from abroad while if the ratio is lower than one this means that the country “exports” students. Analyzing the values shown in Figure 3 we can see that a number of 19 countries from the EU28 countries are exporting to students while only 9 countries are importing students. Among the countries with the highest value of this ratio there are the UK, Denmark, Austria, Belgium, the Czech Republic and the Netherlands. Countries for which there is a larger imbalance but in the opposite direction, the number of students leaving the country being much higher than of those coming in are Romania, Lithuania, Estonia, Poland, Croatia, Cyprus and Slovakia.
Assymetry ratio: the ratio between the number of students coming to study in a country and the students who go to study abroad in 2012

Figure 3

* data source: author’s own calculation after Eurostat data

In order to have an increase of the mobility in the future a series of measures should be taken first by tackling barriers that have been identified so far: lack of appropriate funding, language barriers, issues related to the organization of the studies (undergraduate curriculum structure), issues related to the fields of study where particularly medicine and law studies raises the problem of the recognition of diplomas, the lack of detailed information about opportunities to study abroad, issues related to the separation of families of students.

Among the measures proposed to address these obstacles are:
- portability of the study grants. This measure comes to combat insufficient funding allocated to support mobility. So far, portability of grants is implemented only in Western European countries;
- various forms of support for students studying abroad: offering part-time jobs, providing loans on favorable terms to students, organizing free courses for learning the language of instruction;
- organizing a larger number of study programs in foreign languages, especially in English. Several European countries supports this initiative at the legislative level. The law of higher education and research which was adopted in July 2013 in France allows higher education institutions to open study programs in languages other than French within international partnerships while in Belgium the law allows up to 25% of courses in undergraduate studies and 50%
of master’s study programs to be taught in a language other than the national language;
• create a legal framework to solve problems related to recognition of diplomas.

3.2 Academic staff mobility

Academic staff mobility is considered as important as student mobility but so far there is no statistical system to quantitatively assess this type of mobility. Academic staff mobility is related to all types of personnel: professors, researchers and administrative staff. It can contribute to the socio-cultural and scientific exchanges and to the labor market reform (Cradden, 2007). Academic staff mobility includes visits and sabbaticals, grants and fellowships, untenured or tenured employment. The problems of academic staff mobility analysis are similar to those of student mobility and they include:
• the direction of the mobility: academic staff leaving to teach in another country versus academic staff coming from other countries;
• the duration of mobility;
• the category of personnel: professors, researchers, PhD students, administrative and technical staff.

Some European countries such as for instance the Czech Republic included the academic staff mobility into the strategic plan of the Ministry of Education creating facilities for bringing foreign experts to teach in Czech universities while Estonia, Finland, France, Romania or Slovenia’s strategic plans in the field of tertiary education even include quantitative targets regarding the mobility of academic staff. In Lithuania the strategic plan stipulates that 10% of the academic staff must participate to mobility programs by 2020 and in Romania, the National Agency for Community Programs (http://www.anpcdefp.ro) foresee an annual increase of the number of the academic staff going to teach in other countries within the Erasmus program by 5%. Among the problems hindering the academic staff mobility at this moment (European Commission / EACEA / Eurydice, 2015) we can mention the lack of funds, administrative personnel load problems, language problems and lack of motivation among the academic staff. Nevertheless, promoting academic staff mobility is an important issue of the higher education policy in the European area.
4. THE DETERMINANTS OF STUDENTS’ MOBILITY

The drivers of the students’ mobility are a new area of research. A number of recent studies try to analyze whether the key motivators for internationalization are of economic nature or not (Hudson, 2016). In our study we will try to identify the factors contributing to the inbound mobility of the students through a series of linear regression models where the endogenous variable is the percentage of the number of foreign students studying in a country and exogenous variables are both economic and non-economic factors (Dragoescu, 2015).

In the category of economic factors we considered the GDP per capita, the social protection expenditure per capita, the rate of employability for graduates of higher education, and the average equalized net income of the population with higher education (this indicator originated from the SILC survey conducted in all EU countries). We also considered two non-economic variables: the number of universities in the Top 500 (Academic Ranking of World Universities, 2012) from the country receiving the students and the ratio between the number of students and the number of professors as a measure of the attractiveness and the quality of the tertiary education. Some descriptive statistics and the sources of the data series used were already presented in section 2.

In table 5 we present the parameter estimations for 8 regression models solved by ordinary least squares method (Wooldridge, 2015) using the R software system. The first 6 models (M1 - M6) are the one indicated by the best subset procedure and in the last two models (M7 - M8) we included two of the economic variables together with the students-professors ratio, removing the intercept.

Analyzing the results shown in Table 5 it can be concluded that the only economic variables that influence the decision to study in a foreign country are the GDP per capita (we noted a positive correlation between the inbound mobility rate and GDP in all models) and social protection expenditure (negative correlation!). The coefficients of these two variables have associated p-values that indicate significance at 1%. The other economic variables, the mean income or the employability rate for people with higher education have coefficients that are not significantly different from zero, thus they cannot be considered as drivers of the students’ mobility.

From the non-economic variables included in our models, the number of universities in Top 500 seems not to have an influence on the student mobility (p-value>0.1 in all cases) while the ratio between the number of students and professors could be considered as a determinant of the mobility (see the results of models M7 and M8). This ratio is used in several European
countries, including Romania, as an indicator of the quality of the higher education: a small ratio means a high quality educational system.

These results indicate that the explanation of the very large number of foreign students in some European countries may also reside in the specific characteristics of higher education systems like for example the possibility of studying in English, facilities for students as scholarships, laboratory equipment in the higher education institutions, the tradition of higher education in the country, the value of the annual fees of study, student services etc. and not only in the macroeconomic indicators characterizing the country. Our results obtained in this study are consistent with other international studies (Seeber et al., 2016).

The estimates of the regression models

<table>
<thead>
<tr>
<th></th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
<th>M5</th>
<th>M6</th>
<th>M7</th>
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<tr>
<td></td>
<td>(p=1.23e- 9)</td>
<td>(p=2.76e-8)</td>
<td>(p=2.29e-8)</td>
<td>(p=1.79e-05)</td>
<td>(p=2.76e-07)</td>
<td>(p=1.56e-6)</td>
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<td>(p=0.29)</td>
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<td>4.925e-3</td>
<td>4.925e-3</td>
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<td>0.84</td>
<td>0.72</td>
<td>0.85</td>
</tr>
</tbody>
</table>

5. CONCLUSIONS

In this paper we analyzed some issues of the higher education internationalization in Romania and EU countries. Internationalization of higher education has several benefits. Among them we can mention improved quality of teaching and research, developing inter-institutional cooperation, improved access to the labor market for graduates, and improved institutional policy-making. Although there are a lot of benefits of the internationalization process we showed that the student mobility in Romania continues to have low levels: during the 2014-2015 academic year only 4.07% of the total number of students in Romania came from foreign countries. The most attractive field of study for foreign students in Romania proved to be medicine since the associated costs are much lower than in other EU countries.
At the EU level, internationalization of the higher education has also a low level: the inbound mobility rate for EU28 countries in 2012 was 3.6% and the outbound mobility was 3.5%. Regarding the academic staff mobility which is another component of the higher education internationalization, there are no statistical indicators comparable at the international level that allows the researcher to measure this process.

We identified MOOC as another form of higher education internationalization but the graduation rate of this kind of courses is still very low (around 10%) and certificates obtained by the graduates have not yet found recognition in education law of any country. The causes for this low are multiple: language barriers, ICT skills, time constraints (Fini, 2009). Nevertheless, MOOC development has led universities to consider this form of education as a form of internationalization that increase the visibility of an institution at international level.

Using a series of econometric models we tried to identify the determinants of the students’ mobility for EU countries. We included both economic variables and non-economic variables in our models. The results of the estimations showed that the GDP per capita is an important economic determinant of the student’s mobility across European countries. Other economic variables included in our study like the employment rate or the mean income for higher education graduates seems not to influence the students’ mobility. Regarding the non-economic variables we found out that the student-professors ratio significantly influences the mobility. This is normal, since this ratio is a measure of the quality of an educational system.

While the average level of the internationalization of higher education in EU countries is rather low, improving the mobility of students and academic staff in the near future requires some measures from universities such as: restructuring their curricula, introduction of more courses in English (which is the main language of study at international level), development of study programs in collaboration with other universities abroad and development of communication skills in a foreign language for the administrative staff. Also, universities should improve their work promoting international study programs to make known their educational offer to students in other countries. At the governmental level, the funds for mobility should be increased and some financial support schemes for students who want to study in another country should be provided.

In the last years Romanian higher education institutions made important efforts to promote internationalization, but Romania still has a very low student mobility ratio among EU countries.
References


The Use of Social Media for Communication In Official Statistics at European Level

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ABSTRACT
Social media tools are widespread in web communication and are gaining popularity in the communication process between public institutions and citizens. This study conducts an analysis on how social media is used by Official Statistical Institutes to interact with citizens and disseminate information. A linear regression technique is performed to examine which social media platforms (Twitter or Facebook) is a more effective tool in the communication process in the official statistics area. Our study suggests that Twitter is a more powerful tool than Facebook in enhancing the relationship between official statistics and citizens, complying with several other studies. Next, we performed an analysis on Twitter network characteristics discussing “official statistics” using NodeXL that revealed the unexploited potential of this network by official statistical agencies.

Keywords: social media, Twitter, Facebook, official statistics, communication

JEL Classification: M3

INTRODUCTION
Accurate and reliable information as well as its ease of access is crucial for democracy and democratic decision-making (Kavanaugh et al., 2016). The internet and particularly social media have a great potential to increase interactivity, transparency, openness and accountability of the public sector, gradually transforming public communication (Bonson et al., 2012, Zhong and Lu, 2013). The role of social media in public administration is essential in order to enhance the role of citizen as partner rather than customer in delivering public services (Linders, 2012). Although social media plays an important role in disseminating information, the adoption of social media as way of communication is still low and limited to little interaction (Abdelsalam
et al., 2013). Furthermore, as Warren et al. (2014) points out social media helps increasing trust in government institutions. Social media is successfully used by government institutions and also by other private entities in crisis communication to share messages that promotes maximum compliance (Freberg, 2012). Also, social media has become an essential tool for journalists and politicians not just for young adults (Kelling et al. 2013).

In order to achieve its mission to increase engagement and transparency, social media instruments must be carefully selected as there are various factors influencing the success of social media, including organizational characteristics (Oliveira and Welch, 2013). Also, one must understand that there are several stages of maturity in social media-based public engagement each facing its own challenges, management complexity and risks: the initial phase that presumes certain legal and technological conditions exist in public administration for the use of social media but social media is seldom used, data transparency phase when government institutions begin to exploit Big Data for their purposes, open participation, open collaboration and full engagement of government institutions and citizens (Lee and Kwak, 2012). Social media usage in government institutions is still in the beginning as information posted on official pages tend to be monotonous, rigid and formal (Zheng and Zheng, 2014). In order to succeed on social media, the contents posted must constantly evolve and must be as exciting as possible to the user (Kaplan, 2011). Moreover, the success of social media practice depends on the understanding of all its functionalities and the introduction of a multi-way online interaction (Jiang et al. 2016).

Nevertheless, as social media offers many opportunities for strategic communication (Zerfass and Schramm, 2014) a comprehensive study on this issue is of a great importance for nowadays communication. In this context, our study aims to analyse how social media is used by Official Statistical Institutes to interact with citizens and disseminate information. In order to achieve this scope, first we present the importance of social media, along with websites, in official statistics communication, as it was previously identified by the literature (section 1). Second, we will explore which social media channel is more effective in increasing interaction between users and Official Statistical Institutes (section 2). Third, we will analyse network characteristics of the most relevant social network for official statistics communication (section 3). Finally, conclusions and further research suggestions are stated.
SOCIAL MEDIA IN OFFICIAL STATISTICS COMMUNICATION

According to Statista (2016), the number of social media users around the globe will reach 2.95 billion users, almost three times higher compared to 2010. Moreover, according to the same source, social networking is one of the most popular online activities, offering countless possibilities of user engagement.

Figure 1 below shows the percentage of individuals participating in social networks to the total number of internet users at European level. As one can observe, the lowest value was registered for Italy (32% of the individuals) and the highest for Iceland (79%). In recent years, it became essential for National Statistical Institutes to be visible on social media platforms and to define clear objectives and steps to follow in this regard (Eurostat, 2011). The presence of statistical agencies on social media complies with the European Code of Practice as follows (Government Statistical Service, 2012): alerting the users to newly released statistics and engaging in discussion with them helps respecting principle 1; announcing users in a timely fashion with regard to changes in methods, classifications, in the release of statistics or errors complies with principle 2; engaging users at minimum costs complies with principle 6.

Percentage of individuals participating in social networks to the total number of internet users for 2013

*Figure 1*

Data source: Eurostat
In the context of online behaviour, statistical institutes must empathize with the evolution of online media, and the admission that statistical user counts to communicate via interactive online media platforms (Eurostat 2011). The presence and access of more and more citizens to modern mobile devices increase the interest to consume more and more online information in a shorter time comparing to the traditional internet access (Derks and Bakker, 2010).

Social media usage in Official Statistics has been developing quickly and is certainly evolving fast (Westström et al., 2011). Yet, the most important mean of communication in official statistics is the web page, often seen as one of the most important page in the country (Dewis, 2015). In Official Statistics, the need to use social media is closely linked to the desire to increase statistical literacy, in order to spread information and support the use of statistics with the aim of social interaction (United Nations Economic Commission for Europe, 2014).

WHICH SOCIAL MEDIA NETWORK IS MORE EFFICIENT IN INCREASING THE WEBSITE TRAFFIC?

Two most important social media tools used in official statistics communication are Facebook and Twitter, as 25 out of 32 EU official statistics agencies have a Twitter account and 9 have a Facebook account. Other social media channels such as YouTube or Google+ are used but they are less popular. Twitter pages are relatively new across the studied agencies, as in most cases the first post on the Twitter page occurred in 2015 or 2016. Facebook pages, although new across the EU are relatively older, as first posts usually occurred in 2012 and 2013. The official statistics team in Estonia is pioneer in this area, as its first post on Twitter occurred on 14-Dec-09 while on 17-Feb-10 posted on Facebook. Only seven countries use both of the social media tools.

Next, we examine the relationship between the social media platforms (Twitter and Facebook) of National Institutes of Statistics, as the two most important social media tools used by EU official statistical agencies, and the popularity of their official sites, as the most important mean of communication in official statistics. We used a sample of data obtained from 32 Twitter and Facebook official pages of the National Institutes of Statistics in Europe. The data was collected between 1st and 2nd of June 2016 and it reveals characteristics in keen relation to that moment in time. Also, we gathered data about the websites of these institutes using the “http://www.alex.com/” platform on the same days.

We estimate a predictive model using statistical regression technique in investigating the relationship among variables. The general model is defined as below:
response = operator1 term1

where response is the outcome or dependent variable and term is the predictor variables and operator is an operator that indicates how the terms that follow are included in the model. Furthermore, for the data processing we use R software and minipack.lm package to determine the linear model. Therefore, the main element to build a regression model in R is lm function. The variable used in this study are listed and defined below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic_rank_in_country</td>
<td>site popularity in a specific country</td>
</tr>
<tr>
<td>Nr_likes_Twitter</td>
<td>total number of likes on Twitter page</td>
</tr>
<tr>
<td>Nr_likes_Facebook</td>
<td>total number of likes on Facebook page</td>
</tr>
</tbody>
</table>

According to our research based on the previous literature, we carried out two hypotheses focusing on two possible situations that can affect the site popularity of National Institutes of Statistics – Twitter or Facebook official profiles.

The hypotheses are presented below:
1. The total number of likes on Twitter profile has a positive effect on traffic site rank in that country.
2. The total number of likes on Facebook profile has a positive effect on traffic site rank in that country.

The results for the first hypothesis are based on a simple regression model in which the total number of likes on Twitter profile predicted site popularity was significant. The F-statistic test performs is F=5.483 resulting a p-value probability p < 0.05 and R-squared=0.13. In this case we can say that in our model the total number of likes on Twitter is a significant predictor of site rank in the country.
Linear regression analysis model (dependent variable - traffic rank in country)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nr_likes_Twitter</td>
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<td>-0.019</td>
</tr>
<tr>
<td>Adj. R²</td>
<td>5.483</td>
<td>0.412</td>
</tr>
<tr>
<td>β</td>
<td>2.459</td>
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</tr>
<tr>
<td>t</td>
<td>2.342</td>
<td>0.642</td>
</tr>
<tr>
<td>Sig.</td>
<td>0.026 *</td>
<td>0.526</td>
</tr>
</tbody>
</table>

Studying the second model we can conclude that hypothesis two is rejected. There is no significant relationship between total number of likes on Facebook official pages and the traffic site rank, confirming that hypothesis two is not true and the predictor traffic site rank is not significant in this model.

WHAT ARE THE CHARACTERISTICS OF THE TWITTER NETWORK DISCUSSING OFFICIAL STATISTICS?

As one could observe from the previous section, Twitter is a powerful tool in increasing website traffic in the case of official statistics organisations. Next, we will conduct a brief analysis on the characteristics of the Twitter network discussing official statistics. It is crucial for any organisation to analyse such network characteristics as well as independent people characteristics, because the way of interacting with people present on social media affects their attitude towards the organisation’s products (Jiao et.al., 2013). Furthermore, integrating a brand within a community is easier to be performed via social media (Chou, 2014).

For the scope of our analysis, we will use NodeXL. NodeXL is a free and open source extension of Microsoft Excel that can perform powerful analysis on the networks characteristics on various social media platforms including Youtube, Facebook, Twitter and Flickr, providing various types of graph analysis and metrics (Hansen and Smith, 2010). In order to perform the analysis we used NodeXL as follows:

- The search limit was set for 18000 Tweets, yet one must take into account that Twitter rarely exceeds this limit as there is an age limit of one week that the social network imposes (Pewreasearch, 2011).
- We imported tweets from Twitter Search Network using the Basic network type of research. According to NodeXL information menu this means the following:
  - A vertex is created for each unique user who tweeted one
An edge is created between these vertices displaying the relationships between them as follows: “Tweet” displays a relationship that was neither a reply nor a mention (self-loop edge); “Mentions” displays a relationship that describes a tweet that mentioned someone else; “Replies-to” displays a relationship that describes a tweet that replies to a user.

- We used the keyword “official statistics” as search query. This keyword was chosen for accuracy but one should take into account that people thinking at official statistics may actually post about statistics. A further comparative analysis should be performed in order to compare the networks characteristics discussing “statistics” vs. “official statistics”.
- The search was performed on 30th October 2016.

The search results show that there is a high number of Tweets (74) and Mentions (83) and a low level of Replies (9). This shows that the usually the topic is the subject of only one way communication, rather than a bilateral one. Figure one below, representing a direct graph, emphasizes this result.
Next, some basic metrics for this network have been calculated. These metrics help us characterise even further our network. The interpretations of these metrics are made according to the results in table 3 and based on the definitions provided by NodeXL information menu.

- **Graph Type: directed.** We chose the direct graph type as the communication via Twitter can be in both ways and a user can mention another user even without following.

- For our network 148 vertices and 131 unique edges resulted. Moreover, there were 35 edges with duplicates, meaning approximately 21% of the total edges (166 edges).

- The number of self-loops resulted is 74, that is half of the total number of vertices. This shows that approximately half of the number of users that tweeted about “official statistics” were actually isolated.

- The Reciprocated Vertex Pair Ratio is approximately 0.03 meaning that only 3 out 100 users actually had a mutual communication about the topic discussed. The Reciprocated Edge Ratio is approximately 0.07 meaning that only 7 out 100 edges were in both ways. Although, this is a little bit higher than the Reciprocated Vertex Pair Ratio, it also shows a low popularity of the topic among users.

- The number of connected components for our network is 78, more than half of the resulted vertices, while the number of single vertex connected components for our network is 47. This means the topic is usually discussed among isolated groups of users.

- The number of maximum vertices in a connected component is 7, meaning that the largest number of vertices in a component that is connected to the rest of the graph is 7. The number of maximum edges in a connected component is 12, meaning that the largest number of edges in a component that is connected to the rest of the graph is 12.

- The maximum geodesic distance is 2 while the average geodesic distance is 0.95. A small average and maximum geodesic distance usually indicates that the network is not complicated, facilitating the information transfer (Albert and Barabasi, 2002). Yet, based on the fact that there is a small number of connected components, we conclude that these values should be interpreted as low connectivity.

- For this network, the graph density is very low, of only 0.004, meaning that the network is far from being developed to its full potential.
Network basic characteristics for Twitter network query “official statistics” provided by NodeXL Version 1.0.1.361, retrieved on 30th October 2016

<p>| | |</p>
<table>
<thead>
<tr>
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<tr>
<td>Graph Type</td>
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</table>

CONCLUSIONS AND FURTHER RESEARCH

Based on research conducted by Paniagua and Sapena it is found out that Twitter is a more powerful tool in enhancing the performance of an organization than Facebook (Paniagua and Sapena, 2014). This is due to the fact that Twitter is one of the easiest ways to make “Word of Mouth” marketing (Mucan and Özeltürkay, 2014). For government agencies, particularly, Twitter has the most powerful impact for the citizens (Sweetnam, 2015). Furthermore, considering official statistics, Twitter, compared to Facebook has several advantages: it does not require too much time for posting and creating messages and the questions from the followers are easy to manage (Brunet, 2015). Our research complies with these studies, as we found out that the number of likes on Twitter is a good predictor for the traffic rank of official statistics websites, while for Facebook is not.

Next, our study performed a basic analysis on the Twitter network discussing “official statistics” using NodeXL. All the accounted metrics as well as the network graph revealed that the subject is not popular among Twitter users being discussed in small groups, at best. However, basic network statistics revealed that it has great growing potential. It is mandatory public administration institutions to harness the unexploited potential of social media networks, as “presence and activity on social media is no longer a matter of choice for most governments as these platforms are used by large parts of the
One further research possibility is to make a more in-depth investigation on the aspects of increasing traffic on social media pages (Ballings et al. 2016) in keen relation with the behavioural key events of the users, as literature within this area is rather scarce. A relevant study in this area is the one done by Allagui and Breslow (2016, p.20) who concluded that social media campaigns should employ digital storytelling techniques that are both immersive and emotive, and that promote various forms of content sharing. As found out in their study (Allagui and Breslow, 2016) these stories should involve members of the target audience in at least one form of open-ended offline engagement that involves sharing behaviours. It is therefore essential for the content to be optimized for mobile displays and controls and, finally, the content to be delivered in a timely fashion. Although their study did not involve campaigns designed by public entities there is also another aspect to be considered when moving in this research direction. A recent study that examines user’s motivation to interact via government social media pages shows that information seeking is one of the most important drivers on their will to visualize such social media pages (Guo et al., 2016). Taking in consideration these aspects, in order to increase traffic on National Institutes of Statistics web pages firstly there should be seen an improved model for targeting social media pages with specific content adapted to the motivation of their users. Such campaigns are to be delivered in such a format that can be easy, accessible and correlated with the social environment at that time. Nevertheless a behavioural study on how the information is perceived by the users is necessary in order to improve the quality of the content that is delivered and ultimately impacting the visibility of the National Institute of Statistics in the online environment. As our society is furthermore interconnected and moving forward in this direction, new metrics should be considered for measuring the content relevance with direct impact amongst online visibility.

References


Two Decades of Research Collaboration: A Keyword Scopus Evaluation

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ABSTRACT

One issue that has become more important over the years is to evaluate the capability for worldwide research networks on different areas of research, especially in the areas that are identified as being worldwide significant. The study investigated the research output, citations impact and collaborations on publications listed in Scopus authored by researchers all over the world, research published between 1999-2014, selected by a group of keywords identified by authors. The results of the analysis identified an increasing trend in scientific publications starting with 2006, especially on three of the analyzed keywords. We also found differences in the citations patterns for the Black Sea and Danube Delta keywords in the contributing countries. The results of this study revealed a steady increase of the collaboration output and an increasing trend in the collaboration behavior, both at the European and national level. Additionally, at the national level the study identified the collaboration network between Romanian institutions per counties.

Keywords: Statistical software R, data collection, research, citations, articles, collaboration networks

JEL Classification: O15, O32, C80, C88

INTRODUCTION

Governments and non-governmental organizations and companies worldwide have been increasingly explored how the publication and use of open and linked data can have impacts not only on knowledge, but also on policy, governance, economic growth and societal challenges. Environmental research has exhibited an increasing trend in the number of publications in the last two decades, as well as the number of researchers involved in this research area and consequently the impact of the environmental research in the academic community has greatly increased. (Halevi, 2014) conducted a comprehensive search in Scopus data between 2001-2011 on a list of limited

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subject categories to identify the highly cited articles, performing an in-depth analysis in the top 5 articles in each area.

In 2013, the UK department of Business, Innovation and Skills commissioned Elsevier to assess the performance of UK’s research with respect to the performance of seven other selected countries (Elsevier, 2013), addressing publications trend, global research collaboration, research impact, strength and vulnerable areas and the share of global articles. In 2012, on all published articles, UK ranked third after United States and China, consistent with our findings for the keywords identified. (Kim, 2016) presented the results of the investigation of the research trends and collaboration status of China, Japan and South Korea regarding marine biodiversity through a bibliometric analysis of scientific articles on Web of Science data for a 20-year period. The study focused on identifying the countries’ research trends and collaboration trend, since it was considered significant for the strategic policy-making, economic and political environment.

The European Commission invests for the 2014-2020 funding period, through the LIFE financial instrument over 34 billion euros in nature conservation and climate change research projects (LIFE, 2013), with three priority areas nature and biodiversity, environment and resource efficiency, climate change adaptation, encouraging the participation of countries outside EU, as well. When involved in science policies, scientific collaboration and interactions among research institutions and scientists is viewed as an essential characteristic. In the last two decades one can see a trend of a remarkable increase in collaboration between countries, between and within institutions, both in the scope of scientific output, as well as policy initiatives (Melin, 1996). Through funded projects with more institutional participation, the research produced is a result of a collaborative network, where costly experiments and studies can be conducted by the joint effort of the participants and where the entities involved are not only universities, but also research institutes and industry.

The present study presents the summarized information regarding funded research and research collaboration in the past two and a half decades, focusing on environmental sciences and identifying a set of priority research actions among the conducted research analyzed. The analysis is conducted on Scopus data, identifying a set of keywords of interest, using the R environment for the statistical analysis and the generation of figures and tables. Once the set of keywords is identified (the process is described in the next section), the focus of the paper is on the analysis of research and collaboration on biodiversity, climate change at the global level and zoomed inside these areas on the research on Danube Delta and Black Sea at the national level.

Given the preparatory phase of the strategic national project DANUBIUS-RI that is implemented under the coordination of Romania, with
the hub in Danube Delta, Murighiol, the findings of this study will provide a good reference for policymakers and researchers to expand the existing collaboration networks and research efforts in the identified priority directions.

MATERIALS AND METHOD

Through the effort funded under the European Commission FP7 - Environment project, “DANube macroregion: Capacity building and Excellence in River Systems (basin, delta and sea)” - DANCERS, data has been gathered on what has been accomplished in the Danube basin in the last two decades. While performing analysis on the metadatabase (http://www.dancers-fp7.eu/) created under this project, database that gathered information about all existing projects and programmes regarding water management and environmental issues in the Danube Basin in the last two decades, strengths, weaknesses of the outcomes of two decades of research in this area were identified, as well as solutions to the gaps identified by a comprehensive analysis of the data.

Out of the 478 projects entered in the metadatabase, 397 were projects with complete information that were analyzed. The projects were collected with the help of an especially designed online questionnaire (http://bioinformatica.dbioro.eu/doc/QUESTIONNAIRE.pdf) and by using internet search tools. These projects were projects coordinated during 1993-2014 and were catalogued as projects with thematic areas in Life Sciences, Earth Sciences, Socio Economics and Multidisciplinary Sciences. The thematic focus of the evaluated projects in total was distributed as follows: Figure 1 presents the projects distribution by thematic areas. One can note that 26.1% of the projects are projects that were subscribed in more than one of the four categories presented above, 26.1% were multidisciplinary projects, and about 22.3% of the projects were Life Science projects, and the rest Earth Sciences and Socio Economics projects.

Thematic area of the projects

Figure 1
Investigating the top keywords associated with each project entered in the database for the collected 397 projects, a set of keywords, consistently associated with the research performed and outcomes was selected. The set of representative keywords to Danube research contains the following: water management, pollution control, ecosystem, Danube, Danube Delta, climate change, environmental protection, biodiversity, flood risk, sustainable development, biomaterials, biofuels, nanomaterials, bioeconomy, biobanking and Black Sea.

The analysis carried out in this manuscript is focused on evaluating quantitatively (number of publications) and qualitatively (impact through the citations number) the research having one or more of the above keywords in the interval 1999-2015. Once the keywords set was selected from the projects records, the evaluation analysis was performed on data from the Scopus database. The Scopus database is one of the largest database of peer-review literature (articles and reviews) containing more than 60 million journal records as is stated on the official webpage. The desired information was retrieved using the Advanced Search interface where for each identified keyword a search was performed selecting keywords assigned to the document by the author, i.e. function AUTHKEY().

A search example is given by the following command:

```plaintext
```

The obtained results were exported as csv (comma separated value) and bib (bibliographic information) files. Each such file contains information about the authors, title of publication, year of publication, abstract, author’s affiliations, volume of publication, journal, etc. To remove errors and other inconsistencies (for example duplications) all the data was cleaned.

The DANCERS databases collected projects on two decades, starting from 1993 and ending in 2015, however Scopus contains incomplete data on research before 1996. The qualitative analysis was adjusted to the 1996-2015 period, since Scopus does not have complete citation information for articles published before 1996; hence the number of citations was investigated only for the period 1999-2015.

To measure the research impact for each keyword, the H-index (Hirsch, 2005) and G-index (Egghe 2006) were computed. Both metrics are used to measure the scientific productivity and citation impact of the publications records at the researcher’s level. In this study the indices will be used to evaluate the scientific output of the keyword.
The collaboration networks between countries have been generated using information from the Authors with Affiliation field. For each paper, the information regarding the affiliation countries of all authors was extracted and used to compute a collaboration matrix that counts for each pair of countries the number of scientific publications co-written between these countries. Both the sizes of nodes and edges in the resulted collaboration networks are proportional to the values given by this matrix. It should be noted that self-collaborations were not included in the network plots.

For the collaboration map between Romanian counties, only publications with at least one Romanian author were taken into consideration. A data mining algorithm that extracts from the affiliation of the Romanian authors, the address, and generates automatically the corresponding county along with its geographical references, was implemented. The resulted collaboration matrix between counties was used to establish the network nodes size.

All the mapping and analysis in this article\(^1\) were performed using the open source software R (https://cran.r-project.org/) and are dynamically generated.

**RESULTS AND DISCUSSION**

Existing data sources, such as Scopus and Thomson Reuters Web of Science have incomplete data caused by irregular coverage, errors or changes in indexing policies and standardization problems (Taskin, 2014), (Bar-Ilan, 2009). For a researcher interested in duplicating the analysis or carrying out similar research, some comments regarding the constraints identified need to be made.

- The citation overview page (an option available in Scopus) can display up to 16 years. A shorter year range has to be selected to have a full display on the page.
- The search for any given keyword may result in a large number of results. If one is interested in viewing the results, one has to keep in mind that only the first 2000 records can be viewed. One of the available ways to overcome the issue is to change the sort order of the results to view more of the results.

Table 1 summarizes the number of publications and citations that were identified in the Scopus index papers for each of the keywords identified as consistently describing the funded research grants collected into the mentioned metadatabase.

\(^{1}\) This article was created in Rmarkdown and it is reproducible. All tables and figures that appear in this article are automatically created (follow this link for the source code).
The number of publications, citations and the corresponding H-index and G-index for each keyword

<table>
<thead>
<tr>
<th>Keyword</th>
<th>H-index</th>
<th>G-index</th>
<th>Number of papers</th>
<th>Number of citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>biobanking</td>
<td>19</td>
<td>34</td>
<td>224</td>
<td>1688</td>
</tr>
<tr>
<td>biodiversity</td>
<td>218</td>
<td>333</td>
<td>22206</td>
<td>469484</td>
</tr>
<tr>
<td>bioeconomy</td>
<td>18</td>
<td>31</td>
<td>139</td>
<td>1200</td>
</tr>
<tr>
<td>biofuels</td>
<td>160</td>
<td>253</td>
<td>8396</td>
<td>178311</td>
</tr>
<tr>
<td>biomaterials</td>
<td>156</td>
<td>257</td>
<td>8513</td>
<td>172388</td>
</tr>
<tr>
<td>Black Sea</td>
<td>62</td>
<td>90</td>
<td>1992</td>
<td>21172</td>
</tr>
<tr>
<td>climate change</td>
<td>245</td>
<td>355</td>
<td>39566</td>
<td>759232</td>
</tr>
<tr>
<td>Danube</td>
<td>36</td>
<td>55</td>
<td>917</td>
<td>7246</td>
</tr>
<tr>
<td>Danube Delta</td>
<td>16</td>
<td>25</td>
<td>97</td>
<td>783</td>
</tr>
<tr>
<td>ecosystem</td>
<td>244</td>
<td>369</td>
<td>28282</td>
<td>594203</td>
</tr>
<tr>
<td>environmental protection</td>
<td>50</td>
<td>78</td>
<td>2503</td>
<td>12097</td>
</tr>
<tr>
<td>flood risk</td>
<td>51</td>
<td>76</td>
<td>1051</td>
<td>11180</td>
</tr>
<tr>
<td>nanomaterials</td>
<td>158</td>
<td>271</td>
<td>8480</td>
<td>180267</td>
</tr>
<tr>
<td>pollution control</td>
<td>49</td>
<td>91</td>
<td>1366</td>
<td>14482</td>
</tr>
<tr>
<td>sustainable development</td>
<td>117</td>
<td>175</td>
<td>13855</td>
<td>118634</td>
</tr>
<tr>
<td>water management</td>
<td>88</td>
<td>126</td>
<td>4534</td>
<td>51050</td>
</tr>
</tbody>
</table>

One can see that “climate change” is a keyword selected by authors most often in the analyzed time period, appearing in 39566 articles, being also the keyword that identified papers with the largest H-index of 245. This means that out of the 39566 identified articles, when considering the H-index, 245 articles has been cited at least 245 times. This keyword identified papers that have the largest number of the citations between 1999-2015, 759232 citations.

“Ecosystem” is a keyword that was selected by authors in 28282 papers and generates the second largest number of citations among the groups having an H-index of 244.

It is interesting to note that this keyword has a H-index 1.5 times bigger than the corresponding H-index for biomaterials, biofuels and nanomaterials keywords, although the number of papers, as well as the number of citations for these keywords is four times smaller than it is for those produced by the ecosystem keyword.

“Biodiversity” is the keyword that generates the third largest number of papers and citations in the timeframe set for investigation and the third largest H-index, having at least 218 papers with over 218 citations. One should note that there is a similar trend in the self citations number for every
keyword in the analysis, between 12-25% of all citations are citations by author, independent of the number of papers for the keyword or number of citations produced. One can formulate the hypothesis, that is not tested here, that in every paper, roughly 1 in 5 are citations by author.

As one can see from Table 2 and illustrated in Figure 2, most scientifically productive countries in research focusing on the areas identified in Table 1 are United States, China, United Kingdom, our findings being supported also by the RELX Group Corporate 2015 report, \((\text{Relx, 2015})\).

**World Map**

![World Map](image)

**Top ten most productive countries in the world**

<table>
<thead>
<tr>
<th>ID</th>
<th>Country</th>
<th>Number of articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United States</td>
<td>30947</td>
</tr>
<tr>
<td>2</td>
<td>China</td>
<td>16374</td>
</tr>
<tr>
<td>3</td>
<td>United Kingdom</td>
<td>13147</td>
</tr>
<tr>
<td>4</td>
<td>Germany</td>
<td>8896</td>
</tr>
<tr>
<td>5</td>
<td>Australia</td>
<td>8123</td>
</tr>
<tr>
<td>6</td>
<td>Canada</td>
<td>7435</td>
</tr>
<tr>
<td>7</td>
<td>France</td>
<td>6088</td>
</tr>
<tr>
<td>8</td>
<td>Italy</td>
<td>4819</td>
</tr>
<tr>
<td>9</td>
<td>Spain</td>
<td>4563</td>
</tr>
<tr>
<td>10</td>
<td>Netherlands</td>
<td>4516</td>
</tr>
</tbody>
</table>

One can note a significant increase in the number of papers at the interface of climate change, biodiversity and ecosystems in North and South America, Australia and Asia, indicating that the importance of both these research areas, as
well and the interconnections among them was identified, (Dangles, 2016). The 2003-2012 ecological climate change impact research was evaluated in some studies in the literature, (Felton, 2009) and (Jaeschke, 2014).

The European Commission Joint Research Center carries out research to alleviate the effects of climate change and to preserve the environment. Starting with 1991, the European Commission’s has taken many initiatives related to climate change, environment and biodiversity, several programs funding research in these areas. (Zhang, 2012) identified UK as one of the leading countries in climate change research and the country with does the top research in climate change in Europe) based on ranking the 314 climate change research institutes according to the scores in terms of Policy, Academic, Enterprise, Public and Comprehensive influence, a characteristic consistent with our findings on the analysis of the research published in the 1999-2015 period.

Our analysis highlighted the fact that the top countries in Europe, ranked by publications, performing research in the key areas identified in Table 1, are United Kingdom, Germany and France, with Romania being ranked as 17 in the classification, see Table 3.

**Europe Map**

![Europe Map](image)

---

<table>
<thead>
<tr>
<th>Number of articles</th>
<th>1000-200</th>
<th>200-100</th>
<th>100-50</th>
<th>50-25</th>
<th>25-10</th>
<th>10-6</th>
<th>6-3</th>
<th>3-0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>20%</td>
<td>15%</td>
<td>15%</td>
<td>10%</td>
<td>8%</td>
<td>6%</td>
<td>4%</td>
<td>4%</td>
</tr>
</tbody>
</table>

*Figure 3*
Top ten most productive countries in Europe and the rank occupied by Romania

Table 3

<table>
<thead>
<tr>
<th>ID</th>
<th>Country</th>
<th>Number of articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United Kingdom</td>
<td>13147</td>
</tr>
<tr>
<td>2</td>
<td>Germany</td>
<td>8896</td>
</tr>
<tr>
<td>3</td>
<td>France</td>
<td>6088</td>
</tr>
<tr>
<td>4</td>
<td>Italy</td>
<td>4819</td>
</tr>
<tr>
<td>5</td>
<td>Spain</td>
<td>4563</td>
</tr>
<tr>
<td>6</td>
<td>Netherlands</td>
<td>4516</td>
</tr>
<tr>
<td>7</td>
<td>Sweden</td>
<td>3395</td>
</tr>
<tr>
<td>8</td>
<td>Switzerland</td>
<td>3045</td>
</tr>
<tr>
<td>9</td>
<td>Finland</td>
<td>1959</td>
</tr>
<tr>
<td>10</td>
<td>Norway</td>
<td>1929</td>
</tr>
<tr>
<td>17</td>
<td>Romania</td>
<td>1475</td>
</tr>
</tbody>
</table>

An illustration of the number of publications by year in the time period 1999-2015 illustrates a significant increasing trend in research output in climate change, ecosystem and biodiversity, all three categories changing the growing rate in 2006, Figure 4.

The number of publications per year

Figure 4

The citation number follows a similar trend as the number of publications, the three research areas being clearly delimited with respect the other research areas analyzed, the growing rate slowing in 2014, Figure 5.

Cumulative number of citations per year
A ranking of the top ten countries in terms of number of published papers for each keyword identified in Table 1 is presented in Appendix A.

The two keywords that identified Romania as one of the top 10 contributors were Danube Delta and Black Sea. There were 1982 papers published, having these two keywords in the analyzed period, showing an increasing trend in publication in the period 2005-2014. Since when the data was gathered year 2015 still had some papers to be indexed in the database, the drop in number of publication may not be supported. As one can see in Figure 6, most of these papers were multi-author articles, exhibiting a similar trend as the total number of articles.

**Total and Multi-Authored Articles per year**

![Figure 6](image)
Romania is ranked second in the number of publications with keywords *Danube Delta* or *Black Sea* and only ranks 7 in terms of the citations numbers, Figure 7. Among the citations received by these two categories, an average of only 78.63% were identified as citations without no self citation, a percentage smaller than the percentage for the other categories that were identified to be above 80%. (Ghane, 2011) performed a comparison analysis between Iran and Turkey on author self-citation. The result indicated the influence of author self citation is to some extent a citation behavior at national and international level and discipline differentials, with Iran exhibiting a stronger tendency towards self-citation as compared to Turkey. To what extent this justifies the larger number of self citations in these two categories and if and how much this percentage can be attributed to the top three countries (Turkey, Romania and Ukraine) that published in this area, it is not addressed in this analysis. (Sangwal, 2013) identified that for the analysis performed in 2008 journals indexed in the 2008 JCR database from Romania, Turkey and Brazil show high self-citations, part of these journals being indexed in Scopus, as well.

**Most productive countries**

![Documents by country for "Danube Delta" or "Black Sea" keywords](image)

![Documents by country for "Danube Delta" or "Black Sea" keywords](image)

Figure 8 presents the collaboration network of the top 7 collaborators on *Danube Delta* and *Black Sea* research in the analyzed time frame. The data analyzed looks at the affiliation institutions county of each co-author.
of the papers analyzed. The size of the bullets shows the magnitude of the collaboration number for the respective country, identifying Romania, United States, Ukraine and Turkey as the countries with the highest number of collaboration in this network. The edges of the graph illustrate each country collaborators. As it can be seen in Table 4, each country has the most collaborators among its country institutions, and it is highlighted in the table the country with which every country in the network collaborates most.

**Collaboration network between countries**

*Figure 8*

**Top 7 country collaborations**

![Collaboration network between countries](image)

**Top 7 collaborations between countries (including self collaborations)**

*Table 4*

<table>
<thead>
<tr>
<th>Country</th>
<th>Turkey</th>
<th>Bulgaria</th>
<th>Germany</th>
<th>Romania</th>
<th>United States</th>
<th>Ukraine</th>
<th>United Kingdom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkey</td>
<td>652</td>
<td>19</td>
<td>7</td>
<td>9</td>
<td>32</td>
<td>37</td>
<td>25</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>19</td>
<td>186</td>
<td>9</td>
<td>24</td>
<td>6</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td>Germany</td>
<td>7</td>
<td>9</td>
<td>128</td>
<td>12</td>
<td>15</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Romania</td>
<td>9</td>
<td>24</td>
<td>12</td>
<td>283</td>
<td>16</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>United States</td>
<td>32</td>
<td>6</td>
<td>15</td>
<td>16</td>
<td>187</td>
<td>18</td>
<td>13</td>
</tr>
<tr>
<td>Ukraine</td>
<td>37</td>
<td>23</td>
<td>9</td>
<td>14</td>
<td>18</td>
<td>294</td>
<td>19</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>25</td>
<td>8</td>
<td>9</td>
<td>8</td>
<td>13</td>
<td>19</td>
<td>98</td>
</tr>
</tbody>
</table>
Figure 9 identifies and illustrates the top 10 countries with the institutions of which Romanian institutions collaborated in the last two decades in publications with keywords Danube Delta and Black Sea, Bulgaria, France and Greece being among the top ranked ones. Particularly, Table 5 presents the number of publications identified and used for the generation of the network plot in Figure 9.

**Collaboration network between Romania and other countries**

*Figure 9*

Romania's top 10 country collaborations
Romania and its collaborations with other countries (including itself)

<table>
<thead>
<tr>
<th>Countries</th>
<th>Number of articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Romania</td>
<td>283</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>24</td>
</tr>
<tr>
<td>France</td>
<td>21</td>
</tr>
<tr>
<td>Greece</td>
<td>19</td>
</tr>
<tr>
<td>United States</td>
<td>16</td>
</tr>
<tr>
<td>Ukraine</td>
<td>14</td>
</tr>
<tr>
<td>Germany</td>
<td>12</td>
</tr>
<tr>
<td>Italy</td>
<td>11</td>
</tr>
<tr>
<td>Turkey</td>
<td>9</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>8</td>
</tr>
</tbody>
</table>

It can be seen from Table 5 that most of the Romanian authors have their collaborators within Romanian’s institutions. Figure 10 illustrates the collaboration network between Romanian institutions per counties. The size of the nodes is given by the number of scientific publications within the institutions belonging to that county.

CONCLUSIONS

Increase in the number of publications at the intersection of biodiversity, climate change and environmental issues has been tremendously increasing over the last two decades, indicating that scientists both in Europe and in the world have recognized the importance of studying the connections between among these fields. The percentage of publications in these areas
of publications has also significantly increased between 2006 and 2014; the increase in publication in the three topics was higher than that for other topics presented in Table 1.

Our study reveals significant differences in collaboration patterns within the countries performing research on Danube Delta and Black Sea area, most of the publications and multi-authored. Our study results indicate that the collaboration of geographically specific areas, such as Danube Delta and Black Sea, is biased towards a few countries, which tend to exhibit specific behavior in term of citations and self-citations. An extended analysis will follow over all the keywords identified as significant for the analysis.

The results of this study revealed a steady increase of the collaboration output and an increasing trend in the collaboration behavior, both at the European and national level.

As it can be seen from Table 4, Romania has an 77.32% collaboration within its institutions in the published papers, after Turkey with an 83.48% within its institutions collaboration and followed by Ukraine with 71.01% and Germany with 67.72%. Figure 10 illustrates the collaboration network inside Romania, between its institutions per counties. The size of the nodes is given by the number of scientific publications within the institutions belonging to that county. One can note that publications with keywords Danube Delta and Black Sea come from research co-authored mainly by institutions in Bucharest, Constanta, Tulcea, Galati, Cluj and Iasi, the figure also giving you the degree of collaboration in each county, based on the number of edges from each node.

The analysis presented in this study is followed by the recommendation that the Romanian institutions have to increase their collaboration network outside Romania. From the analysis on keywords presented in Figures 11-18, and considering the actions of the European Commission to invest on climate change, biodiversity and nature conservation research, Romania has to increase its efforts, have scientific results and be visible in these areas, the figures mentions highlighting the gaps identified in the national research conducted in the last two decades on these topics, hence it may serve as a reference for where future funding should be provided.

**Acknowledgements:** This work was financially supported by the Institutional Core Program BIODIVERS-105 Project.
Appendix A

For the keywords: water management, pollution control
Documents per country

Figure 11

For the keywords: ecosystem, Danube
Documents per country

Figure 12
For the keywords: Danube Delta, climate change
Documents per country

Figure 13

For the keywords: environmental protection, biodiversity
Documents per country

Figure 14
For the keywords: flood risk, sustainable development
Documents per country

Figure 15

For the keywords: biomaterials, biofuels
Documents per country

Figure 16
For the keywords: nanomaterials, bioeconomy
Documents per country

![Figure 17]

For the keywords: biobanking, Black Sea
Documents per country

![Figure 18]

References
Explaining the Migration Intentions Of Romanian Youth: Are Teenagers Different?

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ABSTRACT
The paper aims at determining the factors that influence the decision of young Romanians to migrate with the focus on adolescents, as they are the most willing to emigrate. We have used a survey-based analysis of data provided by the Friedrich Ebert Foundation in Romania and logistical regression models in order to estimate the significant factors that motivate young individuals to migrate. The results indicate that age is a relevant factor for the intention of the youth to migrate: the younger a person is, the higher the probability of wanting to emigrate. The use of internet and social class of the family are factors that determine the teenagers’ propensity to migrate, while the feeling of discrimination and the entrepreneurial behaviour are key factors that influence the migration intentions of young adults.

Keywords: migration intention, youth migration, logistic regression
JEL Classification: J13, P30, C10

INTRODUCTION
The decision to migrate and the factors that determine the individuals to take this decision have been an important topic for researchers. Several theories emerged regarding the reasons why individuals decide to migrate.

In explaining the causes of migration, the literature is dominated by the neoclassical theory (Lewis, 1954; Harris and Todaro, 1970). This is the theory that assigns the highest role to the economic factors as determinants of migration, stating the following:

(1) Each rational migrant seeks an optimal combination of financial benefits, job security and travel costs (the theory addresses several variables such as investment in education, skills, cost of travel, cost of living while seeking work, learning a new language/
adapting to a new culture, the difficulty of entering a new labour market).

(2) Eliminating the wage gap will close the labour force movement, and migration will not occur in the absence of these differences.

(3) The highly skilled workers are very sensitive to the differences in the rate of return on human capital, therefore having a distinct pattern of migration compared to unskilled workers.

(4) The labour market is the main mechanism through which international labour flows are induced, other markets have no significant effects on international migration.

(5) The government can control the migration flow through labour market regulations from both sending and receiving countries.

The main criticism regarding the neoclassical theory was that the migrants are not only poor people seeking higher wages – as the theory suggests – but also a significant number of highly skilled workers - a phenomenon known as brain drain. They decide to migrate for a better social and economic situation but mostly for accessing suitable jobs according to their education and skills.

In the 80’s, Stark and Bloom focused on the motivations of people to migrate and their study took the form of a new theory, known as the “The New Economics of Labour Migration”. This theory is based on the following assumptions:

(1) The decision to migrate is not an individual one; this decision is taken by large units of individuals, typically households or families, individuals acting together to maximize revenues and minimize the risks arising with the constraints of a variety of markets, not only the labour market.

(2) The families send a person to work abroad, even if that person has a job on the local market, to provide higher financial support than he/she would give in the country of origin.

(3) In developed countries, the risks to household income are generally minimized through private insurance or government programmes, but in developing countries institutional risk management mechanisms are imperfect, absent or unaffordable to poor families, giving incentive for them to minimize risks through migration.

(4) The households are not sending their workers abroad only to improve earnings in absolute terms, but also to increase revenue compared to other households, and reduce poverty in comparison to a reference group.

(5) Local labour market failures and constraints to create opportunities of income for poor households may increase the attractiveness of migration.
(6) Wage differences from one country to another are not a prerequisite in the decision to migrate as many people migrate even without a higher prospective salary.

By considering migration a social phenomenon generated by economic circumstances, several assumptions regarding the study of migration have been developed and regrouped into a new theory, the “World System Theory”, which views migration in the context of globalization, linking the determinants of migration to structural change in world markets. This theory is attributed to Wallerstein (1974) and it refers to the fact that there is a world economic system some countries have benefited, while others were exploited. Because there are many ways of communication with the outside world, through complex technologies of communication and transport, almost every country is participating in this world system, as a source of raw materials, production or consumption. Based on this theory, migration is considered a main element of production.

In Romania, the massive migration is a phenomenon that affects all geographic regions and every social category, having a significant influence on the demographic development and the functioning of the national labour market. The emigration of working age Romanians has determined significant changes in the demographic structure, family status and reproductive behaviour, with important consequences: a decline of the population and an aging process, resulting in a higher forecast rate of dependence. Since emigration in Romania seems to be rather permanent, and because people are leaving heavily from certain domains of activity, if the situation does not recover, the effects on the internally available workforce will be lasting and acute.

The departure of health professionals (doctors and nurses), as well as teachers and educators, endangers the sustainability of the health and education systems and produces a long-term deficit in the provision of these basic services. The emigration of engineers, IT specialists and researchers, along with the migration of young people for studies, which, unfortunately, have a very small rate of return, forms the phenomenon of brain drain, with a major impact on Romania’s economic and social development potential.

In this context, our research focuses on determining the factors that influence the decision to migrate of young Romanians. We have used a survey-based analysis of data provided by Friedrich Ebert Stiftung Romania, as well as a logistical regression model to estimate the significant factors that motivate the intention to migrate of young individuals aged 20 to 29 years. The second part of our research concentrates on adolescents (15-19 years old), as they seem to be the most willing to emigrate.

The paper is structured as follows: Section 2 comprises a review of the literature on the intention of the youth to migrate; Section 3 provides a
brief overview of the econometric method used in our analysis; Section 4 describes the characteristics of the database, the variables and the assumptions used in the research; Section 5 contains a brief presentation of the empirical outcomes regarding the decision to emigrate, as well as the econometric results, followed by conclusions.

LITERATURE REVIEW

The existing information on adolescents’ migration is limited. Social programmes and research focus more on children (0-18 years) affected by migration, without emphasis on the youth (ages 12-18) who migrate with their families or independently (Cortes, 2011). There is a need for more information about the characteristics of migrant adolescents, age and sex composition of migrant flows, their educational and socio-economic situation and the conditions of observing adolescents’ rights both in the country of origin and the host country.

Most studies on migration do not usually concentrate on children and adolescents unless they relate to adolescents as victims of trafficking or abuse in various forms (Tienda and Taylor, 2007). It is not always clear whether adolescents migrate alone or accompanied by other family members, if the decision to migrate is independent or it is a family decision, or if the adolescent is accompanying a spouse. Researchers focused mainly on trafficked children and adolescents, rather than on their independent migration; lack of information suggests that most migration experiences are assumed to be harmful (Whitehead and Hashim, 2005). Studies that specifically address migration issues for teenagers in Burkina Faso, Ghana and Mali (Riisoen et al, 2004) or adolescents in rural Bolivia who migrate to Argentina (Punch, 2002) show that traffic is not the main element in the migration process.

Country-level research on adolescent migration reveals some common features, but the socio-economic conditions as well as the causes and reasons for migration are far from homogeneous. An important part of the studies concluded that unemployment is a major determinant of adolescents’ migration (van der Lind, 2010). Other points of view emphasize the role of the push factors in the origin country (the absence of educational and employment opportunities, the need to financially help their family), and the pull factors in destination countries, shaping a mirage for the adolescents – superior living conditions, improved welfare, greater access to consumption. Studies for Nepal, Cambodia, Bolivia and Central America found that deprived teenagers, both girls and boys, consider migration a survival strategy (Adhikari and Pradhan, 2005).
Adolescents from poor rural communities migrate out of necessity in search for work opportunities. A study of adolescents from Central America and Ecuador (aged 12-17 years), in transit through Mexico to the United States, analysed the main reasons for migration: most parents of these adolescents have migrated and the younger ones want to reunite with their family, whereas the older ones are planning to find a job (LACRO, 2010).

In Peru, the Statistical Office conducted a survey among urban inhabitants aged 15-29 years in order to assess their intentions and motivations to migrate. The study found that 62% of adolescents aged 15-19 have the intention to migrate, but only half of them plan to leave within three years. Regarding the main reasons for wanting to emigrate, 45% of the adolescents answered that they wanted to improve their economic situation and 34% said they were planning to continue their studies (INEI, 2009).

In rural Bolivian communities, adolescents face a major decision: (1) to continue their education and attend secondary school - which would require them to live in another community, (2) to work without pay in their own households or to seek a paid job or (3) to migrate for agricultural or domestic work elsewhere in Bolivia or in Argentina. The results of a study showed that boys started migrating around the age of 14-15 and girls around 18, half of adolescents had migrated to Argentina, while the other half remained in the community, working without pay (Punch, 2007).

The literature also claims that the economic purpose is only one aspect of the decision to migrate in the case of children and adolescents. The adolescents consider migration as part of their transition to adulthood and not only as an opportunity to generate income. Qualitative interviews as part of studies for Bangladesh, Ghana, Burkina Faso and India indicated that among the reasons for adolescents’ migration stands their aspiration to maturity and personal development, conclusions obtained especially in the areas with intensive emigration of Africa (Whitehead et al, 2007).

Among rural residents in Guatemala there is a tradition that teenagers aged between 14 and 17 years are sent to Chiapas (Mexico), where they find a job through networks of other migrants from Guatemala. Parents expect that, once abroad, the children help support the family left at home. The idea of migration is cultivated since childhood and parents often send their children to Mexico as soon as they turn 13 years. Boys generally travel on their own or accompanied by an adult, while the girls travel in groups and are employed as domestic helpers in Mexican households (Giron, 2010).

Given its long tradition of temporary migration, for Egypt there are several studies examining the determinants of such an intention, but the adolescents are not extensively analysed. The results of a survey among young...
people (15-29 years) conducted in 2009 suggested that 21.8% of the people aged between 15 and 17 years is planning to leave Egypt, the intention to migrate being on a declining trend as people get older (Elbadawy, 2011). In 2011, 22,978 people aged 15 to 29 years were interviewed. The younger (15-17 years) declared that they rather wanted to migrate to a Western country (USA, Italy) compared to the group 25-29 years which chose the Gulf region – Saudi Arabia, UAE, Kuwait – as preferred countries of destination. Also, the most important reasons for emigrating are the lack of employment opportunities and unsatisfactory living conditions, and the major pull factor for migration is the higher wage prospect abroad (IOM, 2011).

In a recent study on the migration of young people from the Philippines, Asis and Battistella (2013) concluded that the adolescent intend to migrate from the desire to help their family, to improve the financial situation from back home. Apart from economic reasons, young people choose to go abroad also for professional development, to become more independent and to experience a different lifestyle. Most young people who emigrate are women, and they are usually working abroad in services (household work) or production. Moreover, the migration for studies has recently grown with China and India being the preferred destinations. A lot of young Filipinos who plan to migrate expressed their intention to return, hoping to apply what they have learned abroad when they return home. An interesting contradiction is that most young Filipinos who have already left the country and work abroad have declared that they have no plans to return to the Philippines in the near future.

For Europe, Otrachshenko and Popova (2011) analysed the determinants of the intention to emigrate, making a comparative analysis between the group of countries from Western Europe and the countries from Central and Eastern Europe. This comparison was based on the idea that a lower level of life satisfaction can intensify the desire to migrate and the literature is documenting a significantly lower level of satisfaction in the CEE countries compared to Western European countries. The findings indicate that individuals with similar characteristics (age, gender, education, social status, income) have higher intention to migrate from CEE countries compared with the non-CEE countries.

In Portugal, ever since 1993, Silva and Neto expressed their interest in identifying predictive factors for adolescents’ intention to migrate. Factors like: socio-demographic characteristics (gender, level of education), access to information on migration, connections with other migrants, a favourable attitude regarding migration and the level of attachment to the family were considered relevant. The results indicated that the most important factors contributing to the intention to migrate are the attitude towards migration, the
network of connections with other migrants and family attachment.

A recent analysis of the situation in Ireland reveals that 51% of young people aged 18 to 24 years are planning to emigrate. An important indication that this intention often materializes is a survey from 2011 according to which 43% of the emigrants were young individuals between 18 and 24 years. The main factors influencing the intention to migrate are the lack of employment opportunities on the local labour market and the expectation to have better work prospects abroad. Also, young people are unhappy about the way the authorities manage the problem of youth unemployment (McAleer, 2013).

When studying the determinants of migration, a variety of methodologies can be used. Holst and Schrooten (2006) used probabilistic models, namely probit or logit model – logistic regression – in order to estimate the probability of the decision to migrate. These are the most common techniques to estimate the models with dichotomous dependent variable.

Heering, van der Erf and van Wissen (2004) applied logistic regression analysis to determine the intention to migrate and its determinants in Morocco. Glytsos (1997) emphasized the importance of the immigrants’ intention to return to the country of origin in determining remittance behaviour by showing that temporary migrants remit more than permanent ones. Huy (2009) applied the logistic regression model in order to analyse the determinants of migration decision in Vietnam and to investigate the differences between the ethnic groups.

Studies on the effects of migration in Romania indicate that if Western countries continue to attract labour from our country, the economic growth will be seriously affected (Nicolae and Radu, 2007). Also, Silasi and Simina (2008) examined the Romanian labour market in the context of international migration. They believe that a country with distortions on the labour market like Romania will benefit from migration in the short term, but in the long run it will become an importer of workers. Constantin et al. (2004) analysed migration from a regional perspective and in the context of Romania’s accession to the European Union. Roman and Goschin (2011) investigated the effects of migrants’ religious denomination on their economic performance, while in a more recent study (Roman and Goschin, 2014) they focused on return migration in the economic crisis context, with a focus on healthcare professionals.

The existing evidence in the literature provides a constellation of potential factors that affect the teenagers and young adults’ decision to emigrate both in European countries and in other parts of the world. These factors could cover demographic or family characteristics of the respondents, being also related to their human capital or to economic characteristics.
METHODOLOGY: THE BINARY LOGISTIC REGRESSION MODEL

The econometric analysis is based on a binary logistic model, which is used to identify the socio-demographic factors that influence the decision to migrate.

The dependent variable in a logistic regression is usually a dichotomous variable, which takes the value 1 with a probability of success $q$, or the value 0 with the probability $1-q$. In our study, the binary dependent variable in the model is the probability of a person to emigrate.

We assume that the values of $y$ (binary variable) are coded 0/1, with 1 expressing the realisation of a certain event, so the model estimates the probability of this event to occur based on the values of the independent variables.

The general form of the model is:

$$
\ln \left( \frac{p}{1-p} \right) = \beta_0 + \sum_{i=1}^{k} \beta_i x_i + \epsilon,
$$

where $p$ is $P(y = 1 \mid x_1, x_2, \ldots, x_k)$ [1]

We can immediately get the equivalent exponential form.

The interpretation of $\beta_i$ coefficients is obvious: the increase of logit (logarithm of OR) when $x_i$ increases by one (with other variables held constant).

We can rewrite the model in the following form:

$$
P(y = 1 \mid x_1, x_2, \ldots, x_k) = \frac{\exp(\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k)}{1 + \exp(\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k)}
$$

[2]

After a simple calculation we obtain

$$
\exp(\beta_0) = \frac{P(y = 1/x_1 = x_2 = \ldots = x_k = 0)}{P(y = 0/x_1 = x_2 = \ldots = x_k = 0)}
$$

[3]

that is OR, when all factors are set to zero. For the $\beta_i$ coefficient we obtain:

$$
\exp(\beta_j) = \frac{P(y = 1/x_1 = 1, x_j = 0 \text{ for } j \neq i) \times \frac{1}{OR_{base}}}{1 - P(y = 1/x_1 = 1, x_j = 0 \text{ for } j \neq i) \times \frac{1}{OR_{base}}} = OR_{base} = \exp(\beta_j)
$$

[4]

Thus, from the multiplicative nature of the logistic model, we have:

$$
OR_{x_1, x_2, \ldots, x_k} = \exp(\beta_0) \prod_{i=1}^{k} \exp(\beta_i x_i)
$$

[5]

with the useful interpretation that each $\beta_i$ expresses the contribution of the $x_i$ factor in explaining the probability (as OR) of the event $y = 1$. 

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Thus, by setting \( x_i = 1 \), \( \exp(\beta_i) \) will be the constant multiplicative factor, regardless of the values of other independent variables. If \( \beta_i = 0 \), the corresponding factor has no effect (multiplication by 1). If \( \beta_i < 0 \), the presence of the factor reduces the likelihood of the event \( y = 1 \) and \( \beta_i > 0 \) increases this probability.

**DATA DESCRIPTION AND VARIABLES**

In recent years, there has been a high interest among researchers and policy-makers in studying the behaviour of young people in relation to their decision to emigrate. Among the institutions that actually contribute to the study of social phenomena in Romania we can mention the Friedrich Ebert Stiftung (FES). Since 1994, the FES Foundation has been working to promote democracy, social justice and the rule of law in Romania.

The data used in this study comes from quantitative research conducted by FES, “Romanian youth: worries, aspirations, values and lifestyle”, authored by Daniel Sandu, Catalin Augustin Stoica and Radu Umbres. The sample used was random, stratified, with proportional allocation of respondents. The sampling universe was the resident population of non-institutionalized Romanian aged between 15 and 29 years. The timeline of the interviews was 19 to 31 July, 2014. The theoretical margin of error for the entire sample was +/- 2.7% at a confidence level of 95%.

The survey contains questions about the intention of young people to emigrate, the reasons that would make them leave the country, the chosen destinations or long-term plans, allowing a detailed analysis of the determinants of migration intentions among Romanian youth.

The database contains 1302 respondents. After eliminating those who did not answer the question regarding the intention to emigrate, we obtained a sample of 1269 young people aged 15 to 29 years, out of which 443 are teenagers (15 - 19 years).

The aim of this study is to analyse the factors that influence the intention to migrate of Romanian youth, therefore the variable of interest is a dummy and takes the value 1 if the respondent intends to emigrate and 0 if the respondent has no intention to emigrate.

In designing the econometric models, various variables were considered, in line with the literature: demographic and socio-economic variables (gender, age, residence, social class), variables that characterise the respondent’s human capital (education level, number of hours spent on the Internet, experience with volunteering), as well as values, opinions, ideals and plans for the future.
Gender is a binary variable with value 1 for male respondents and 0 for female respondents. Age provides the respondent’s age in years at the date of the interview. Residence is a binary variable equal to 1 when the respondent lives in urban area and 0 when the respondent is a resident of rural area.

As an economic indicator, we used the respondent’s social class (sclass_resp) and the social class of their parents (sclass_par), since the commonly used variables (income, economic status) are not suited for teenagers (15-19 years). We had the same reason for not including in our analysis variables like marital status or number of children.

In order to quantify the level of education, we used the respondent’s highest educational qualification (educ_re) and the educational qualification of the respondent’s father (educ_f). We used three dummies: primary and less than primary, medium and higher education, and only the first two dummies were employed for the teenagers’ model. Volunteering is a binary variable equal to 1 if the respondent was engaged in any voluntary work over the last 12 months preceding the interview. The number of hours spent on the Internet (internet_use) is an important variable in the context of migration, because of social media communication channels that facilitate the transfer of information from people who have already migrated.

The young Romanians’ values, opinions, ideals and plans for the future were integrated into our models using the following variables:

- alarming – a binary variable showing if migration is considered a threat;
- discrim – a dummy variable taking the value 1 if the respondent felt discriminated against on the country/city of origin;
- corruption – dummy variable taking the value 1 if the respondent felt alarming about the inefficiency fight against corruption
- business – a binary variable indicating if the respondent is planning to start a business in the coming years;
- tenyears – shows if the respondent sees himself as an accomplished person in Romania or in a different country.

This last category of factors is less described in the literature and including them as determinants of young people decision to emigrate could provide new information in analysing and explaining such behaviour. Taken into advantage the rich dataset we have used, we have focused on the contribution of the respondents’ perceptions and their future plans for explaining their propensity for living abroad.
RESULTS

In the first stage of our research we focused on determining the factors that increase the probability to migrate of young adults, 20 to 29 years old. In order to highlight the significant factors, we applied a binary logistic regression model. In the second stage, we concentrated on finding what is causing an increase in the desire to emigrate among teenagers, considering the fact that this group (15 to 19 years) seems most eager to leave Romania (see Figure 1).

Migration intentions of Romanian youth

Indeed, a proportion of 68.4% of young people aged 15-19 said they were planning to emigrate. Figure 1 suggests an inverse relationship between age and willingness to migrate: as the age increases we observe that there are fewer respondents who want to leave Romania, but their share, though lower than for other age groups, it is not negligible (52.7%).

The first logistic regression model (see Model 1 in Table 1) was estimated using a sub-sample of 798 Romanian young adults (individuals in the 20-29 age group). There are eight significant factors that determine the decision to emigrate in the first model, explaining 11.8% of the variation of the propensity to migrate.

One of the most important demographic variables that proved to influence the probability to migrate is age. The sign is negative, as we expected, meaning that a younger person is more likely to intend to migrate. Gender also significantly affects the decision to migrate: males show a greater desire to
emigrate than females. Other demographic factors, such as residence, have no significant influence on the migration intentions.

Among the variables that characterise the respondent’s human capital, we can see that the respondent’s level of education does not have a significant impact on the intention to migrate, but the father’s level of education has a statistically significant influence. On the other hand, the number of hours spent online daily has a strong influence on the dependent variable: the more hours a young person spends on the internet, the greater the probability of intention to migrate. The internet is used, among other things, as a means of communication and socialization, so it is possible for young people to communicate with people abroad (relatives, friends), which would explain the influence of this factor.

The volunteering experience has proved not to be a significant factor in the Romanian youth’s decision to emigrate, maybe because Romania does not have a long volunteering tradition. Also, the respondents’ plans to start a business in the next period do not influence the intentions of young people to emigrate.

An interesting aspect of our analysis is the fact that those who feel discriminated against on the grounds of country or city of origin manifest a higher probability to emigrate compared with young people who were never put in discriminatory situations.

The opinion about corruption in Romania does not significantly influence the intention of young people to migrate, but their expectations of their situation in 10 years’ time - if they see themselves as an accomplished person in Romania or abroad - largely influence the decision to emigrate. In other words, the youth’s intention to emigrate is related to the fact that they already want a life abroad, not necessarily on financial considerations.

The economic variables included in the model - the respondent’s social class and the parents’ social class – do not have a significant impact on the youth’s intention to leave Romania. And last, the opinion that emigration is a danger to Romania does not explain the intention to migrate.
### Binary logistic regression models

**Table 1**

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<td>N</td>
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Young people from Romania (15-29 years) have different economic, social or educational characteristics. Teenagers (young people between 15 and 19 years) are a more homogeneous group, having similar features: most of them are still in school, are not active on the labour market, they are living with their parents and are financially dependent on them. Regarding the intention to migrate, teenagers showed the greatest desire to leave Romania; therefore we have a high interest in determining the factors that influence their intention to migrate using a distinct logistic regression model (see Model 2 in Table 1 for the results).

This second model indicates that demographic indicators such as gender or residence area have no impact on the migration intention of Romanian teenagers.

Also, it seems that the teenagers’ probability to emigrate is not influenced by human capital specific variables. The respondent’s levels of education or any experience with volunteering have no significant impact on the intention to emigrate. However, we found that the level of education attained by the respondent’s father is involved in the teenagers’ intention to leave Romania. The relation is negative, indicating that teenagers coming from families with a lower level of education are more likely to emigrate.

As in the case of young adults, the number of hours spent on the internet explains to a large extent their intentions to migrate.

A similar result is observed regarding the economic indicators. Although the respondent’s social class is not statistically significant in explaining the intention to migrate, the parents’ social class is found to be a factor of influence for teenagers’ future plans. This high impact of family characteristics is not surprising because the analysis is carried out on very young individuals.

The most important factor in determining the migration intentions of teenage Romanians is the respondent’s perception about their life in ten years’ time: if they see themselves as an accomplished person in Romania or abroad, in which case the probability to emigrate significantly increases.

The results of the logistic regression econometric model indicated that teenagers are not reacting to discrimination on the grounds of country/city of origin with an increased desire to leave the country. Also, we did not find statistical evidence in support of a relationship between the teenagers’ plans to start their own business and their intention to emigrate.

The analysis proves that Romanian youth have a high intention of living abroad, but the factors that explain this behaviour are different when considering two age groups: adolescents and young adults, age being an important factor that needs to be taken into account when predicting the
probabilities for migration. Unlike young adults, teenagers are more influenced by their family background, while both categories are influenced by their expectations of a better life abroad and by the number of hours spent on the internet.

CONCLUSIONS AND POLICY RECOMMENDATIONS

Demographic evolution and changes in the size and the structure of labour resources in Romania in the last 15 years have generated a less favourable context for achieving the goal of full, sustainable and inclusive employment. The main demographic characteristics indicate a continuous decline in the total population of Romania, a negative natural increase and a rise of the population’s median age. Moreover, the significant decrease in the share of young people in the total population has worrying consequences for both employment growth and social insurance policies. Another area of concern regarding the situation of young people in Romania (especially those under 18) is that more than half of them live below the poverty threshold (60% of the median income), being one of the most deprived social groups.

After joining the European Union, Romania experienced an explosive growth in the number of migrants for employment. An important part of the working age population and especially young people went to Western countries in search of higher wages and better living conditions. This massive migration of active labour force in a relatively short period of time unbalanced the labour market, the phenomenon being very difficult to manage, so the need for appropriate policies to balance demand and supply became crucial.

The analysis of the youth’s intention to migrate is a relevant indicator for the behaviour of young people in relation to the labour market and it helps identifying future trends of emigration. We investigated the factors that influence the migration intentions of young Romanians, by estimating two logistic regression models: one for the young adults (20-29 years), and the other for the adolescents (15-19 years old).

The results indicated that age is a relevant factor for the intention of the youth to migrate – the younger a person is, the higher the probability of wanting to emigrate. The study conducted on the young adults led to the conclusion that the use of internet and the goal setting for a future abroad are the key factors that significantly determine the migration intentions. Also, young men are more willing to leave the country than young women, and those who felt discriminated against on the grounds of country/city of origin and young adults coming from low educated families have higher probability of wanting to emigrate.
For the Romanian teenagers the results indicated that their intention to migrate has a lot to do with their perceived accomplishment in another country and with the time spent on the internet, therefore showing similarities with young adults. But teenagers are still very influenced by their family – the intention to migrate also depends on the father’s level of education and the parents’ social class.

Our study showed that the majority of young Romanians have the intention to emigrate. The young population is one of the most important resources for a country’s socio-economic development, as it possesses innovative knowledge, therefore it is important to have legislative and institutional framework in order to promote young people in Romania. Nevertheless, there is no national strategy in the area of youth migration.

At the moment, policies that target young people focus mainly on their relation to the labour market. The National Strategy for Youth 2014-2020 tackles issues such as: the increase of youth’s employment rate; an easy school to work transition; provides tax incentives to employers who create jobs and hire young people; promotes youth mobility for work. The “Youth Guarantee” is another important programme which assumes that, within 4 months after completing their studies or losing their job, any young person will receive an offer consisting of a job opportunity, an internship or apprenticeship contract, or a training course1.

The policy makers could target the youth migration by eliminating or reducing the causes of migration. Many young people see external migration as the only option for a decent life. An integrated strategy aimed at strengthening rural development and poverty alleviation, investment in rural infrastructure and agriculture, and, most of all, opportunities for decent work, could provide a favourable environment for young people to contribute to the national economic and social development.

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References:
Likelihood Estimation of the Systemic Poison-Induced Morbidity in an Adult North Eastern Romanian Population

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ABSTRACT

Purpose: Acute exposure to a systemic poison represents an important segment of medical emergencies. We aimed to estimate the likelihood of systemic poison-induced morbidity in a population admitted in a tertiary referral center from North East Romania, based on the determinant factors.

Methodology: This was a prospective observational cohort study on adult poisoned patients. Demographic, clinical and laboratory characteristics were recorded in all patients. We analyzed three groups of patients, based on the associated morbidity during hospitalization. We identified significant differences between groups and predictors with significant effects on morbidity using multiple multinomial logistic regressions. ROC analysis proved that a combination of tests could improve diagnostic accuracy of poison-related morbidity.

Main findings: Of the 180 patients included, aged 44.7 ± 17.2 years, 51.1% males, 49.4% had no poison-related morbidity, 28.9% developed a mild morbidity, and 21.7% had a severe morbidity, followed by death in 16 patients (8.9%). Multiple complications and deaths were recorded in patients aged 53.4 ± 17.6 years (p < .001), with a lower Glasgow Coma Scale (GCS) score upon admission and a significantly higher heart rate (101 ± 32 beats/min, p < .011). Routine laboratory tests were significantly higher in patients with a recorded morbidity. Multiple logistic regression analysis demonstrated that a GCS < 8, a high white blood cells count (WBC), alanine aminotransferase (ALAT), myoglobin, glycemia and brain natriuretic peptide (BNP) are strongly predictive for in-hospital severe morbidity.

Originality: This is the first Romanian prospective study on adult poisoned patients, which identifies the factors responsible for in-hospital morbidity using logistic regression analyses, with resulting receiver operating characteristic (ROC) curves.

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Conclusion: In acute intoxication with systemic poisons, we identified several clinical and laboratory variables, such as GCS, WBC, ALAT, myoglobin, glycemia and BNP, as early predictors for in-hospital morbidity, allowing the physician to provide an accurate diagnosis and management.

Key words: systemic poison, likelihood, morbidity, logistic regression, ROC.

JEL classification: C29; C39; C88; I19.

INTRODUCTION

Acute poisoning with xenobiotics represents a life-threatening situation and a global public health problem. According to the World Health Organization, 370,000 people die of acute self-poisoning each year globally, and the mortality is higher in low- and middle-income countries in Europe, than in any other region in the world (Mathers et al., 2004).

Acute exposure to a systemic poison (which affects the entire body at various degrees, with major effects manifested in at least two organs or systems) represents an important segment of acute poisoning and medical emergencies (Lionte et al, 2016). Our previous experience showed that acute drug poisonings represent the majority of the total number of poisoned patients in our area, with a mortality rate of 0.3% (Sorodoc et al, 2011). After exposure to chemicals such as cholinesterase inhibitors, the mortality rate in our area is 3.8% (Gazzi et al, 2015).

The poison’s effect on an organism is measured using vital function parameters and laboratory tests. Based on the severity of a poisoning, the patient may develop one or multiple complications reflecting the poison-related morbidity. The management of a poisoned patient uses laboratory tests and specific biomarkers to assess the morbidity. Thus far, some investigators have documented the use of laboratory tests (i.e. arterial lactate level, MB isoenzyme of creatine kinase – CKMB, and troponin) as prognostic indicators in order to identify high-risk patients in acetaminophen, carbon monoxide (CO) or paraquat poisoning (Shah et al, 2011; Kao et al, 2009; Liu X.W. et al, 2013).

There is little knowledge about the role of routine laboratory tests as early predictors for a systemic poison-induced morbidity.

Our aim was to identify the factors influencing the in-hospital morbidity of a cohort of patients acutely exposed to systemic poisons, and to determine the value of conventional laboratory tests obtained upon admission, combined with different demographic and clinical characteristics, for likelihood assessment of the subsequent morbidity in a tertiary referral center from North East Romania. The physician could immediately use these clinical and laboratory data to identify patients at risk for developing complications.
or death and improve their management, early referring these patients to an intensive care unit (ICU).

**LITERATURE REVIEW**

Acute poisonings represent a worldwide problem. In our area, epidemiological data suggested that 97.27% are acute drug poisoning in suicide attempts, using combinations of drugs in 32.92% cases (Sorodoc et al, 2011). The reports from the National Poison Data Systems in United States show that poisoning with pharmaceutical products is the leading cause of accidental death (Dart et al, 2015), data that are consistent with epidemiological reports from Central Europe (Krakowiak et al, 2011). Poisoning with non-pharmaceutical agents, such as toxic alcohols, gases, and miscellaneous chemicals are associated with the largest number of fatalities, CO being the leading cause of death in the United States (Mowry et al, 2013).

Several retrospective studies attempted to identify prognostic or mortality indicators in acute poisonings, such as CO poisoning (i.e. lactate, cardiac biomarkers – Cervellin et al, 2014; Liu S. et al, 2014), or pesticide poisoning (acid-base status, male sex, or age). (Liu JH. et al, 2008; Hsu et al, 2013).

It was argued before, after a retrospective analysis, that some indicators, such as toxicological history, Glasgow Coma Scale (GCS) score, or serum lactate level, could help the emergency physicians to distinguish between low- and high-acuity poisoned patients with deliberate drug poisoning, in order to avoid excessive morbidity (Maignan et al, 2014).

Our previous experience showed that there are some indices available upon the arrival of a patient acutely exposed to a systemic poison, such as the poisoning severity score, a GCS < 10, initial and 4h-arterial lactate level, brain natriuretic peptide (BNP), and 6h-CKMB, which can early predict a poor short-term outcome, and mortality (Lionte et al, 2016).

The logistic regression models have been extensively used during the last years in medical research, including toxicology (Hunt and Li, 2006), dentistry (Javali and Pandit, 2012), or epidemiology (Bender, 2009), etc. Multivariable statistical models can be useful tools for the prognosis prediction, when are developed accurately (Harrell et al, 1996). The goal of an analysis using a logistic regression model is to find the relationship between response variable and a set of factors. In order to have an accurate model, a reduced number of variables, or a simplified model must be used (Harrell et al, 1996). To investigate the risk factors associated with poison-related morbidity, outcomes or mortality, the regression methods have become an important component of any data analysis regarding to the relationship...
between a response variable (i.e. outcome or death) and one or more predictor variables called factors (i.e. age, poisoning severity score, etc).

Receiver operating characteristic (ROC) curve analysis was used extensively for the assessment of diagnostic ability of laboratory tests and for the classification of diseased from the healthy subjects using imaging tests in the last several years (Hajian-Tilaki, 2013).

**METHODOLOGY**

**Study Design and Setting**

This work was designed as a prospective observational study in a tertiary referral center for toxicology, admitting patients from North East Romania with acute poisoning. Over a period of 15 months (April 1st 2015 – 31st March 2016), we enrolled consecutive patients with a diagnosis of acute poisoning, which were admitted in the Medical Clinic, or in the intensive care unit (ICU) of the ‘Sf. Spiridon’ Emergency County Clinic Hospital, Iasi. All subjects or their families (in the situation of an unconscious patient) signed an informed consent prior to the enrollment. The study was funded by an internal research grant of the university, and approved by the Ethics Committee.

**Selection of Participants**

The study included hospitalized patients acutely exposed to a systemic poison, older than 18 years, irrespective of gender. Patients were poisoned with prescription drugs, illicit drugs, miscellaneous chemicals (pesticides, toxic alcohols, hydrocarbons etc.), toxic gases or were exposed to multiple systemic poisons.

Patients without a signed informed consent, younger than 18 years, with a history of diabetes, with exposure to a poison with a local irritant effect, or with an acute pathology associated to poisoning (i.e. trauma, burns, etc.) were excluded from our study.

**Patient assessment**

All patients with a confirmed diagnosis of acute intoxication with a systemic poison, based on clinical examination, and toxicological tests, underwent routine assessment (complete blood count, arterial blood gases, glucose, electrolytes, C reactive protein, troponin I, BNP, creatine phosphokinase - CK, CKMB, myoglobin, renal and liver function profile). Patients were clinically monitored, by means of electrocardiogram (ECG), pulse oxymetry and non-invasive blood pressure measurements.
The management of these patients’ involved measures of basic life support, special interventions in case of respiratory failure, shock, and cardiac arrest, decontamination measures, supportive and antidote therapy, which were continued after admission in the medical clinic, or ICU, as recommended by the guidelines.

The main objective was to assess the poison-related morbidity during hospitalization. Patients were divided into three groups: without morbidity (no complications during hospitalization), with a mild morbidity (only one complication involving a single organ or system resolved during hospital stay), and with severe morbidity (defined as in-hospital multiple complications and/or death). The presence of an early complication was defined as follows: central nervous system complication (coma, stroke, or seizures); rhabdomyolysis (CK > 1000 IU/L); acute respiratory failure, defined as a condition requiring mechanical ventilation for correction of hypoxia, or hypercapnia, for more than 24 hours; cardiovascular complications (hypotension, defined as systolic blood pressure less than 90 mm Hg, or arrhythmias with circulatory compromise, and acute myocardial injury, based on cardiac biomarkers and ECG); acute liver injury, defined as markedly elevated serum alanine and aspartate aminotransferase levels > 10 times the upper limit of the normal range, accompanied by mild or moderate elevations in alkaline phosphatase levels (Chalasani et al, 2014); acute kidney injury, defined as urine volume < 0.5 ml/kg/h for 6 hours, based on KDIGO criteria (Kidney inter., Suppl, 2012); gastroenteral, defined as lesions indicated by a superior or inferior digestive endoscopy; multiple complications (at least two organs or systems affected).

**Statistical analysis**

Numerical variables are presented as mean ± SD, median with interquartile range, or frequency for categorical variables. To identify significant differences between the patient morbidity groups defined, taking into account clinical and demographic data, laboratory tests associated with poisoning-related complications and fatalities, Student’s t test or Mann-Whitney U test for normal distributed variables, as well as the Chi-square test and Cochrane’s statistic for categorical variables were used to perform univariate analysis (Jaba and Grama, 2004). We calculated Sig. for the differences between parameters for patients with or without morbidity. A Sig. < .05 was considered statistically significant. All variables found to be significant in the univariate analyses for morbidity were subjected to a logistic regression analysis. First we applied simple binomial logistic regression for each statistically significant variable. Then we applied multinomial logistic regression on variables characterizing different systems and organs. Risk was
expressed as odds-ratios (OR) with confidence intervals (CI). Goodness-of-fit for multivariate models was confirmed using Hosmer and Lemeshow test. The receiver operating characteristic curve (ROC) was used as a measure of diagnostic performance, to validate the discriminatory power of the model predictive variables (Hajian-Tilaki, 2013). Statistical analyses were performed with SPSS (version 22.0; SPSS, Inc., Chicago, IL).

RESULTS

During the study period, 180 patients were enrolled with a mean age of 44.7 ± 17.2 years (range, 18-90 years), 51.1% males, all Caucasians. The majority of cases were self-poisonings (91.1%), 16 cases being accidental poison exposures. The mean time interval between poison exposure and admission was 5.5 ± 1.9 hours. The population’s demographic, clinical, and laboratory characteristics based on the morbidity recorded are presented in the Table 1.
Characteristics of the observed variable distribution in total cohort and groups of patients

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<tr>
<th>Variable</th>
<th>Total N=180 patients</th>
<th>No complication N=89 patients</th>
<th>Single complication N=52 patients</th>
<th>Multiple complications N=39 patients</th>
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<td>Age (years)</td>
<td>44.7 ± 17.2</td>
<td>42.3 ± 15.7</td>
<td>42.1 ± 17.4</td>
<td>53.4 ± 17.6</td>
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<tr>
<td>Gender; F/M (%)</td>
<td>88/92 (48.9/51.1)*</td>
<td>54/35 (61.4/38)</td>
<td>20/32 (22.7/34.8)</td>
<td>14/25 (15.9/27.2)</td>
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<td>Origin; R/U (%)</td>
<td>90/90 (50.0/50.0)*</td>
<td>51/38 (56.7/42.2)</td>
<td>23/29 (25.6/32.2)</td>
<td>16/23 (17.8/25.6)</td>
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<td>GCS; N (%) &gt; 8</td>
<td>146 (81.1)*</td>
<td>86 (58.9)</td>
<td>42 (28.8)</td>
<td>18 (12.3)</td>
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<tr>
<td></td>
<td>≤ 8</td>
<td>3 (8.8)</td>
<td>10 (29.4)</td>
<td>21 (61.8)</td>
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<td>HR (beats/min)</td>
<td>91.63 ± 24.47</td>
<td>86.91 ± 16.7</td>
<td>92.81 ± 25.44</td>
<td>100.85 ± 31.6</td>
<td>.011</td>
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<td>SBP (mmHg)</td>
<td>123.59 ± 25.40</td>
<td>122.15 ± 21.31</td>
<td>125.54 ± 24.28</td>
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<td>DBP (mmHg)</td>
<td>75.65 ± 14.7</td>
<td>76.36 ± 12.64</td>
<td>76.71 ± 14.7</td>
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<td>Poison involved; N (%)</td>
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<td>Combinations</td>
<td>53 (29.4)*</td>
<td>31 (58.5)</td>
<td>14 (26.4)</td>
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<td>Prescription medicines</td>
<td>67 (37.2)*</td>
<td>41 (61.2)</td>
<td>13 (19.4)</td>
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<td>Drugs of abuse</td>
<td>10 (5.6)*</td>
<td>4 (40.0)</td>
<td>6 (60.0)</td>
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<td></td>
<td>Chemicals</td>
<td>35 (19.4)*</td>
<td>10 (28.6)</td>
<td>11 (31.4)</td>
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<td></td>
<td>Toxic gases</td>
<td>15 (8.3)*</td>
<td>3 (20.0)</td>
<td>8 (53.3)</td>
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<td>Lactate (mmol/L)</td>
<td>3.08 ± 3.16</td>
<td>2.49±2.53</td>
<td>2.84±2.31</td>
<td>4.74±4.61</td>
<td>.001</td>
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<tr>
<td>pH</td>
<td>7.36 ± .13</td>
<td>7.41 ± .06</td>
<td>7.37± .09</td>
<td>7.22 ± .21</td>
<td>.000</td>
</tr>
<tr>
<td>Base excess (mmol/L)</td>
<td>22.86±5.17</td>
<td>24.68±2.89</td>
<td>23.39 ± 4.09</td>
<td>17.99 ± 7.19</td>
<td>.000</td>
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<tr>
<td>Sodium (mEq/L)</td>
<td>140.37±5.71</td>
<td>140.29±3.53</td>
<td>141.88±5.35</td>
<td>138.51±8.93</td>
<td>.019</td>
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<tr>
<td>CRP (mg/dl)</td>
<td>1.82±4.59</td>
<td>63 ± 1.33</td>
<td>1.66 ± 4.84</td>
<td>4.76 ± 7.17</td>
<td>.000</td>
</tr>
<tr>
<td>WBC (*1000/μg/L)</td>
<td>10.43 ± 4.88</td>
<td>8.16 ± 2.53</td>
<td>11.09 ± 4.61</td>
<td>14.74 ± 6.10</td>
<td>.000</td>
</tr>
<tr>
<td>Hemoglobin (g/dL)</td>
<td>13.78 ± 1.61</td>
<td>13.51 ± 1.56</td>
<td>14.08 ± 1.21</td>
<td>13.98 ± 2.07</td>
<td>.004</td>
</tr>
<tr>
<td>Glicemia (mg/dl)</td>
<td>131.05 ± 55.34</td>
<td>115.79±36.92</td>
<td>124.40±32.48</td>
<td>179.74±55.37</td>
<td>.000</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>389 ± 42</td>
<td>80 ± 22</td>
<td>.81 ± 20</td>
<td>1.18 ± 74</td>
<td>.000</td>
</tr>
<tr>
<td>ASAT (U/L)</td>
<td>43.34 ± 78.63</td>
<td>23.22±12.14</td>
<td>41.23±57.24</td>
<td>92.08±144.69</td>
<td>.000</td>
</tr>
<tr>
<td>ALAT (U/L)</td>
<td>50.47±34.52</td>
<td>21.35±12.62</td>
<td>33.42±38.64</td>
<td>47.33±52.35</td>
<td>.000</td>
</tr>
<tr>
<td>Methylmalonic acid (mg/mL)</td>
<td>37 (0.0)*</td>
<td>34 (7.3)</td>
<td>10 (21.7)</td>
<td>2 (4.3)</td>
<td></td>
</tr>
<tr>
<td>BNP (pg/mL)</td>
<td>77.28 ± 145.16</td>
<td>39.63±109.39</td>
<td>74.55±128.06</td>
<td>166.84±194.89</td>
<td>.000</td>
</tr>
<tr>
<td>CK (U/L)</td>
<td>646.76±240.30</td>
<td>130.84±89.32</td>
<td>303.85±56.14</td>
<td>2281.31±894.64</td>
<td>.023</td>
</tr>
<tr>
<td>CKMB (ng/mL)</td>
<td>8,12±12.87</td>
<td>5.08±7.78</td>
<td>8.05±10.86</td>
<td>15.14±20.24</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICU therapy; N (%)</td>
<td>140 (77.8)*</td>
<td>85 (60.7)</td>
<td>41 (29.3)</td>
<td>14 (10.0)</td>
<td>.000</td>
</tr>
<tr>
<td>Not needed Administered</td>
<td>40 (22.2)*</td>
<td>4 (10.0)</td>
<td>11 (27.5)</td>
<td>25 (62.5)</td>
<td></td>
</tr>
<tr>
<td>Antidote therapy; N (%)</td>
<td>95 (52.8)*</td>
<td>47 (49.5)</td>
<td>26 (27.4)</td>
<td>22 (23.2)</td>
<td>.000</td>
</tr>
<tr>
<td>Nonexistent</td>
<td>2 (1.1)*</td>
<td>1 (50.0)</td>
<td>0 (0.0)</td>
<td>1 (50.0)</td>
<td></td>
</tr>
<tr>
<td>Unavailable</td>
<td>46 (25.6)*</td>
<td>34 (73.9)</td>
<td>10 (21.7)</td>
<td>2 (4.3)</td>
<td></td>
</tr>
<tr>
<td>Administered</td>
<td>37 (20.6)*</td>
<td>7 (18.9)</td>
<td>16 (43.2)</td>
<td>14 (37.8)</td>
<td></td>
</tr>
<tr>
<td>Hospitalization (days)</td>
<td>4.5 ± 3.6</td>
<td>3.2 ± 1.7</td>
<td>4.3 ± 2.4</td>
<td>7.7 ± 5.8</td>
<td>.000</td>
</tr>
</tbody>
</table>

F, female; M, male; *, % of total; R, rural; U, urban; GCS, Glasgow Coma Scale score; HR, heart rate; SBP, systolic blood pressure; DBP, diastolic blood pressure; CRP, C-reactive protein; WBC, white blood cells; ASAT, Aspartate Aminotransferase; ALAT, Alanine Aminotransferase; BNP, brain natriuretic peptide; CK, creatine kinase; CKMB, MB isoenzyme of creatine kinase; ICU, Intensive Care Unit.

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Poisoning with prescription drugs (37.22%), followed by the combination of poisons (29.44%) represented the majority of agents used in self-poisoning by our patients (Fig. 1).

The poisons involved in acute poisoning of the cohort analysed

![Fig. 1](image)

Based on the significant differences between means, or frequencies of the considered patients’ groups (no complications, a single complication or multiple complications) we identified variables, which were included in the logistic regression analysis. Significant predictors of poison-related morbidity are shown in Table 2.

Variables influencing the morbidity identified using the simple binomial logistic regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>Sig.</th>
<th>Exp (B)</th>
<th>95% C.I. for EXP (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP</td>
<td>.090</td>
<td>.091</td>
<td>.972</td>
<td>.324</td>
<td>1.094</td>
<td>(.915, 1.307)</td>
</tr>
<tr>
<td>Base excess</td>
<td>.017</td>
<td>.070</td>
<td>.060</td>
<td>.807</td>
<td>1.017</td>
<td>(.887, 1.166)</td>
</tr>
<tr>
<td>WBC</td>
<td>.240</td>
<td>.073</td>
<td>10.786</td>
<td>.001</td>
<td>1.272</td>
<td>(1.102, 1.468)</td>
</tr>
<tr>
<td>Glycemia</td>
<td>.006</td>
<td>.005</td>
<td>1.113</td>
<td>.290</td>
<td>1.017</td>
<td>(.887, 1.166)</td>
</tr>
<tr>
<td>Creatinine</td>
<td>-.282</td>
<td>.070</td>
<td>.785</td>
<td>.354</td>
<td>.754</td>
<td>(.600, 5.700)</td>
</tr>
<tr>
<td>ALAT</td>
<td>.035</td>
<td>.013</td>
<td>7.739</td>
<td>.006</td>
<td>1.036</td>
<td>(1.010, 1.062)</td>
</tr>
<tr>
<td>Myoglobin</td>
<td>.017</td>
<td>.006</td>
<td>7.522</td>
<td>.006</td>
<td>1.017</td>
<td>(1.005, 1.029)</td>
</tr>
<tr>
<td>BNP</td>
<td>.003</td>
<td>.002</td>
<td>2.384</td>
<td>.123</td>
<td>1.003</td>
<td>(.999, 1.006)</td>
</tr>
<tr>
<td>CKMB</td>
<td>.039</td>
<td>.024</td>
<td>2.664</td>
<td>.103</td>
<td>1.040</td>
<td>(.992, 1.089)</td>
</tr>
<tr>
<td>GCS &lt; 8</td>
<td>-2.625</td>
<td>.814</td>
<td>10.388</td>
<td>.001</td>
<td>.072</td>
<td>(.015, .358)</td>
</tr>
<tr>
<td>Age &gt; 65 years</td>
<td>-.427</td>
<td>.746</td>
<td>1.468</td>
<td>.227</td>
<td>.653</td>
<td>(.151, 2.814)</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.172</td>
<td>2.568</td>
<td>1.526</td>
<td>.217</td>
<td>.042</td>
<td>(95% C.I. for EXP (B))</td>
</tr>
</tbody>
</table>

CRP, C reactive protein; WBC, white blood cells; ALAT, Alanine Aminotransferase; BNP, brain natriuretic peptide; CKMB, MB isoenzyme of creatine kinase; GCS, Glasgow Coma Scale score.
Although patients with multiple complications were significantly older than patients without complications (Table 1), old age (> 65 years) was not correlated with morbidity after logistic regression analysis, in acute intoxication with systemic poisons (Table 2).

Among the cardiovascular parameters, only the heart rate was significantly correlated with complications (Table 1) but was not predictive for morbidity in our patients, after logistic regression analysis.

The significant variables influencing the morbidity identified after multinomial logistic regression.

Table 3

<table>
<thead>
<tr>
<th>Morbiditya</th>
<th>B</th>
<th>Std. Error</th>
<th>Wald</th>
<th>Sig.</th>
<th>Exp(B)</th>
<th>95% CI for Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single complication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALAT</td>
<td>.034</td>
<td>.014</td>
<td>6.381</td>
<td>.012</td>
<td>1.035</td>
<td>1.008 1.063</td>
</tr>
<tr>
<td>Myoglobin</td>
<td>.013</td>
<td>.006</td>
<td>5.323</td>
<td>.021</td>
<td>1.013</td>
<td>1.002 1.025</td>
</tr>
<tr>
<td>Prescription drugs</td>
<td>-1.779</td>
<td>.922</td>
<td>3.979</td>
<td>.046</td>
<td>.169</td>
<td>.029 969</td>
</tr>
<tr>
<td>GCS &gt; 8</td>
<td>-2.325</td>
<td>.676</td>
<td>7.187</td>
<td>.007</td>
<td>.098</td>
<td>.018 535</td>
</tr>
<tr>
<td>Multiple complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WBC</td>
<td>.289</td>
<td>.101</td>
<td>8.223</td>
<td>.004</td>
<td>1.335</td>
<td>1.096 1.626</td>
</tr>
<tr>
<td>Glycemia</td>
<td>.022</td>
<td>.008</td>
<td>7.504</td>
<td>.006</td>
<td>1.022</td>
<td>1.006 1.039</td>
</tr>
<tr>
<td>ALAT</td>
<td>.055</td>
<td>.016</td>
<td>11.331</td>
<td>.001</td>
<td>1.057</td>
<td>1.023 1.091</td>
</tr>
<tr>
<td>Myoglobin</td>
<td>.022</td>
<td>.007</td>
<td>11.727</td>
<td>.001</td>
<td>1.023</td>
<td>1.010 1.036</td>
</tr>
<tr>
<td>BNP</td>
<td>.006</td>
<td>.003</td>
<td>5.102</td>
<td>.024</td>
<td>1.006</td>
<td>1.001 1.011</td>
</tr>
<tr>
<td>Drugs of abuse</td>
<td>-19.246</td>
<td>.000</td>
<td>.</td>
<td>.</td>
<td>4.381E-9</td>
<td>4.381E-9</td>
</tr>
<tr>
<td>GCS &gt; 8</td>
<td>-4.718</td>
<td>1.171</td>
<td>16.240</td>
<td>.000</td>
<td>.009</td>
<td>.001 809</td>
</tr>
</tbody>
</table>

a. The reference category is: No complications. WBC, white blood cells; ALAT, Alanine Aminotransferase; GCS, Glasgow Coma Scale score; BNP, brain natriuretic peptide.

On multivariable analysis, 4 of the 19 candidate variables were predictive of a single complication, and respectively 6 variables were predictive for multiple complications or death (Table 3).

Upon admission to hospital, the patient characteristics that were most strongly predictive of in-hospital severe morbidity included high WBC count (33.5%), high ALAT level (5.7%), an increased myoglobin and glucose level, whereas a GCS > 8 was associated with a 9.8% reduction in mild morbidity, and 0.9% reduction of severe morbidity.

Interestingly, an exposure to a prescription drug was associated with an 83.1% reduction in occurrence of a single complication (Table 3). Of particular interest was the finding that acute exposure to drugs of abuse was associated with a lower risk of severe morbidity, such as multiple complications or death, particularly because in our region, the illicit drugs are used on a limited extent, while the substances associated with a major morbidity (such as cocaine) are expensive and not readily available.
We checked the validity of our model using ROC methodology (Fig. 2). Five of the observed variables showed a good discriminatory capacity, with an area under the ROC curve (AUC) > 0.5, as follows: WBC (AUC, 0.79; CI 95%, 0.69–0.88; p < .001), glycemia (AUC, 0.70; CI 95%, 0.58–0.81; p < .001), ALAT (AUC, 0.64; CI 95%, 0.53–0.75; p .01), myoglobin (AUC, 0.80; CI 95%, 0.71–0.89; p < .001), and BNP (AUC, 0.79; CI 95%, 0.71–0.88; p < .001). The optimal cut-off values, as resulted from this ROC analysis are: WBC 10.56 *1000/mcgL, with a 72% sensitivity and a 71% specificity, glycemia 115 mg/dL, with a 72% sensitivity and a 57% specificity, ALAT 57 U/L, with a 21% sensitivity and a 96% specificity, myoglobin 114 ng/mL, with a 69% sensitivity and a 88% specificity, and BNP 108 pg/mL, with a 49% sensitivity and a 92% specificity.

Complications recorded during hospitalization (Fig. 3) occurred in 91 patients (50.6%). Among those, 39 were patients with multiple complications (21.7%), and 17 were patients with cardiovascular complications (9.4%).

Out of the 180 patients included, 16 patients died during hospitalization (8.9%) as a cause of multi-organ failure, having a length of hospital stay of 6.9 ± 5.9 days, significantly longer compared with the survivors (4.3 ± 3.4 days, Sig. .005).

Validation of the predictive variables for systemic poison-related morbidity with receiver operating characteristic curves

Fig. 2
Some limitations in this study should be mentioned. There could be a possible selection bias in the population studied, which included patients from a single tertiary center in North East Romania, although the epidemiological and toxicological data are consistent with those reported in other areas. (Dart et al, 2015; Krakowiak et al, 2011) We could not calibrate the influence of toxin serum concentration (because the quantitative toxicological tests are not available immediately after admission in the majority of poisoning). We failed to monitor the morbidity of the patients exposed to a systemic poison after discharge from the hospital.

**CONCLUSIONS**

Early prediction of clinical decompensation and subsequently morbidity in patients acutely exposed to a systemic poison is limited.

The main objective of our study was to identify and analyze the determinants of the morbidity in a cohort of patients with acute systemic poisoning, and to estimate the value of conventional laboratory tests obtained upon admission, combined with different demographic and clinical characteristics, to assess the likelihood of in-hospital morbidity.
To the best of our knowledge, this is the largest cohort of patients exposed to systemic poisons prospectively analyzed in a Romanian tertiary center.

In order to identify the factors that mostly impact the poison-related morbidity, multiple logistic regression analysis was applied taking into account significant variables associated with the occurrence of complications, and the discriminatory power of the model predictive variables was validated using ROC analysis.

Our results suggest that the in-hospital morbidity for poisoned patients can be reliably identified with clinical parameters, such as the Glasgow Coma Scale score and routine laboratory tests obtained upon admission. Admission level of WBC, ALAT, myoglobin, glycemia and BNP are strong independent predictors of in-hospital severe morbidity.

The use of these parameters identifies poisoned patients, after exposure to a systemic toxin, at high risk for in-hospital severe morbidity, and who might benefit from careful monitoring and aggressive intervention.

There is a need for further efforts to define the factors influencing morbidity and mortality risk for all patients hospitalized with acute poisoning.

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**References**