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Real wages, inflation, and labor productivity: Evidences from Bulgaria and Romania

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ABSTRACT

This study examines the effect of inflation and real wages on labor productivity for two European Union(EU) countries: Bulgaria and Romania using cointegration Autoregressive Distributed Lag (ARDL) test and causality test of Toda and Yamamoto (1995). Results suggest that inflation reduces labor productivity. Moreover, the impact of wages on labor productivity is far greater the impact of inflation. Additionally, there exists unidirectional relation between inflation and real wages for Bulgaria, and real wages and labor productivity for Romania.

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1.0 Introduction

> *"Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker"*
>
> (Paul Krugman 1994).

Productivity is usually defined as a ratio between production size and input size. It is the fundamental element in distinguishing the standard of living for each country. It is usually measured as GDP per capita in most countries and in all regions within a country. For a long time, productivity growth was the only way to sustain improvements in the standard of living or quality of life. (Krugman, 1994). It provided the basis for investments, environment's improvement and poverty reduction. Furthermore, it was a vital factor of international competitiveness. Given its importance, the improvement of productivity has been a substantial national issue for many countries. This led to give emphasis on the comprehension of factors that lead to a higher increase of productivity both for research and politics. (Tang and Wang, 2004).

The increase of productivity in all countries has played an important role on the preservation of competitiveness and the long-run economic growth. Therefore, the role of central banks and governments is to keep low the levels of interest rates and stable the levels of inflation aiming at the improvement of competitiveness. From a macroeconomic point of view, labor productivity has been related with real wages and inflation both in theoretical and empirical literature. Thus, the analysis of the relationship between labor productivity, real wages and inflation is of vital importance for governments that make plans for structural breaks for the strengthening of productivity and for inflation control.

Inflation is the increase on average level of the prices of goods and services in an economy during a time period. When the price level is increasing, we buy less goods and services. Thus, inflation reflects the reduction of purchasing power for each currency unit. A measure of inflation is the consumer price index. Inflation affects economies positively and negatively. The negative consequences of inflation consists the increase of opportunity cost of holding money whereas uncertainty over future inflation discourages investments and savings. The positive results of inflation are the reduction of real burden of public and private debt keeping the nominal interest rates above zero, so that central banks can adjust the interest rates for the stabilization of economy and the reduction of unemployment due to nominal wage rigidity (Mankiw 2002).

Wages is regarded as the compensation that an employer gives to the employee as a return for his labor. Yet, economists separate wages in nominal and real. Nominal wages is measured in money. Real wages is the one adjusted on inflation. Real wages are received by the deflator of nominal wages index based on the consumer price index. Real wages is a guide for how the cost of living has changed.

Information related to wages' level is essential in evaluating the standard of living, labor conditions and life of employees. Given that nominal wages fail to explain the purchasing power of employees, real wages is considered an important index of purchasing power and can be used as proxy for income level. Fluctuations on the real wages rate have significant consequences on poverty and income distribution. When used in relation to other economic variables, for instance employment or output, it is a valuable measure in the analysis of business cycles. (Malik and Ahmed 2000).

Literature supports that wages' rise positively affects labor productivity with the reduction on labor positions. Furthermore, the empirical literature claims that wage increase influences labor productivity positively by reducing the number of jobs. Moreover, the empirical literature shows the direction of causality that variables can have between them. For example, the theory of wage efficiency claims that causality runs from wages to productivity from wages to productivity whereas marginal productivity theory argues that causality runs from productivity to wages. There are also two more theoretical views for the causal relationship between productivity and inflation. The first argues that causality runs from productivity towards inflation and the second that causality runs from inflation to productivity.

Bulgaria and Romania have similar routes on the transition and integration of EU structures. However, they differ on the economy size, on some features connected with industrialization and on different macroeconomic evolution due to different options on monetary policy. The differences on monetary policies applied on Bulgaria and Romania respectively, have impact on the economic and political system on these countries. (Nenovsky et al. 2013). The monetary and fiscal policies that Bulgaria applied, led the economic activity to the private sector. The policy applied by the Central Bank of Romania was the accumulation of public deficit.

Despite the differences in monetary and fiscal policies, the accession of Bulgaria and Romania in EU had the same positive impact on the realization of economic growth, which is driven by private consumption, investment activities, exports' growth and unemployment reduction. This fiscal discipline allows for tax cuts aiming at investments' attraction and the reduction of taxes on the population. The average rate of economic growth for Bulgaria and Romania is 6% on average each year. The favorable economic situation on EU affects positively the development of Romania and Bulgaria from 2006 until 2008. Investments which are an integral part of the strategy of economic development, were 20-30% of GDP for Bulgaria for 2005-2008 and almost 10% of GDP for Romania for the years 2004-2008. Economic crisis stops the trend of economic development on the two countries.

Despite the crisis, Bulgaria's GDP was 1.28% on 2013, 1.55% on 2014 and 2.97% on 2015. For Romania, GDP increased by 3.5% on 2013 thanks to exports of industrial production while this increase was 2.96% on 2014 and 3.74% on 2015. The main sources of the Romanian economic growth were industrial activity, agriculture and construction. The purchasing power of Bulgaria has increased in combination with low inflation. Inflation on Bulgaria was 0.9% for 2013, -1.4% for 2014 and -0.1% for 2015 while for Romania was 4% for 2013, 1.08% for 2014 and -0.6% for 2015. Moreover, the decline of interest rate improves credit conditions. On the contrary, in Romania wages on public sector have frozen for several years.

In empirical literature there are many studies that analyze the relationship between labor productivity and wages, and also between labor productivity and inflation. However, there are few studies that examine the relationship among labor productivity, real wages and inflation and fewer that are focused on less developed countries.

This paper examines the interconnections among labor productivity, real wages and inflation on two countries of European Union, Bulgaria and Romania for the period 1991 until 2014 using the ARDL technique for cointegration of variables and Toda and Yamamoto technique for causality testing. This paper is important for two reasons. No other study has been conducted with reference to the relationship of the examined variables for the two countries. Secondly, there is no other study that examines these variables using the above methodology for developing countries.

The results of the paper show a long-run relationship between real wages and labor productivity on both countries, as well as between inflation and productivity. Moreover, real wages have larger effect on productivity rather than inflation on both examined countries. There is a unidirectional causal relationship between inflation and wages for Bulgaria and unidirectional causal relationship between wages and productivity for Romania. The results of this paper provide some policy implications. Central Banks on both countries can considerably contribute to productivity, hence to long run development controlling inflation and keeping interest rates in low levels. Moreover, the attraction of foreign direct investment and rapid absorption of European funds will help in the increase of productivity and development.

This paper is structured as follows. Section 2 is a brief overview of the empirical literature. Section 3 describes data and methodology. Section 4 presents the empirical results. Finally, Section 5 provides conclusions and policy implications.

2.0 Literature review

The relationship between labor productivity and wages and also labor productivity and inflation has drawn the attention of many researchers. The literature is being surrounded by a number of empirical tests on a data group corresponding to the above variables.

2.1 Inflation and productivity

During the last decades, there are many studies that examined the relationship between inflation and productivity. The findings from these studies are mixed. Some have found out a negative relationship between inflation and productivity (see Buck and Fitzroy 1988, De Gregorio 1992, Christopoulos and Tsionas, 2005, Barsden et al. 2007, Narayan and Smyth 2009). According to Barsden et al. (2007), inflation reduced the motives for labor and leads companies to insufficient investment plans, influences capital amortization coefficients and causes changes in the preferences of production techniques. Christopoulos and Tsionas (2005) support that inflation shrinks tax reductions for amortization resulting in price increase of capital leasing, cutting down productivity growth.

However, other papers have established that there is no important relationship between inflation and productivity (see Cameron et al.1996, Hondroyiannis and Papapetrou, 1998, Freeman and Yerger 2000). These studies that have been conducted, as far as the causal relationship between inflation and productivity is concerned, show ambiguous results. For example, Freeman and Yerger (2000) claim that there is a unidirectional causal relationship running from exogenous productivity to inflation. Many authors have claimed that the correlation between inflation and productivity is false due to cyclical movements between two variables. (see Hondroyiannis and Papapetrou, 1998, Freeman and Yerger 1998).

Recent studies examine the long-run relationship between productivity and inflation using unit root and cointegration techniques (see Mehra, 2000, Christopoulos and Tsionas 2005). For example, the study of Mehra (2000) concluded that the relationship between inflation and productivity is bidirectional in a long run basis. Finally, there is a number of studies claiming that a rise in inflation rate could adversely affect productivity.

2.2 Real wages and productivity

The positive relationship between real wages and labor productivity is well anchored in economic theory. According to the efficiency of economic theory, a rise on real wages can cause higher labor productivity with a higher opportunity cost of job loss. In a macroeconomic level, a rise of real wages will raise the unit of labor cost, thus causing substitution from labor to capital. The labor substitution from capital could increase the marginal labor productivity (see Wakeford, 2004). On the other hand, we can say that a positive relationship between real wages and labor productivity show that higher real wages increase the opportunity cost of job loss and strengthens the labor effort in order to avoid dismissal. Finally, the relationship between real wages and labor productivity is based on the fact that larger capital stocks will raise demand, thus raising real wages and stimulating labor productivity. Several studies have established the positive relationship between real wages and labor productivity (see Erenburg 1998, Hsu, 2005, Mora et al. 2005, Klein 2012).

2.3 Inflation, real wages and productivity

All the above relationships have been merged aiming at empirical results on several studies. Mehra (1991) examined the relationship between inflation, productivity and adjusted wage and found out that long run inflation has a positive effect per unit labor costs. Hondroyiannis and Papapetrou (1997) examined the relationship among inflation, productivity and wages in Greece for the period 1975-1992. On their results, they found that inflation has a negative influence on productivity while there is no clear impact for wages on productivity. Strauss and Wohar (2004) examine the long-run relationship between price wages and productivity in a group of 459 manufacturing industries of USA for the period 1956-1996. Using cointegration technique on panel data they found out that long run relationship among variables is valid for many industries not for all of them. However, Granger causality showed a bilateral relationship between real wages and productivity.

Narayan and Smyth (2009) employ cointegration techniques on panel data in order to examine the relationships between inflation, real wages and productivity of G7 countries during the period 1960-2004. The results of their paper showed a positive relationship between real wages and productivity but there is no important relationship between productivity and inflation. Kumar et al. (2009) analyzed the relationship between real wages, inflation and labor productivity for Australian data for the period 1965-2007 using cointegration technique and Granger causality. The results of this paper confirmed that a 1% increase of wages has driven to an increase of productivity between 0.5% and 0.8% with the presence of a structural break on 1985. The relationship between inflation and productivity showed a restricted statistical significance. Finally, Yildirim (2015) examined the relationships between productivity, real wages and inflation for a Turkish manufacturing industry using quarterly data for the period 1988-2012. Using cointegration technique and Granger causality he presented that inflation has larger influence on labor productivity rather than real wages. Moreover, Granger causality test showed that there is a strong bilateral relationship between labor productivity and inflation.

Other related studies are those of Hall (1986) and Alexander (1993) that proved inflation, real wages and productivity have a cointegrating relationship for United Kingdom, with an implication that higher wage rates stimulate labor productivity via the efficiency wage argument. Gunay et al. (2005) examined the relationship among inflation, real wages and profit margins over twenty-nine Turkish manufacturing sub-sectors during 1980-1996. They ascertained that profit margins are influenced by real wage costs and price inflation positively and in a significant level. Wakeford (2004) examining the relationship among labor productivity, unemployment and wages for South Africa, found a long- term equilibrium between real wages and productivity.

Mahadevan and Asafu- Adjaye (2006) study the relationship between inflation, productivity and money supply in nine Asian countries showing a bi-directional relationship between inflation and productivity. Sonmez- Atesoglu and Smithin (2006) examined the relationship among productivity, real wages and economic growth of G7 countries from 1960-2002. On their findings, they argue that an explicit inflation-targeting policy is not likely to be a desirable monetary policy rule.

3.0 Data and methodology

3.1 Data

According to theoretical and empirical literature, labor productivity depends on real wages and inflation. This paper uses annual data from 1991 until 2014 from labor productivity (proxied by real values added per worker). Productivity represents average labor productivity (production index/employment index). Real wages (proxied by real salaries and wages paid for the manufacturing sector) are obtained by deflating the nominal wage index with the CPI deflator. Inflation rate (proxied by the growth of the consumer price index) represents the growth of the CPI deflator. Data were obtained from the International Financial Statistics (IFS). All data used in the study are in logarithmic form. This transformation was made to minimize heteroscedasticity problems (see Gujarati 2004).

3.2 Unit root tests

Our first aim is to investigate the order of integration on series data. The test of series order will lead us to use the most suitable test for series cointegration. In order to find the integration order of series, we use the Dickey-Fuller (ADF) (1979, 1981) and Phillips-Perron (PP) (1988) tests.

3.3 Cointegration tests

Following Kumar et al. (2012), we specify the production function as follows:

$$PR_t = \beta_0 + \beta_1 W_t + \beta_2 CPI_t + e_t \quad (1)$$

where PR_t is the labor productivity, W_t is the real wages, CPIt is the price levels and e_t is white noise. The coefficient of β_1 of real wages shows the labor's productivity elasticity in relation to real wages and is expected to be positive. The coefficient β_2 of inflation shows labor's productivity elasticity and is expected to be negative. Logarithmic transformation of the above equation would leave the basic equation as follows:

$$\ln PR_t = \beta_0 + \beta_1 \ln W_t + \beta_2 \ln CPI_t + e_t \quad (2)$$

For the long run relationship between the series on equation (2) there is a number of tests. The most popular tests of an equation for the cointegration of a group of series integrated order I(1) are the tests of Engle-Granger (1987) and Phillips-Ouliaris (1990) named as residuals tests. Also, there is Johansen methodology (1988, 1991) which is referred to a system's equations of the series and uses the method of maximum likelihood.

Recently, in most empirical studies we find the Autoregressive Distributed Lag ARDL cointegration test, developed by Pesaran et al (2001). The basic advantages of ARDL test in relation to other tests are the following:

1. It has more power when the size of the sample is small (see Pesaran et al. 2001).
2. It can be used on series which are not integrated same order as long as there are no series second order I(2). (see Pesaran et al. 2001).
3. It allows series to have different optimal lags.
4. It uses just one single equation.

ARDL (p,q_1,q_2) test presupposes the estimation on the following unrestricted error correction model:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \sum_{j=0}^{q_1} \gamma_j \Delta x_{1t-j} + \sum_{k=0}^{q_2} \delta_k \Delta x_{2t-k} + \varphi_0 y_{t-1} + \varphi_1 x_{1t-1} + \varphi_2 x_{2t-1} + e_t \quad (3)$$

where p,q_1,q_2 is the order of lags on the variables y_{t-i}, x_{1t-j} and x_{2t-k} respectively.

ARDL (p,q_1,q_2) procedure consists the following steps:

This test uses F distribution and the null of non-cointegration of series as follows:

$H_0 : \varphi_0 = \varphi_1 = \varphi_2 = 0$ (No cointegration of series).

against the alternative of cointegration of series.

$H_1 : \varphi_0 \neq \varphi_1 \neq \varphi_2 \neq 0$ (series cointegration).

The asymptotic critical values are provided by Pesaran et al. (2001). An important issue in applying the bounds testing procedure is the selection of the lags (p,q_1,q_2). The maximum lag length is selected based on the minimum value of Akaike (AIC), Schwarz (SBC), Hannan-Quinn (HQC) criteria.

If bounds test lead us to series cointegration, we can estimate the long run relationship of series from equation (4) as well as the restricted error correction model from equation (5).

$$y_t = \alpha_0 + \alpha_1 x_{1t} + \alpha_2 x_{2t} + u_t \quad (4)$$

$$\Delta y_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \sum_{j=0}^{q_1} \gamma_j \Delta x_{1t-j} + \sum_{k=0}^{q_2} \delta_k \Delta x_{2t-k} + \vartheta z_{t-1} + e_t \quad (5)$$

where p,q_1,q_2 is the order of lags on the variables y_{t-i}, x_{1t-j}, and x_{2t-k} respectively, the term z_t is the error term created by the cointegrating regression (equation 4).

3.4 Causality analysis

On this section we examine the causal relationship between labor productivity, real wages and inflation using the seemingly unrelated regression model with three variables. Toda and Yamamoto (1995), in order to investigate the causality they developed a method based on the estimation of an augmented VAR model $(k+d_{max})$. VAR causality model of Toda and Yamamoto is being formed as follows:

$$y_t = \mu_0 + \left(\sum_{i=1}^{k} \alpha_{1t} y_{t-i} + \sum_{i=k+1}^{d_{\max}} \alpha_{2t} y_{t-i} \right) + \left(\sum_{i=1}^{k} \beta_{1t} x_{t-i} + \sum_{i=k+1}^{d_{\max}} \beta_{2t} x_{t-i} \right) + \varepsilon_{1t} \quad (6)$$

$$x_t = \varphi_0 + \left(\sum_{i=1}^{k} \gamma_{1t} x_{t-i} + \sum_{i=k+1}^{d_{\max}} \gamma_{2t} x_{t-i} \right) + \left(\sum_{i=1}^{k} \delta_{1t} y_{t-i} + \sum_{i=k+1}^{d_{\max}} \delta_{2t} y_{t-i} \right) + \varepsilon_{2t} \quad (7)$$

where k is the optimal time lag on the initial VAR model and d_{max} is the maximum integration order on VAR model variables.

The null hypothesis of no causality is defined for every equation on VAR model. For example, variable x_t will cause variable y_t ($x_t => y_t$) when $\beta_{1t} \neq 0, \forall i$. Toda and Yamamoto test for the no Granger causality can be performed for every integration order of the variables either they are cointegrated or not, given that the inverse roots of autoregressive (AR) characteristic polynomial should be inside of the unit circle, in order the above test to be valid.

4.0 Empirical results

In the empirical analysis, we use annual data for the period 1991-2014 related to labor productivity, real wages and inflation for both countries. We start with series stationarity on both countries.

4.1 Unit root tests

The results of Dickey-Fuller (ADF) (1979, 1981) and Phillips-Perron (PP) (1988) test are presented on table 1.

Table 1: Unit root tests

Variable	ADF		P-P	
	C	C,T	C	C,T
Bulgaria				
lnPRB	-0.796(0)	-1.771(0)	-0.859[2]	-1.738[1]
ΔlnPRB	-5.496(0)*	-5.415(0)*	-5.494[1]*	-5.414[1]*
lnWB	-2.953(2)***	-1.483(1)	-5.554[5]*	-1.285[4]
ΔlnWB	-3.134(1)**	-4.344(1)*	-3.158[4]**	-4.186[8]*
lnCPIB	-14.911(5)*	-1.492(0)	-3.197[1]**	-1.495[2]
ΔlnCPIB	-3.138(0)**	-3.215(1)***	-3.138[0]**	-3.913[2]**
Romania				
lnPRR	0.050(0)	-2.385(4)	-0.093[2]	-1.931[2]
ΔlnPRR	-3.557(0)*	-3.434(0)***	-3.591[2]*	-3.474[2]***
lnWR	-1.470(0)	-2.131(2)	-1.670[2]	-2.618[2]
ΔlnWR	-4.981(0)*	-4.967(0)*	-4.919[2]*	-4.924[2]*
lnCPIR	-5.303(2)*	-2.308(4)	-37.562[22]*	-15.406[22]*
ΔlnCPIR	-2.046(4)	-8.091(5)*	-2.448[11]	-3.017[21]

Notes:
1. *, ** and *** show significant at 1%, 5% and 10% levels respectively.
2. The numbers within parentheses followed by ADF statistics represent the lag length of the dependent variable used to obtain white noise residuals.
3. The lag lengths for ADF equation were selected using Schwarz Information Criterion (SIC).
4. Mackinnon (1996) critical value for rejection of hypothesis of unit root applied.
5. The numbers within brackets followed by PP statistics represent the bandwidth selected based on Newey West (1994) method using Bartlett Kernel.
6. C=Constant, T=Trend, Δ=First Differences.

The results of table 1 show that other series are integrated order null I(0) and other first order I(1) for both countries. Therefore, the methodology we can use for cointegration test is that of ARDL (Autoregressive Distributed Lags).

4.2 ARDL bounds testing approach

From model (3) we find the maximum values for lags p, q_1 and q_2, using Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Criterion (HQC), and Likelihood Ratio (LR) criteria. The results of these criteria are presented on table 2.

Table 2: VAR lag order selection criteria

Lag	LogL	LR	FPE	AIC	SBC	HQC
Bulgaria						
0	48.034	NA*	0.0007	-4.424	-4.126*	-4.374
1	49.173	1.439	0.0007*	-0.439*	-4.091	-4.380*
2	49.174	0.001	0.0008	-4.334	-3.936	-4.266
3	49.185	0.011	0.0009	-4.230	-3.782	-4.154
4	49.186	0.000	0.0010	-4.124	-3.627	-4.040
Romania						
0	44.876	NA*	0.0011	-3.909	-3.644	-3.914
1	44.927	0.063	0.0010*	-4.092*	-3.794*	-4.041*
2	45.085	0.183	0.0012	-3.903	-3.506	-3.836
3	46.751	1.753	0.0011	-3.973	-3.526	-3.898
4	46.769	0.017	0.0013	-3.870	-3.373	-3.786

Notes: *denotes the optimal lag selection

Most of the criteria show that the maximum number of lags for series 1 on both countries. The order of optimal lag length on equation (3) is chosen from the smallest value of AIC, SBC and HQC criteria. On table 3 we present the results on these criteria.

Table 3: Order of optimal lags ARDL(p,q_1,q_2)

ARDL(p,q_1,q_2)	AIC	SBC	HQC
Bulgaria			
($p=1$, $q_1=0$, $q_2=0$)*	**-4.65**	**-4.31**	**-4.57**
($p=1$. $q_1=1$, $q_2=0$)	-4.54	-4.19	-4.46
($p=1$, $q_1=0$, $q_2=1$)	-4.63	-4.28	-4.55
($p=1$, $q_1=1$, $q_2=1$)	-4.54	-4.19	-4.46
Romania			
($p=1$, $q_1=0$, $q_2=0$)*	**-3.98**	**-3.64**	**-3.90**
($p=1$. $q_1=1$, $q_2=0$)	-3.21	-2.87	-3.13
($p=1$, $q_1=0$, $q_2=1$)	-3.92	-3.57	-3.84
($p=1$, $q_1=1$, $q_2=1$)	-3.04	-2.69	-2.96

Notes: *denotes the optimal lag selection, Statistics in bold denote the value of the minimized AIC, SBC and HQC.

Results on table 3 show that ARDL model (p,q_1,q_2) with lags $p=1$ $q_1=0$ and $q_2=0$ is the best for both countries. Afterward, we conduct independence test of the errors (LM test) until first order (maximum number of lags). The following table presents the above test.

Table 4: Errors independence test (LM Test)

Bulgaria	
F-stat =0.086	Prob. $F(1,14)=0.773$
$N^*R^2=0.134$	Prob. $X^2(1)=0.134$
Romania	
F-stat =0.060	Prob. $F(1,14)=0.809$
$N^*R^2=0.094$	Prob. $X^2(1)=0.758$

Notes: N=observations.

The results on table 4 introduce that errors are not autocorrelated. We continue testing for dynamic stability of ARDL (1,0,0) test for both countries. This test is conducting with the unit cycle. If inverse roots of equation (3) are inside the cycle, then the model is characterized as dynamically stable.

The results of diagram 1 show that there is a dynamic stability of the models on both countries. Before continuing with the bounds test we introduce the actual and fitted residuals from ARDL (1,0,0) on both countries which is the unrestricted error correction model.

Diagram 1: Dynamic stability of models

Bulgaria | Romania

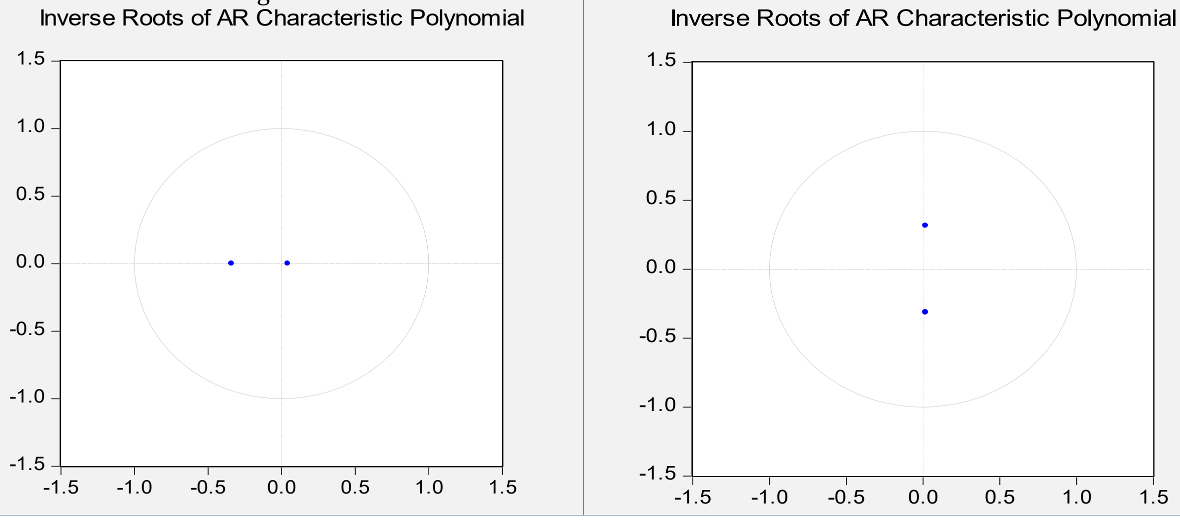
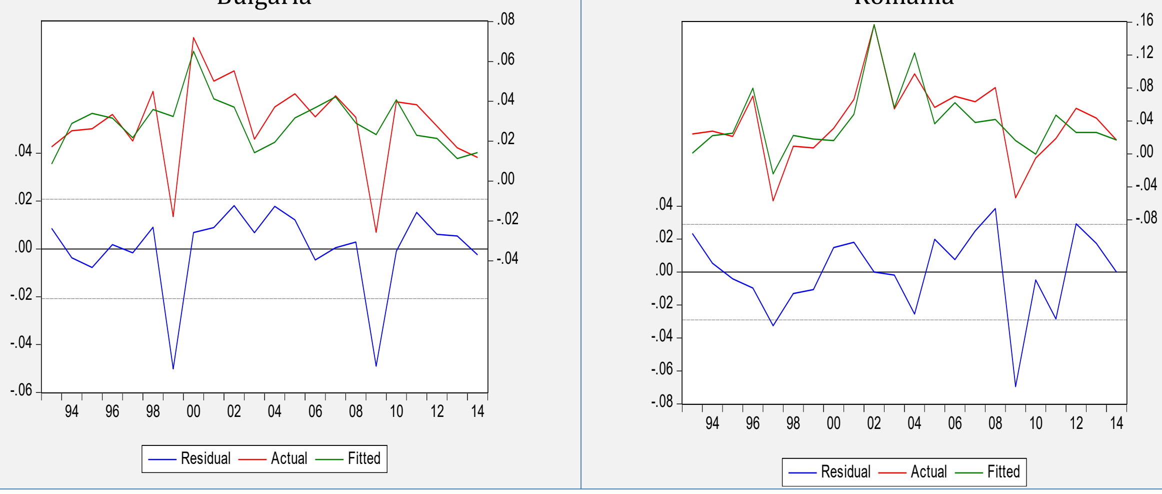


Diagram 2: Real and fitted residuals of the models

Bulgaria | Romania



Afterwards, we continue with cointegration test of the bounds on autoregressive distributed lag. In other words, we test if coefficients φ_0, φ_1 and φ_2 of the model (3) are zero on the estimated models.

Table 5: Bounds test (wald test)

Test Statistic	Value	df	Probability
Bulgaria			
F-statistic	4.415*	(2,15)	0.094
Chi-square	4.830	(2)	0.089
Romania			
F-statistic	4.590*	(2,15)	0.091
Chi-square	5.180	(2)	0.087

Notes: Table CI (iii) on page 300 of Pesaran et al. 2001 give lower and upper bounds for 10%, 5% and 1% levels of significance [3.17, 4.14], [3.79, 4.85] and [5.15, 6.36] respectively. *, ** and *** show significant at 1%, 5% and 10% levels respectively.

The results of the above table show that the value of F-statistic for both countries is larger from the upper bound of Pesaran et al. (2001) table, for 10% level of significance (see Pesaran et al. 2001, p.300) for (k+1)=3 variables. So, we can say that there is cointegrated relationship between examined series on both countries for 10% level of significance.

On the following table the results from the estimation of unrestricted error correction model (equation 3) are presented for both countries.

Table 6: Estimation of unrestricted error correction model

Dependent variable = $\Delta lnPR_t$					
Short run analysis					
Bulgaria			Romania		
Variables	Coeffic.	t-statistic	Variables	Coeffic.	t-statistic
Constant	-4.417	-1.586	Constant	-0.127	-0.127
$\Delta lnPRB_{t-1}$	-0.272	-1.874	$\Delta lnPRR_{t-1}$	0.021	2.147
$\Delta lnWB_t$	1.205	1.948	$\Delta lnWR_t$	0.995	4.192
$\Delta lnCPIB_t$	-0.006	-1.610	$\Delta lnCPIR_t$	-0.049	-2.051
$lnPRB_{t-1}$	-0.235	-2.029	$lnPRR_{t-1}$	-0.144	-2.041
$lnWB_{t-1}$	0.340	1.973	$lnWR_{t-1}$	0.185	1.509
$lnCPIB_{t-1}$	-0.003	-2.508	$lnCPIR_{t-1}$	-0.009	2.481
R^2	0.346		R^2	0.727	
F-stat	1.326		F-stat	6.667	
D-W	2.050		D-W	2.045	
Diagnostic Test	X^2	Prob.	Diagnostic Test	X^2	Prob.
Normalily	5.217 (2)	0.102	Normality	4.217 (2)	0.121
Serial Corr.	0.094 (1)	0.758	Serial Corr.	0.094 (1)	0.758
ARCH	0.302 (1)	0.582	ARCH	0.302 (1)	0.582

Notes. ***, ** and * show significant at 1%, 5% and 10% levels respectively. Δ denotes the first difference operator, X^2 Normal is for normality test, X^2 Serial for LM serial correlation test, X^2 ARCH for autoregressive conditional heteroskedasticity, () is the order of diagnostic tests.

The results on table 6 show that both statistic and diagnostic tests are quite satisfying. Before move on to the next step, we find the long-run results from the unrestricted error correction model equation (3).
For Bulgaria we get:

$$-\left(\frac{LWB}{LPRB}\right)=-\left(\frac{0.340}{-0.235}\right)=1.45 \qquad -\left(\frac{LCPIB}{LPRB}\right)=-\left(\frac{-0.003}{-0.235}\right)=-0.013$$

For Romania we get:

$$-\left(\frac{LWR}{LPRR}\right)=-\left(\frac{0.185}{-0.144}\right)=1.28 \qquad -\left(\frac{LCPIR}{LPRR}\right)=-\left(\frac{-0.009}{-0.144}\right)=-0.062$$

Thus, we can say that an increase of 1% on wages, will bring an increase on labor productivity by 1.45% in Bulgaria and by 1.28% in Romania. Furthermore, an increase in inflation by 1% will reduce labor productivity by 0.013% in Bulgaria and by 0.062% in Romania.

We estimate the long and short run relationship of the series on equations (4) and (5).

Table 7: Estimation of the long and short run relationship

Dependent variable = $lnPR_t$					
Long run analysis					
Bulgaria			Romania		
Variables	Coeffic.	t-statistic	Variables	Coeffic.	t-statistic
Constant	-21.832	-10.521	Constant	-6.169	-8.658
$lnWB_t$	5.954	12.483	$lnWR_t$	2.437	14.156
$lnCPIB_t$	-0.040	-3.620	$lnCPIR_t$	0.117	19.406
R^2	0.961		R^2	0.967	
F-stat	262.251		F-stat	308.224	
D-W	0.903		D-W	1.263	
Diagnostic Test	X^2	Prob.	Diagnostic Test	X^2	Prob.
Normality	1.456 (2)	0.482	Normality	0.348 (2)	0.839
Serial Corr.	5.757 (1)	0.016	Serial Corr.	2.915(1)	0.087
ARCH	0.613 (1)	0.433	ARCH	1.287(1)	0.256
White	1.968 (5)	0.853	White	3.049(5)	0.692

Dependent variable = $\Delta lnPR_t$					
Short run analysis					
Bulgaria			Romania		
Variables	Coeffic.	t-statistic	Variables	Coeffic.	t-statistic
Constant	0.031	3.704	Constant	0.043	3.704
$\Delta lnPRB_{t-1}$	-0.257	-1.237	$\Delta lnPRR_{t-1}$	-0.165	-1.024
$\Delta lnWB_t$	1.215	1.835	$\Delta lnWR_t$	1.249	5.142
$\Delta lnCPIB_t$	-0.011	-1.621	$\Delta lnCPIR_t$	-0.019	-1.674
ECM_{t-1}	-0.227	-2.024	ECM_{t-1}	-0.306	-1.923
R^2	0.293		R^2	0.684	
F-stat	1.764		F-stat	8.665	
D-W	1.964		D-W	1.892	
Diagnostic Test	X^2	Prob.	Diagnostic Test	X^2	Prob.
Normalily	11.35 (2)	0.03	Normality	2.568 (2)	0.276
Serial Corr.	0.047 (1)	0.827	Serial Corr.	0.095 (1)	0.757
ARCH	0.352 (1)	0.552	ARCH	0.009 (1)	0.922
White	6.012 (14)	0.966	White	10.99 (14)	0.686

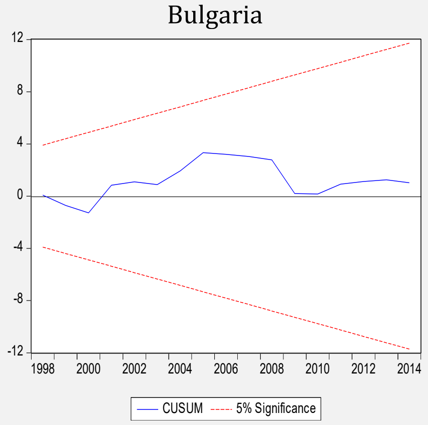
Notes: ***, ** and * show significant at 1%, 5% and 10% levels respectively. Δ denotes the first difference operator, X^2 Normal is for normality test, X^2 Serial for LM serial correlation test, X^2 ARCH for autoregressive conditional heteroskedasticity, and X^2 White for white heteroskedasticity . ( ) is the order of diagnostic tests.

The results on table 7 show that both statistic and diagnostic tests are quite satisfying. The unrestricted dynamic error correction model derived from ARDL bounds test within a simple linear transformation, incorporates the short run dynamic with long run equilibrium. The negative and statistically significant estimation of the coefficients on error correction model ECM_{t-1} on equation (5) show a long run relationship between variables on the examined model.

On the following figures (3) and (4) we examine the dynamic stability of the unrestricted error correction model with Brown et al. tests (1975).

Figure 3: Plot of cumulative sum of recursive residuals

Bulgaria



Romania

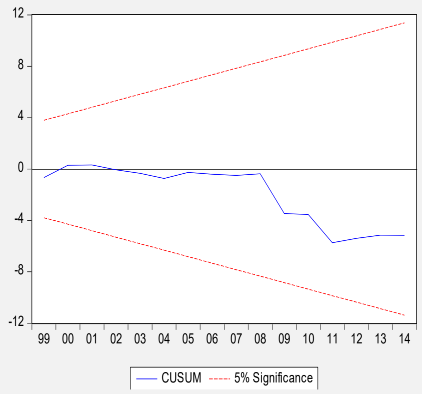
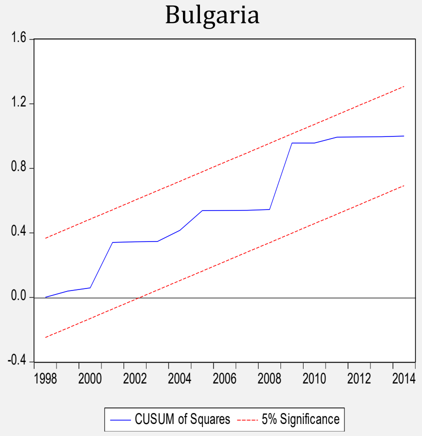
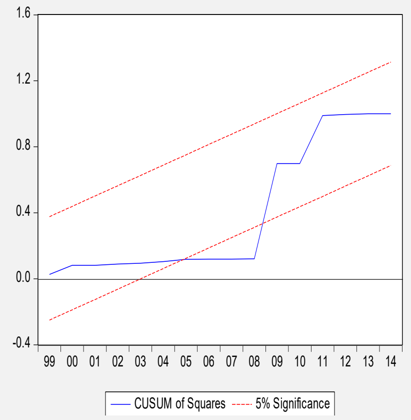


Figure 4: Plot of cumulative sum of squares of recursive residuals

Bulgaria



Romania



From the above figures we can see that Bulgaria has stable coefficients intertemporal on the examined model, contrary to Romania whose coefficients are unstable (figure 4).

4.3 Toda –Yamamoto causality test

Table 8 presents the results of causality test of Toda and Yamamoto according to equations 6 and 7.

Table 8: Toda and Yamamoto no-causality test

Excluded	Lag(k)	Lag(k+dmax)	Chi-sq	Prob.	Direction of Causality
Bulgaria					
Dependent variable: LPRB					
LWB	1	1+1	1.629	0.442	LWB # LPRB
LCPIB	1	1+1	0.297	0.861	LCPIB # LPRB
Dependent variable: LWB					
LPRB	1	1+1	4.373	0.112	LPRB # LWB
LCPIB	1	1+1	5.024*	0.081	LCPIB => LWB
Dependent variable: LCPIB					
LPRB	1	1+1	2.090	0.351	LPRB # LCPIB
LWB	1	1+1	2.716	0.257	LWB # LCPIB
Romania					
Dependent variable: LPRR					
LWR	1	1+1	1.961	0.375	LWR =>LPRR
LCPIR	1	1+1	0.116	0.943	LCPIR # LPRR
Dependent variable: LWR					
LPRR	1	1+1	5.770**	0.055	LPRR # LWR
LCPIR	1	1+1	1.424	0.490	LCPIR # LWR
Dependent variable: LCPIR					
LPRR	1	1+1	1.580	0.453	LPRR # LCPIR
LWR	1	1+1	1.663	0.435	LWR # LCPIR

Notes: The (k+dmax) denotes VAR order. The lag length selection was based on LR: sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion. ***, ** and * denotes 1% and 5%, 10% significance level, respectively. => denotes one - way causality, # denotes not causality. EViews 9.0 was used for all computations.

The results on table 8 show that there is a unidirectional causal relationship between inflation and real wages for Bulgaria with direction from inflation to real wages. For Romania there is a unidirectional causal relationship between real wages and labor productivity with direction from real wages to labor productivity.

5.0 Conclusion and policy implications

This paper expands the literature as far as the relationship between productivity, inflation and real wages in concerned in two countries of EU, Bulgaria and Romania. The aim is to improve the knowledge of these variables due to their complexity and interrelation between them. According to Kumar et al (2012), the analysis of this mutual connection can provide policy directions for productivity improvement, inflation testing and consumption strengthening.

In this paper for the relationship among labor productivity, real wages and inflation in two countries of EU, we use Pesaran et al (2001) cointegration as well as the Toda and Yamamoto (1995) methodology for the causal relationship of the examined variables. Cointegration results show a weak relationship for both countries among the three variables that we examine when labor productivity is dealing as the endogenous variable. Moreover, cointegration results showed that real wages and inflation cause productivity in a long run basis. Also, causality results showed that there is a unidirectional causal relationship from inflation to wages for Bulgaria and from wages to labor productivity for Romania (this result is in accordance with various studies such as Kumar et al (2009) and Yildirim (2015). Thus, the theory of wage efficiency in Romania is confirmed. The lack of causality among real wages and labor productivity for Bulgaria can be explained not only by macroeconomic but also by institutional factors. These factors tend to create a wedge between two variables in the short or long run (Bentolila and Saint-Paul, 2003). Inflation's influence on real wages in Bulgaria has been documented both in theoretical and empirical literature. It is well known that, in the short run, inflation's reduction increase real income and can also increase real wages temporarily. However, in the long run, real wages are not influenced by inflation because real wages depend upon productivity's increase and employees negotiating power.

From a macroeconomic perspective, the most serious risk for economic development in Bulgaria is low consumption. However, in periods of weak domestic demand the Bulgarian economy has been able to partly compensate this low consumption with higher net exports. The decline of FDI entries in Bulgaria can be stimulated by the improvement of EU Structural Funds absorption rate. The continuation of the reform process, in Romania, is necessary particularly on the fiscal consolidation process, based on the preventive financing agreement contracted with EU and IMF. This agreement can bring coherence to the macroeconomic and financial policies, thus adding to the consolidation of investors' confidence and preserving the macroeconomic and fiscal stability.

Finally, if Bulgaria and Romania achieve a higher level of utilization of EU funds, they will be able to reduce the economic gap with the Central European EU states. In the long run, Bulgaria and Romania have a long road ahead in terms of improving their still low absorption capacity. To achieve that, they need to significantly reduce bureaucracy and introduce more transparent processes of project selection.

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