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CONTENTS

GOVERNMENT EXPENDITURE AND ECONOMIC GROWTH NEXUS IN NIGERIA: EVIDENCE FROM NONLINEAR ARDL AND CAUSALITY APPROACHES

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ABSTRACT

The kernel of the debate on the relation between government spending and economic growth is whether the former causes the latter or the latter causes the former. In addition, there is the issue of possibility of nonlinearity in the relation between government expenditure and economic growth.

Purpose. *The purpose of this paper is to examine the relations between government expenditure and economic growth in Nigeria.*

Design/Methodology/Approach. *The nonlinearity and causality in the relation between government expenditure and economic growth are examined using nonlinear autoregressive distributed lag model (NARDL), vector error correction model (VECM) and causality.*

Findings/Implications. *The findings show the existence of cointegration and nonlinear effect on the relation between government expenditure and economic growth in both long- and short-run. The results equally show unidirectional causality that runs from economic growth to government expenditure thus providing support for Wagner's law in Nigeria.*

Originality. *The findings from this study suggest that nonlinearity and asymmetry should be taken into account when examining the nexus between government expenditure and economic growth.*

1. INTRODUCTION

Over the last three decades, the empirical study of the government expenditure-economic growth relation has attracted a great deal of attention in the literature both in the developed and developing economies. The kernel of the debate has been whether the causality between the two variables runs from national income (measured as gross domestic product) to government expenditure or whether the causality runs from government expenditure to national income. The former perspective is associated with the Wagner's law, which is otherwise known as the law of increasing government expenditure. The latter view is associated with the Keynesian theory.

Wagner theory argues that the share of government expenditure tends to increase more than proportionally with economic activity because the goods and services provided by the public sector generally have income elasticities greater than one. Consequently, according to Wagner's law, the causality runs from national income to government expenditure, not in the opposite direction. According to the Keynesian view, an increase in government expenditure leads to an increase in economic growth through an expansionary fiscal policy. It is argued in the literature that as government spending increases, production also increases and thus aggregate demand, which ultimately leads to an increase in economic activity (GDP)[1].

Without doubt, many studies have been conducted on the nexus between government expenditure and national income (measured as GDP); large numbers of the existing studies are focused on developed and industrialized economies. Not many studies have been conducted in Sub-Saharan African countries. Asides, many of the existing studies on the subject matter are fraught with one problem or the others. Firstly, many of the existing studies adopted bivariate analysis. Bivariate model has been found to produce biased results because of problem of omitted variables. As a matter of fact, introduction of other variables into a bivariate could affect not only the direction of causality but also the magnitude of the coefficients of the results. Secondly, some of the previous studies used cross-sectional data and thus not satisfactorily addressing the country-specific issues.

Thirdly and more importantly, all known studies have assumed linear relationship between government expenditure and national income when in actual fact, the relationship may be non linear. Indeed, the inconclusiveness and ambiguity of the various studies testing the government expenditure-economic growth nexus may have stemmed from the possibility of nonlinearity in the relationship. The possibility of nonlinear relationship between government expenditure and economic growth is very high. This is based on the fact that economic structure always undergoes structural and behavioral changes. Consequently, the dynamics of government expendi-

1 Empirical support for the Wagner's law can be found in the works of (Olomola, 2004; Aregbeyen, 2006; Lamartina and Zaghini, 2011; Mahdavi, 2009; Akinlo, 2013; Bayrak and Esen; 2014).However, the works of Huang, 2006; Dogan and Tang, 2006; Alimi, 2013; Ebaidalla, 2013; and Okoro, 2013 have provided evidence in support of the Keynesian hypothesis.

ture in response to changes in economic growth could be diverse and vary in magnitude across phases of the economic cycle. As an illustration, the Wagner law suggests that the elasticity of government expenditure with respect to economic growth will be the same and greater than unity over the boom-bust cycle. Indeed, empirical evidence has shown that relative share of government expenditure in GDP rises in the boom and rather than declining in response to falling GDP in subsequent bust, it often remains high (Hercowitz and Stawczynski, 2004; Ageli, 2013). This argument follows from Ratchet hypothesis (Bird, 1972) that government expenditure ratchet up in the boom and declines little or not at all during the bust. Given this fact, there is the need to investigate government expenditure-growth nexus accounting for possible asymmetric fluctuations of expenditure over economic growth and vice-versa.

This study, therefore, is an attempt to correct the weaknesses of the existing studies by using nonlinear ARDL cointegration methodology (NARDL) proposed by Shin, Yu and Greenwood-Nimmo (2011) for Nigeria[2]. In order to take care of problem of omitted variable bias, the study incorporates two variables namely inflation and trade openness, thus creating a multivariate model. Essentially, a better understanding of the dynamic relation between government expenditure and GDP will aid the comprehension of policy-relevant issues over a short-to medium term horizon. Moreover, estimates from the analysis, in particular, the speed at which government expenditure adjust to the long-term relation with GDP after a shock in economic activity will assist in formulating budgetary adjustment plans that can help in achieving medium term budgetary objective or correct excess deficits in the economy.

Nigeria is an ideal country for examining the relationship between government expenditure and economic output since government in the country plays a significant role in the economy. The government is not just the largest employer of labour, it plays a vital role in the distribution and allocation of the available resources. In addition, a casual examination of the growth rate of government expenditure and output show that the two variables gyrate together over the years possibly reflecting the developments in the oil sector necessitating the need to know which one causes the other. Hence, the objectives of this paper are to examine the nonlinear relationship between government spending and national income measured as gross domestic product (GDP) and determine the direction of causality between the two variables.

The rest of the article is organized as follows: Section 2 discusses the trends in government expenditure and economic growth over the period 1960-2012. Section 3 describes the empirical approach and data. Section 4 presents the empirical results. Section 5 looks at the direction of causality between government expenditure and national income. The last section provides the conclusions.

2 Moreover, this methodology allows for asymmetry in both the long-and short run dynamics of the relationship examined.

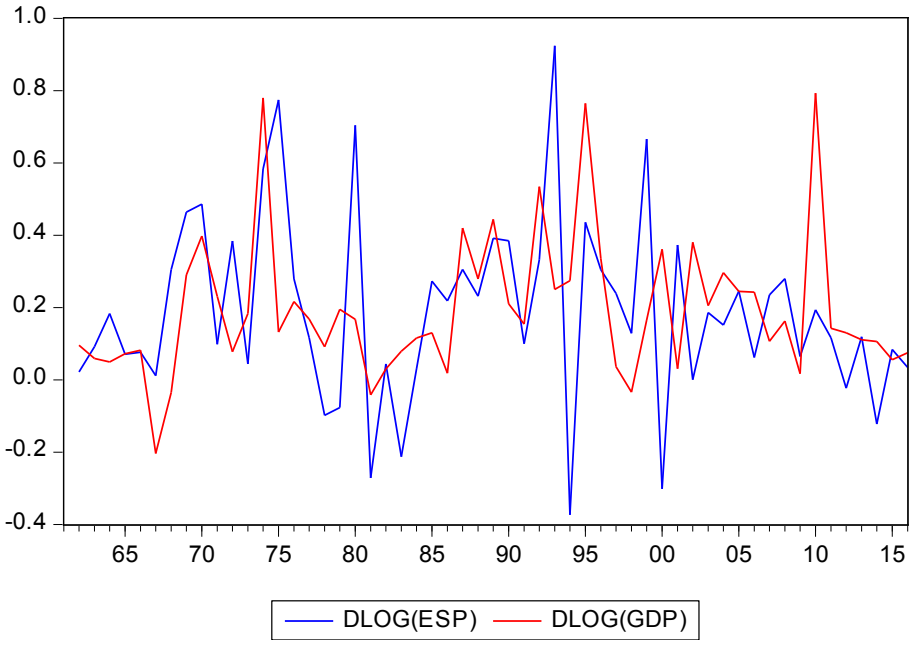
2. TRENDS IN GOVERNMENT EXPENDITURE AND ECONOMIC GROWTH IN NIGERIA

Government expenditure increased sharply in Nigeria between the period 1961 and 2016. It increased from N163.9 billion in 1961 to N903.9 billion in 1970. The figure increased from N1463.6 million in 1971 to N60.286 billion in 1990. Government expenditure increased phenomenally to N941.69 billion in 1999 but decreased to N701.06 billion in 2000. The figure increased consistently to N5160.74 billion in 2016. Generally in terms of the magnitude, government expenditure increased phenomenally between 1961- 2016. This could be attributed to huge revenue from oil since early 70s.

In the same government expenditure as a percentage of GDP was single digit and ranged between 6% and 9% over the period 1961 to 1967. The percentage became double digit from 1968. Specifically, in 1968 the percentage was 13%. The expenditure level increased consistently to 20% in 1972 though the level dropped from 17% in 1970 to 15% in 1971. The total government expenditure, as a percentage of GDP decreased slightly to 18% and 15% in 1973 and 1974 respectively; it however, increased to 30% in 1980 though there was slight drop to 18% in 1979. The large increase in government expenditure between 1968 and 1975 could be attributed partly to the civil war in Nigeria between 1969 and 1970 and partly to rehabilitation and reconstruction work that followed in the early 1970s. Government invested massively in infrastructure in the war torn areas.

Between 1981 and 2001, government expenditure as a percentage of GDP oscillated between 13% and 34%. For example, the expenditure GDP was 34% in 1993. This was the highest level recorded for the entire period 1960-2016. The expenditure level was consistently 10% and 14% between 2002 and 2009. However, from 2010 to 2016, the expenditure GDP ratio maintained a steady value of 5% to 7%. Figure 1. shows the trends of government expenditure and economic growth in Nigeria over the period 1961-2016.

Figure 1.: Trends of government expenditure (ESP) and national income (GDP) in Nigeria



Source: Authors.

The national income (measured as GDP growth rate) increased marginally between 1961 and 1966 but became negative in 1967 and 1968 at -0.184% and -0.3.5% respectively. This was a result of the civil war that started in 1967. The rate was positive from 1969 to reach a peak of 11.8% in 1974. The increase GDP growth rate during this period could be attributed to increase oil production and revenue that started immediately after the civil war in 1970. The growth rate of the GDP maintained positive trend until 1981 when it turned at -0.4%. The trend reversed to positive from 1982 to 2016 except in 1998 and 2016 when the value was -0.33% and -0.24% respectively The negative rate of GDP growth in 1998 was a result of the political crisis that started with the annulment of the election in 1993 in the country, while that of 2016 was the result of the sharp drop in the price of oil and the aftermath of the general election of 2015.. The average growth rate of GDP for the period 1961-1969 was 0.69%. It however increased to 3% for the period 1970-1979. The average GDP growth rate for periods 1980-1989 and 1990-1999 were 1.9% and 3.4% respectively; while for the periods 2000-2009 and 2010-2016, they were 2.4% and 4.4% respectively. The corresponding average growth rates of government expenditure were 1.6%, 3.5% and 2.3% for periods 1961-1969, 1970-1979 and 1980-1989 respectively. The average government expenditure growth rate increased from 2.3% for the period 1980-1989 to 4.4% in the period 1990-1999 but declined to 1.6% and 0.2% for the periods 2000-2009 and 2010-2016 respectively.

In general, the main observation from Figure 1. is the close relationship between the trends of government expenditure and national income measured as GDP over the period 1961-2016. The close movement of the two variables makes rather difficult to know which one leads the other by mere causal observation. It is therefore imperative to conduct a more rigorous analysis of the nexus between government expenditure and national income in Nigeria while taking into account possible nonlinearity in their relationship in Nigeria.

3. METHODS

In the literature, the government expenditure-growth relations are usually examined by means of the standard time series techniques of cointegration, error-correction modeling and Granger causality. Although, these techniques are robust in assessing both the long run and short run relations, the implicit assumption in them is that the effects of changes in government expenditure on economic growth are symmetric. Accordingly, they are not adequate to capture potential asymmetries in the relations between government expenditure and economic growth. However recently, Shin et al (2011) developed a nonlinear ARDL cointegration methodology as an asymmetric extension to the well-known ARDL cointegration model of Pesaran and Shin (1999) and Pesaran, et al. (2001). The nonlinear ARDL is designed to capture both long run and short run asymmetries in a variable of interest.

To begin, we specify the following asymmetric long run equation of government expenditure in line with Peacock-Wiseman tradition[3]:

$$ges_t = \alpha + \beta^{+} gdp^{+} + \beta^{-} gdp_t^{-} + \mu \inf_t + \chi open_t + e_t \quad (1)$$

where ges is government expenditure, inf is the inflation rate and open is the degree of openness and gdp is the economic growth rate. α, β's, μ and χ constitute vectors of long run parameters to be estimated. We have introduced two control variables in the equation (1) namely; inflation and trade openness based on the that other variables could have major impact on government expenditure. The omission of these variables could bias the direction of causality between government spending and national income[4].

3 The Peacock-Wiseman version of the government-national income nexus specifies government expenditure as a function of national income. Other variants of this specification include Musgrave version, Goffman version and Gupta version.

4 The choice of inflation and trade openness as control variables is based on the argument in the literature that changes in trade exert a dominant influence on changes on nominal GDP and that one of the primary causes of fluctuations in national income. In the same vein, it is contended that inflation could drive up goverment spending leading to expansionary monetary policy, which affect interest rate and economic activity.

In equation (1), β^+ and β^- are partial sums of positive and negative changes in gdp: such that

$$gdp_t^+ = \sum_{j=1}^{t} \Delta gdp_t^+ = \sum_{j=1}^{t} \max(\Delta gdp_j, 0)$$

$$gdp_t^- = \sum_{j=1}^{t} \Delta gdp_t^- = \sum_{j=1}^{t} \min(\Delta gdp_j, 0) .$$

Essentially, the long run relation as represented by equation (1) reflects asymmetric long run economic growth pass-through to government expenditure. As shown in Shin, et al. (2011), equation (1) can be framed in an ARDL setting along the line of Pesaran and Shin (1999) and Pesaran et al. (2001) as[5]:

$$\Delta ges_t = \rho ges_{t-1} + \delta_1^+ gdp_{t-1}^+ + \delta_2^- gdp_{t-1}^- + \delta_3 \inf_{t-1} + \delta_4 open_{t-1} + \\ + \sum_{j=1}^{p-1} \beta_j \Delta ges_{t-j} + \sum_{j=0}^{q-1} (\eta_j^+ \Delta gdp_{t-j}^+ + \eta_j^- \Delta gdp_{t-j}^-) + \sum_{j=0}^{r-1} \theta_j \Delta \inf_{t-j} + \sum_{j=0}^{m-1} \varphi_j \Delta open_{t-j} + e_t \quad (2)$$

where Δ denote the first difference and ρ-1, q-1, r-1 and m-1 are the lag lengths.

Equation (2) is the usual model often used in past empirical studies to estimate the long run relationship between government expenditure and economic growth based on the assumption of linearity; except that this study has introduced the possibility of nonlinearity in modeling the relationship. Since all parameters contained in equation (2) are linear, the model can easily be estimated using standard ordinary least square (OLS) method.

The unrestricted specification of NARDL error correction model in equation (2) declares two different types of asymmetry; short and long-run asymmetries, which reflects two restrictions that can be tested by means of the standard Wald tests (Shin, *et al*., 2011):

(i) Long-run nonlinearity model where the null hypothesis of a linear long-run relationship can be tested through $\delta+ = \delta-$

(ii) Short-run nonlinearity model in which the null hypothesis of additive linearity can be tested through $\sum_{j=0}^{q-1} \eta_j^+ = \sum_{j=0}^{q-1} \eta_j^-$

Based on the estimated NARDL, a test for the presence of cointegration among the variables using a bounds testing approach of Pesaran, *et al.* (2001) and Shin, *et al.* (2011) can be performed. This involves the Wald F test of the null hypothesis, $\rho = \delta_1^+ = \delta_2^- = \delta_3 = \delta_4 = 0$. In the final step, given that variables are cointegrated, then examination of long and short run asymmetries in relations between national income and government expenditure is made and inferences are drawn. In this step,

5 For a more extensive derivation of the model see Shin, *et al*. (2011)

we equally derive the asymmetric cumulative dynamic multiplier effects of a one per cent change in gdp^{+}_{t-1} and gdp^{-}_{t-1} respectively as:

$$M_h^+ = \sum_{i=0}^{h} \frac{\partial ges_{t+i}}{\partial gdp_{t-1}^+}, \qquad m_h^- = \sum_{i=0}^{h} \frac{\partial ges_{t+i}}{\partial gdp_{t-1}^-} \qquad h = 0, 1, 2 \ldots$$

$$Note\ that\ as\ h \longrightarrow \infty, \quad m_h^+ \longrightarrow \beta^+, and\ m_h^- \longrightarrow \beta^- \tag{3}$$

To further assess the relationship between government expenditure and national income, we carry out granger causality test based on error correction model and obtained the the impulse response functions and the variance decompositions. The Granger causality based on error correction model helps not only to know the direction of causation but also to identify the variables that are exogenous and endogenous. Asides, the lagged ECM will inform us how it takes to revert back to equilibrium when there is shock to the variable. The VDC and IRFs will provide information on the relative degree of endogeneity and exogeneity of the variables.

3.1. Data

The time-series data adopted for the study are annual and cover the period1960-2016. The data series are sourced from World Bank, World Development Indicator (WDI) CD-Rom (2016) and Central Bank of Nigeria, Statistical Bulletin (2017) edition. Specifically, national income (measured as gross domestic product) (gdp), inflation (inf) measured as consumer price index (1970=100) and openness (open) measured as sum of export and import as share of GDP were sourced from World Development Indicator. Government expenditure (GES) series was obtained from Central Bank of Nigeria; Statistical Bulletin. Gross domestic product and government spending are measured in million of domestic currency Naira.

4. EMPIRICAL RESULTS

4.1. Empirical results and discussion

Given the requirement of the bound testing procedure that no *I(2)* variables are involved, we test for stationarity of the variables using ADF and PP unit roots. The results of these tests are given in Table 1. In the tests, we include both constant and trend terms and employ the AIC and SIC for the optimal lag order. The results in table 1 show that three variables namely; government expenditure, gross domestic product and trade openness are non-stationary in levels but stationary at first differencing using the ADF test. However, inflation is stationary at level. The same results was obtained using Phillips-Perron test except for inflation variable which was stationary at level.

Table 1.: Results of Unit Root Test

Variables	Augmented Dickey-Fuller Test			Philips-Perron Test		
	Level	1st Difference	Remark	Level	1st Difference	Remark
lnGDP	0.456	-4.711***	I(1)	0.644	-6.316***	I(1)
lnGES	-1.246	-4.743***	I(1)	-1.058	-8.304***	I(1)
lnOpen	-1.377	-4.081***	I(1)	-1.492	-8.998***	I(1)
lnInf	2.893*	-8.244***	I(0)	-4.112*	-12.730***	I(0)

Note: ***, ** and * denote significance level for 1%, 5% and 10% respectively.
Source: Authors.

In addition, we apply the Zivot-Andrews (1992) unit root test that allows for one endogenous structural break in the series. The results presented in Table 2, suggest that the variables examined except inflation turn to break stationary process in the first differences.

Table 2.: Unit Root with structural Break

Variables	level	Break Date	First Difference	Break Date	Status
Ln GDP	-1.997	1986	-7.013	1974	L(1)
lnGES	-2.2860	1985	-9.390	1993	l(1)
lnOpen	-2.180	1972	-10.096	2009	l(1)
lnInf	-5.202***	1994	-	-	l(0)

Note: *** denote significance at 1%.
The breaks coincide with major economic and political events in Nigeria. The year 1972 was when the country changed from Pound to Naira and introduced the metric system. In 1974, the Military reneged on the planned to handover power in 1976. In 1985, there was a military coup in the country. 1986 was when structural adjustment programme was implemented. 1993-1994 witnessed political upheavals arising from the cancellation of the general election by General Babangida. In 2009, there was constitutional crisis following the sickness of President Yar Adua and the disruption of oil production by Niger delta militants.
Source: Authors.

Given the fact that none of the variables is I(2), we then proceed to the bounds testing procedure.

Accordingly, we estimate equation (2) and apply the general-to-specific procedure to arrive at the model final specification. The maximum lag order considered is 3. Table 3. provides the results of the bounds F- statistics while Table 4. presents the model estimation results. The results of the bounds test shows that the four variables government expenditure, economic growth, openness and inflation rate, co-move in the long run. The statistic 9.941 exceeds the critical upper bound at both 5% and 1% level of significance.

Table 3.: Bounds Test for Non-linear Cointegration

Critical values					
F-Statistic (prob)	5%		1%		Remark
	Lower Bound	Upper Bound	Lower Bound	Upper Bound	
9.941(0.001)	2.86	4.01	3.74	5.06	Cointegration

Source: Authors.

Table 4.: NARDL Estimation results

Variable Coefficient		T-Statistic	p-Value
Dependent variable: ΔlnGES			
Constant	5.353***	6.912	0.000
$lnGes_{t-1}$	-0.865***	6.519	0.000
$LnGdp+_{t-1}$	0.697***	6.520	0.000
lnGdp-t-1	-3.317***	-4.769	0.000
$lnOpe_{t-1}$	0.605***	5.320	0.000
$Lnlnf_{t-1}$	0.081**	2.130	0.039
ΔlnGdp+t	0.319**	2.192	0.034
$\Delta lnGdp-_{t}$	0.519	0.519	0.607
$\Delta lnGdp-_{t-1}$	1.769*	1.691	0.098
$\Delta lnOpen_{t}$	0.295**	2.403	0.021
$\Delta lnInf_{t}$	0.041	1.208	0.234
Long-run (LR) asymmetric coefficients		**Long- and short-run symmetry tests**	
LR+lnGdp = 0.81***		WLR,lnGdp = 23.09***(0.000)	
LR-lnGdp = -3.83***		WSR,lnGdp =14.75***(0.000)	
Statistics and Diagnostics tests			
χ2SC = 0.47 (0.63)		χ2HET = 0.24 (0.99)	
χ2NORM = 37.01 (0.000)		χ2FF = 0.20 (0.65)	

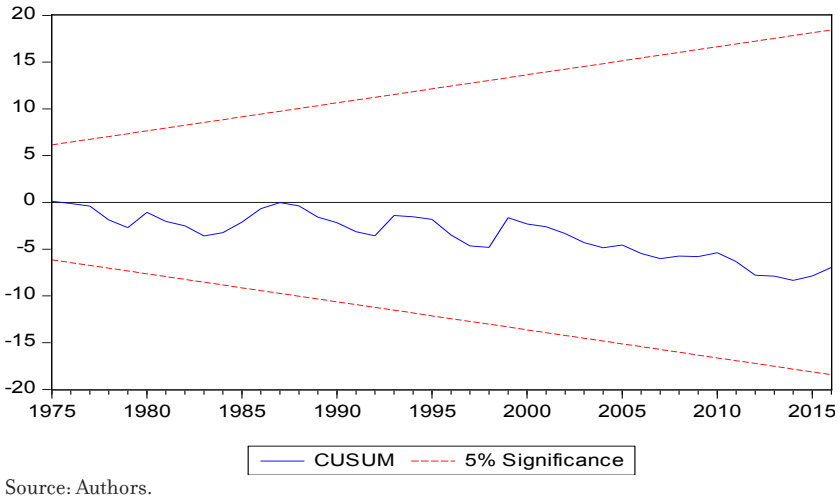
Note: ***, ** and * denote significance level for 1%, 5% and 10% respectively. WLR, WSR: Wald test for the null of long- and short-run symmetry respectively. χ^2SC, χ^2NORM, χ^2HET and χ^2FF refer to LM test for serial correlation, normality, functional form and heteroscedasticity, respectively.
Source: Authors.

The lower part of Table 4. presents some diagnostic tests of the estimated model. The tests for serial correlation LM (χ^2_{SC}) and ARCH $\chi^2_{(HET)}$test for heteroscedasticity indicate that the model estimated is well specified. In addition, graphs of the CUSUM and CUSUMSQ statistics to test for structural stability of the model as shown in Figures 2. and 3. respectively show parameter stability. In both cases, the statistics lie within the critical bounds implying that all the coefficients in the estimated model are stable.

The presence of asymmetric impact in the long and short run is examined by the Wald test. This checks the null hypothesis of symmetry against the alternative of

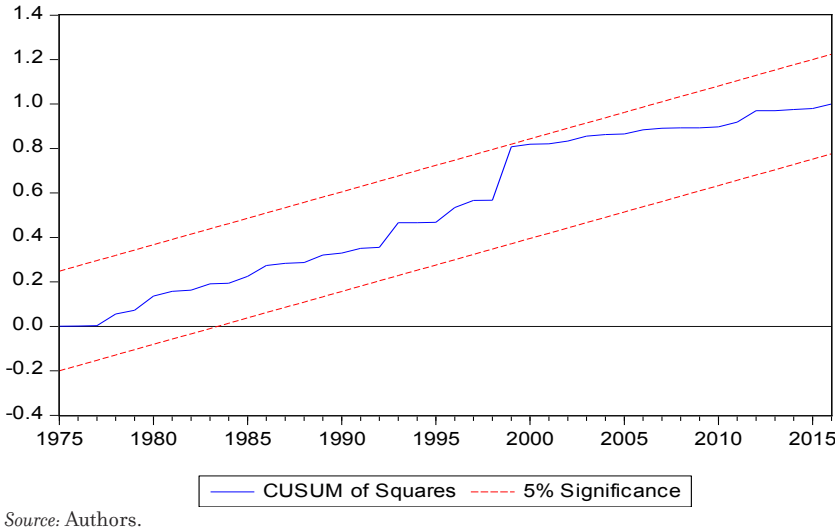
asymmetry. The results as presented at the bottom of Table 4. show the significance of asymmetry in the long- and short-run for government expenditure and national income. This implies that taking nonlinearity and asymmetry into account is important when analyzing the relationship between government expenditure and national income.

Figure 2.: The Cumulative Sum Graph based on the Nonlinear Autoregressive Distributed Lag (NARDL) Model Estimation



Source: Authors.

Figure 3.: The Cumulative Sum of Squares Graph based on the Nonlinear Autoregressive Distributed Lag Model (NARDL) Estimation



Source: Authors.

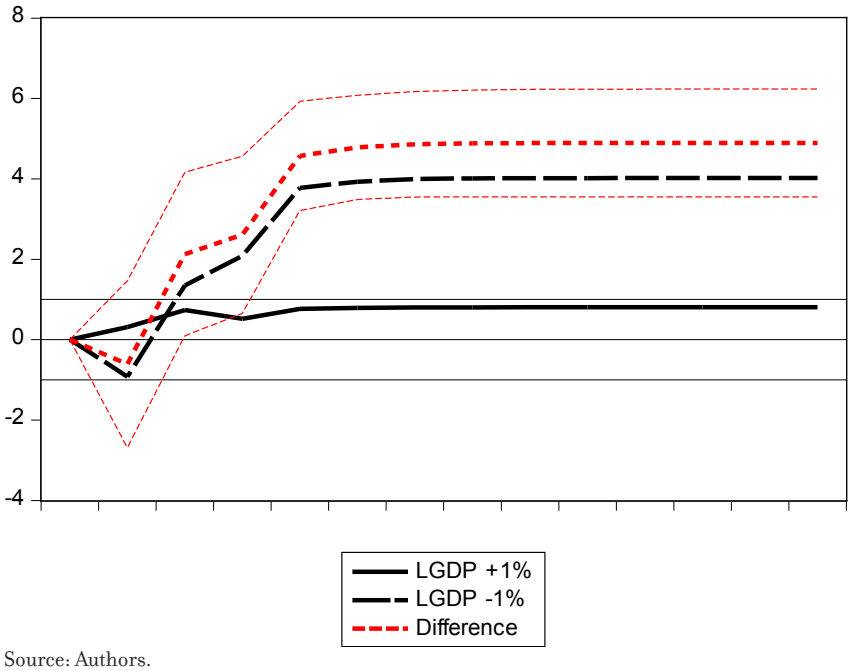
The result as presented in Table 4. shows asymmetric long run relation between government expenditure and national income. The increase in national income (measured and GDP) is positive and significantly related to government expenditure while the reduction in national income is negative and significantly related to government expenditure. Specifically, the result shows that a 1% increase in gross domestic product is related to the increase in the expected government expenditure by 0.8%. This finding implies that in the period of economic boom, government spends more. The result shows that economic growth is a major factor influencing government expenditure in Nigeria. This finding is in conformity with most empirical evidence in the literature (Bayrak and Esen, 2014; Akinlo, 2013; Olomola, 2004). In contrast, the effect of the negative component of GDP (economic downturn) on government expenditure is negatively significant and larger in magnitude, with a 1% decrease in government expenditure resulting in about 3.83% decrease in government expenditure.

Simply put, in the long run, negative growth (economic downturn) has a considerably larger impact on government expenditure compared to positive growth (economic upturn). This finding suggests that government expenditure responses to variations in economic growth need not be the same during the booms (economic upturn) as during recessions (economic downturn) and should rather depend on the intensity/magnitude of the economic fluctuations. This is the main tenet of Bird (1971) Ratchet hypothesis, which posits an asymmetry in government expenditure share to GDP over the business cycle.

The long run coefficient of inflation is positive and significant at 1% significance level in line with a priori expectation. The results suggest that that 1% increase in domestic price level is related to the increase in expected government expenditure by roughly 0.1%. In the same way, the coefficient of trade openness is positive and significant, in line with the literature (Rodrik, 1978). The results show that 1% increase in trade openness leads to 0.67% rise in government expenditure. This supports the findings of Aregbeyen (2014) and Adams and Sakyi (2012) for Nigeria and Sub-Saharan Africa respectively.

To investigate the pattern of dynamic asymmetric adjustment of government expenditure from its initial equilibrium to the new steady state in the long run shock, we use the dynamic multiplier propose by Shin et al (2014). Figure 4. shows the dynamic effects of positive and negative changes in national income where government expenditure responds more rapidly to a decrease in national income as compared to an increase. The positive (undotted line) and negative (dotted line) curves show the asymmetric adjustment to positive and negative shocks at a given forecast respectively.

Figure 4.: Dynamic Multipliers effects



Source: Authors.

5. GRANGER CAUSALITY RESULTS BASED ON VECM

To assess the direction of causality, the paper conducts the Granger causality test based on error correction model. The error correction helps to confirm the long run relationship and assist to identify which variable is exogenous (strong) and which endogenous (weak) and the ECM(-1) is the speed of adjustment that informs us on how long it takes to revert back to long-term equilibrium if that variable of adjustment is perturbed. Table 5 presents the results of the error correction model while Table 6. shows the results of the causal channels. As evidenced from the t-statistic of the ECM, only inflation variable is significant and thus endogenous. Other variables are found to be exogenous (not statistically significant in the ECM results). This shows that a shock to inflation will have strong effect on government expenditure, national income and trade openness. This means that monetary policy must focus on inflation stability as it seems to have profound effect on government expenditure and on the growth of the economy. In terms of the direction of causation, the results in Table 6. shows the national income granger cause government expenditure and not otherwise. Also, the results show unidirectional causality from national income to openness and inflation.

Table 5.: Error Correction Model

	Coefficient	Standard Error	T-Statistic	Significant	Result
ΔGES	0.0296	0.0594	0.4986	Not significant	Exogenous
ΔGDP	-0.0098	0.0507	-0.1875	Not significant	Exogenous
ΔOPEN	0.0668	0.0537	1.2439	Not significant	Exogenous
ΔINF	0.9248***	0.2153	4.2959	Significant	Endogenous

Note: *** denote significance at 1%
Source: Authors.

Table 6.: Granger-Causality Results based on VECM

Independent Variables				
Dependent Variables	χ^2 of lagged first differenced term [ρ -value]			
	ΔGES	ΔGDP	ΔOPEN	ΔINF
ΔGES	---	7.203*** (0.007)	2.719 (0.100)	1.384 (0.239)
ΔGDP	0.007 (0.935)	---	0.027 0.870)	0.752 (0.386)
ΔOPEN	0.045 (0.833)	4.223** (0.039)	---	1.987 (0.159)
ΔINF	0.801 (0.371)	3.011* (0.084)	0.808 (0.369)	---

Note: ***, ** and * denote significance level for 1%, 5% and 10% respectively. The figure in parenthesis represents the p-value
Source: Authors.

While error correction model can show the absolute endogeneity or exogeneity of a variable; it cannot give us the relative degree of endogeneity and exogeneity of a variable. To achieve the latter; we generate the variance decompositions of the variables. The results from Generalized VDCs are as shown in Table 7. The variable that is ranked higher is the leading variable, and therefore should be set as the immediate target by the policymakers. The results in Table 7. for the 10 -years horizon, GDP is the most exogenous. All through the 10-years horizon, own shock accounts for over 90 per cent. Inflation is shown to be the most endogenous as own shock peters out rapidly to reach 57.11 per cent in the 10^{th} period.

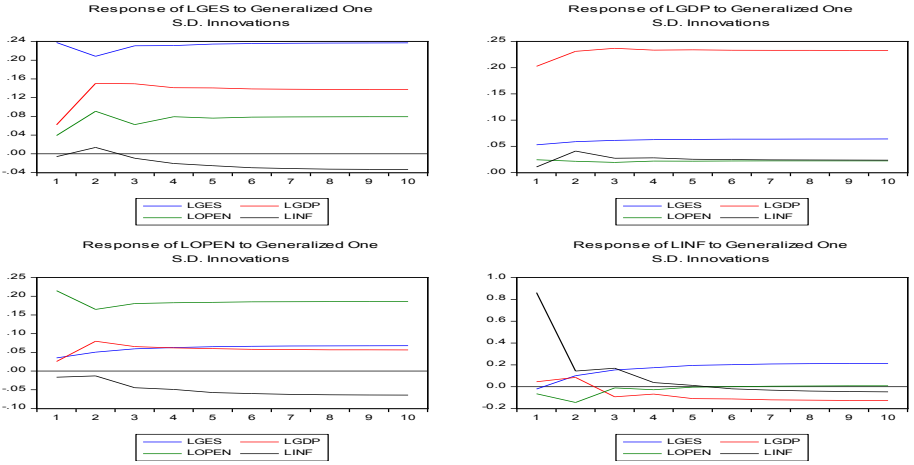
Table 7.: Variance Decompositions (VDCs)

LGES Period	LGES	LGDP	LOPEN	LINF
1	100.0000	0.000000	0.000000	0.000000
2	88.78236	8.781412	2.185496	0.250727
3	87.66912	10.55327	1.579756	0.197853
4	87.29101	10.74878	1.686946	0.273263
5	87.20065	10.75229	1.666701	0.380358
6	87.17504	10.62877	1.692683	0.503509
7	87.17960	10.49858	1.713447	0.608369
8	87.18783	10.37939	1.732784	0.699990
9	87.19920	10.27526	1.749547	0.775991
10	87.20945	10.18717	1.763664	0.839718
LGDP Period	LGES	LGDP	LOPEN	LINF
1	6.817214	93.18279	0.000000	0.000000
2	6.560591	92.55405	0.039266	0.846094
3	6.611315	92.64394	0.079775	0.664968
4	6.767703	92.54836	0.078700	0.605236
5	6.870957	92.50946	0.079922	0.539664
6	6.965927	92.46096	0.078859	0.494254
7	7.038196	92.42587	0.077828	0.458102
8	7.097387	92.39567	0.076835	0.430104
9	7.144948	92.37146	0.075952	0.407640
10	7.184048	92.35132	0.075199	0.389429
LOPEN Period	LGES	LGDP	LOPEN	LINF
1	2.694232	0.635394	96.67037	0.000000
2	4.933824	6.558275	88.48872	0.019184
3	6.479144	6.837161	85.70650	0.977192
4	7.509922	6.632767	84.19326	1.664049
5	8.244072	6.352319	82.98679	2.416824
6	8.781702	6.055533	82.15457	3.008196
7	9.184229	5.812929	81.50198	3.500862
8	9.496007	5.609191	80.99858	3.896223
9	9.741824	5.442849	80.59666	4.218664
10	9.940240	5.305284	80.27149	4.482983
LINF Period	LGES	LGDP	LOPEN	LINF
1	0.062498	0.372268	0.607918	98.95732
2	1.307356	0.799702	4.114096	93.77885
3	3.882307	2.891128	3.837434	89.38913
4	6.937994	4.228931	3.888506	84.94457
5	10.29684	6.743406	3.682401	79.27735
6	13.43608	9.047442	3.476965	74.03951
7	16.31824	11.33861	3.265084	69.07807
8	18.88354	13.41301	3.068051	64.63541
9	21.16198	15.29133	2.888350	60.65834
10	23.18268	16.97148	2.726509	57.11933

Source: Authors.

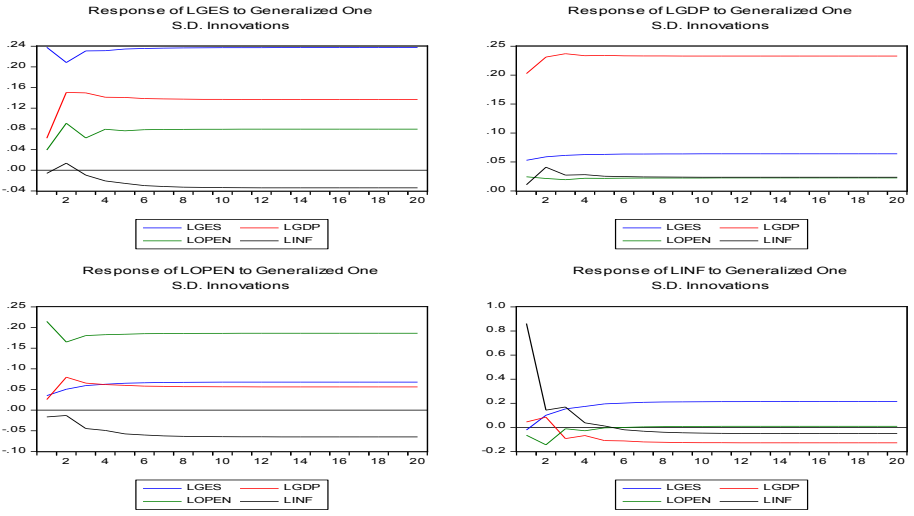
We proceed further to find the impact of shock of one variable on others and validate the degree of response and how long it would take to normalize using the Impulse Response functions (IRFs). Figure 5., 6. and 7. are the graph for the period 10, 20 and 30 years. As revealed in Figures 5., 6. and 7., a perturbation to the inflation variables generate a fast response from the three other exogenous variables.

Figure 5.: Impulse Response Functions (IRFs) results - 10 years



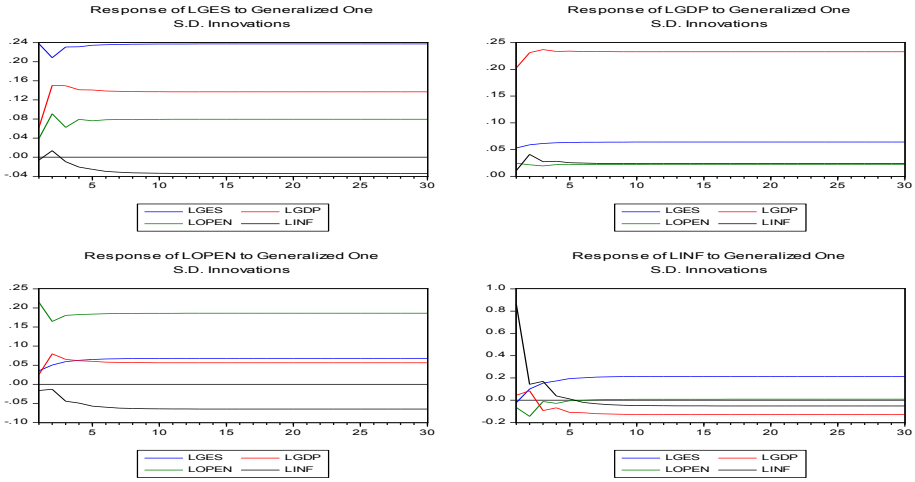
Source: Authors.

Figure 6. : Impulse Response Functions (IRFs) results - 20 years



Source: Authors.

Figure 7.: Impulse Response Functions (IRFs) results - 30 years



Source: Authors.

6. CONCLUSION

The paper examines the government expenditure-national income nexus in Nigeria over the period 1960 - 2012 using nonlinear ARDL and causality approaches. The paper employed the nonlinear ARDL cointegration developed by Shin et al. (2014) and test the causal relationship the variables by employing vector error correction model, variance decompositions and Impulse response functions techniques. The nonlinear ARDL result shows that government expenditure is cointegrated with economic growth. The results provide evidence in support of asymmetric fiscal adjustments, that is, government expenditure reacts differently to increase and decrease in national income in the long run. Specifically, in the long run, decline in national income growth (negative changes) has a larger reducing impact on government expenditure than the increase generated by positive economic growth. The results equally show that government expenditure is associated with both booms (positive growth) and recession (negative growth). The main implication of these findings is that government should ensure that the economy maintains positive growth in order to avoid reduction in government expenditure that is associated with economic downturn. In order to achieve this, government must diversify the economy from oil to agriculture and manufacturing. With the current heavy reliance on oil, the economy is prone to high revenue instability and recession with possible adverse effect on government expenditure.

Finally, the results showed a unidirectional causality running from that national income measured as GDP to government expenditure. Also, the study showed a unidirectional causality from national income to openness and inflation respectively.

The implication of the causality result is that policymakers should impact national income (GDP) to influence government expenditure. It also suggests that increase in government spending might not necessarily means inefficiency on the part of government as some economists have argued. In addition, effort at rolling back the government through rationalization of government spending might not necessarily have adverse effects on national income.

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HUMAN CAPITAL TRAJECTORY: PERFORMANCE OF ALBANIA AND SERBIA IN CATCHING UP THE EU COUNTRIES

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ABSTRACT

Purpose. *This paper focuses on the measurement of the human capital level in Albania, Serbia and European Countries and in identifying the gaps between them. In addition, it focuses on the link between human capital and the Gross Domestic Product (GDP), by extending the analyse in finding the gender disparity of human capital and GDP relationship. Lastly, this study estimates the growth rate of the human capital level for Albania and Serbia and make a comparison with the average human capital of the European Countries.*

Methodology. *The methodology used in the calculation of the growth rate of human capital is exponential trend method which makes possible the estimation of the years needed for Albania and Serbia to catch up the average of EU-28. The data employed mostly in the above-mentioned analysis is the data set taken from Barro and Lee (2010) corresponding the Educational Attainment Data from 1950 to 2010. For the estimation of the growth rate of the human capital level, additional data until 2015 have been used compiled from the UIS database and UN population database, respectively.*

Findings. *The findings show that Albania has a higher probability of an earlier convergence than the Serbia has. Even though the proxy of human capital for year 2010 for Albania (9.85), is lower than Serbia (10.97), Albania is experiencing a rapid increase in the average years of schooling.*

Limitations. *But again, the study is limited to data related to only the years of schooling without considering the quality of education and skills acquired.*

Originality. *This study can serve as a contributor to the performance examination of Albania and Serbia to the EU community with regard to human capital accumulation.*

1. INTRODUCTION

The current and potential candidate countries to join EU - Albania, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Kosovo, Montenegro and Serbia - are facing new challenges comparing to the previous EU candidates. One of the most important challenges remains the difficulty the Western Balkan (WB) countries are having in transition to democracy which is accompanied to economical distortions. WB countries are very often having reforms and structural changes creating loss in welfare, which means economical distortion. This transition could negatively affect various sectors, especially the education sector.

There are numerous studies examining the relationship between human capital and economic growth, as well as the strength and the direction of such relationship. Human capital accumulation serves as a pushing engine to economic growth. According to Lucas (1993), the main engine of growth is the accumulation of human capital -of knowledge-and the main source of differences in living standards among nations is differences in human capital. Empirical evidence strongly supports the theory too, adding that not only human capital positively affects the economic growth of a country, but the economic growth, in turn, positively influences the human capital.

Comparing the micro and macro studies, micro studies are found to be consistent with the finding that years of schooling, acquired skills, etc., tend to have higher probability to be employed and higher incomes. Whereas macro studies have suffered to be consistent and the findings have been controversy (Pritchett, 2001). Since literature review offers such controversies, the main aim of the paper is to explore the literature regarding the relationship among these two variables and the proxies used for human capital accumulation. Secondly, the study aims to compare the performance of WB countries with EU countries with regard to linkage of human capital with gender disparity and per capita GDP. Lastly, the study aims to estimate the years needed for Albania and Serbia in converging the EU level of capital accumulation.

This study focused on the two Western Balkan countries given the available of data starting from 1950. The time series dataset was essential for this study because growth rate calculations needed to be made. The paper is organized five section including introduction: Section 2 presents a literature review of the link between human capital accumulation and economic growth. Section 3 describes the human capital in Albania, Serbia and EU countries, including the gender disparity, and its relationship to per capita GDP. Section 4 estimates the number of years needed for Albania and Serbia to catch up the EU countries. Section 5 summarizes main findings and concluding remarks.

2. LITERATURE REVIEW

Since the 1960s, examining the link between human capital and economic growth using micro and macro theoretical and empirical approaches has been a great interest of scholars. From the microeconomic perspective, the level of education has a direct impact on the individual's income. Education increases the probability to be employed, the individual's labor productivity, skills' enhancement and the chance to fit the market needs. From the macroeconomic perspective, human capital is seen as the promoter of the economy. Education improves labour productivity, pushes the technology and innovation, increases returns to capital by supporting a sustainable economic growth. Madsen and Murtin, in 2017, found that the contribution of education in Britain has been equally important before and after the first industrial revolution. The empirical studies strongly support the fact that both, quantitative and qualitative education have positive effects on economic growth. Some of the key studies are being mentioned as below.

Although the definition of human capital is clear, measuring it still remains ambiguous, because it is hard to measure both the quantitative and qualitative education and it is much more difficult while trying to compare countries by using these measurements.

Different empirical studies have used different proxies of education in order to measure the impact of education on economic growth.

The main proxies of the education quantity founded in the literature review have been:

- Schooling enrolment ratios (Barro, 1991; Mankiw et al., 1992; Levine and Renelt, 1992),
- The average years of education/schooling (Barro and Lee, 1996, 2001 and 2010; Cohen and Soto, 2007; Hanushek and Woessmann, 2007; Krueger and Lindahl, 2001),
- Adult literacy rate (Azariadis and Drazen, 1990; Romer, 1990; Durlauf and Johnson, 1995),
- Education spending (Baldacci et al., 2008).

Most of these studies found a strong relationship between education quantity and economic growth and the education's positive effect on economic growth (Krueger and Lindahl, 2001; Temple, 1999). Education facilitates the spread of innovation, technological progress, so the economic growth and because of wealthy economies, countries can invest more and more in education. However, this relationship can exist just from one side; either the education pushes economic growth or economic growth pushes education. In a very few studies the link between these two variables is found to be weak or even negative (Islam, 1995; Bils and Klenow, 2000; Pritchett, 2001). In some other studies education quantity and economic growth are found to be totally unrelated (Benhabib and Spiegel, 1994). The main proxies of the educa-

tion quality in the literature review are founded to be: survival rates, repetition rates, student/teacher ratios, schooling life expectancy, trained teachers in primary education, and education test scores.

The empirical studies that have used the education quality to examine the relationship with the economic growth are found to be relatively rare compared to the usage of the education quantity in the identification of this relationship.

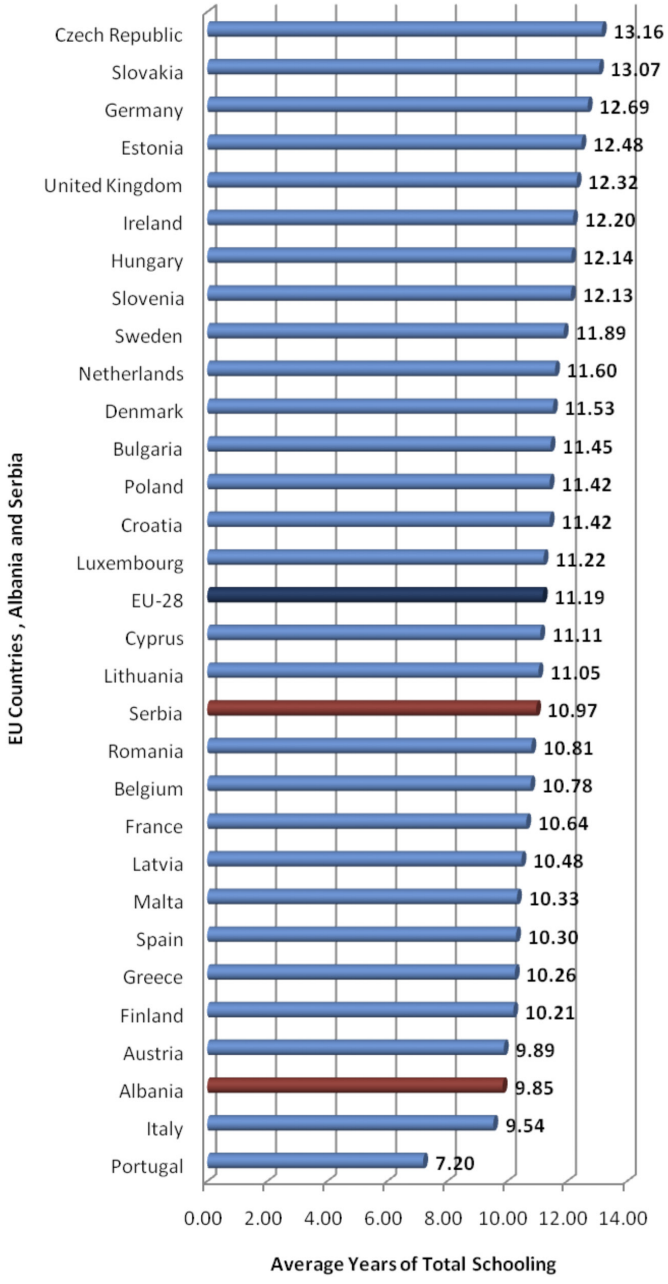
Barro (1990) has measured the schooling quality by using the data on student scores and he found a positive relationship between schooling quality and economic growth. Hanushek and Kim (1995), Hanushek and Kimko (2000), Hanushek and Woessmann (2007) in their study were focused on mathematical and sciences skills concluding that these skills have strong impact on economic growth.

3. HUMAN CAPITAL STOCK IN ALBANIA, SERBIA AND EUROPEAN COUNTRIES

Two different data sets were used to describe the stock of human capital in Albania, Serbia and European Countries. The first data set is the international comparable data from Barro and Lee (2010) covering all European Countries and just two countries from Western Balkans, Albania and Serbia for the time period 1950-2010. This data shows the average years of schooling among the population aged 25 years old and over. Meanwhile, the second data source is based on data set offered by Human Development Report of United Nations Development Program (2015). This data set covers some detailed records for the time period of 2005-2014 for all European Countries including Albania and Serbia. This data set also shows the average years of schooling among the population aged 25 years old and over.

Figure 1. presents average years of schooling for the EU member countries as well as Albania and Serbia. Moreover, EU-28 has been added to the list of these countries. EU-28 shows the average of all actual European Counties and it is used as a reference point for a comparison with Albania and Serbia.

Figure 1.: Average Years of Schooling in EU Countries, Albania and Serbia, 2010

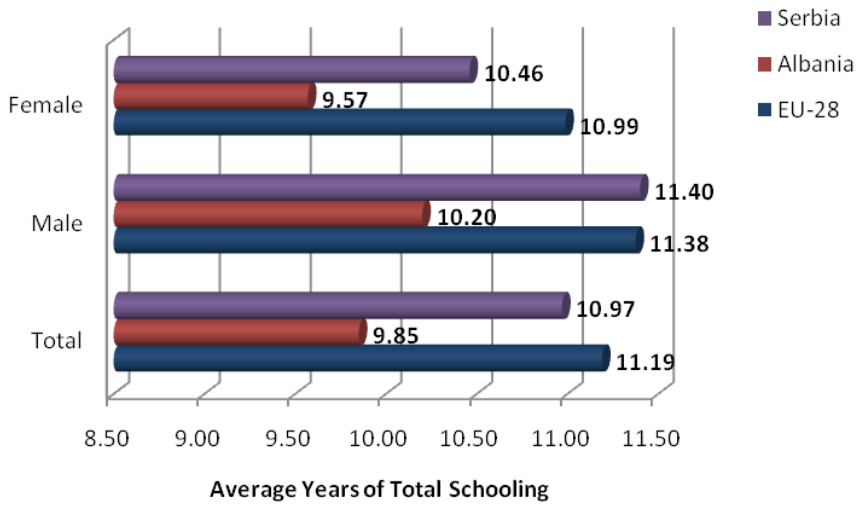


Source: Author's calculations based on Barro and Lee's (2010) data set.

The countries have been listed in descending order in terms of average years of schooling. Barro and Lee's dataset offers the average years of total schooling, whereas the value for EU-28 has been calculated by taking the average of all EU countries. The top five countries representing the highest average years of schooling are Czech Republic, Slovakia, Germany, Estonia and United Kingdom. Czech Republic is placed in the top list, having an average years of schooling per total of population equal to 13.16 and respectively 13.31 for males and 13.03 for females. Portugal and Italy are at the bottom of the list. Even though both Albania and Serbia show low level of average years of schooling comparing to the EU-28, Serbia appears just two countries below the EU average.

Figure 2. presents average years of schooling and gender disparity in EU-28, Albania, and Serbia. The gender disparity is defined as the ratio of females' and males' average years of schooling. In all of these three cases, the average years of schooling has been higher for male comparing to the female population. Even though the average years of schooling in Albania is lower comparing to both Serbia and EU-28, Albania shows a better performance in the gender disparity. Specifically, gender disparity is 0.97 in EU-28, 0.94 in Albania, 0.91 in Serbia.

Figure 2.: Average Years of Schooling and Gender Disparity in EU-28, Albania and Serbia, 2010

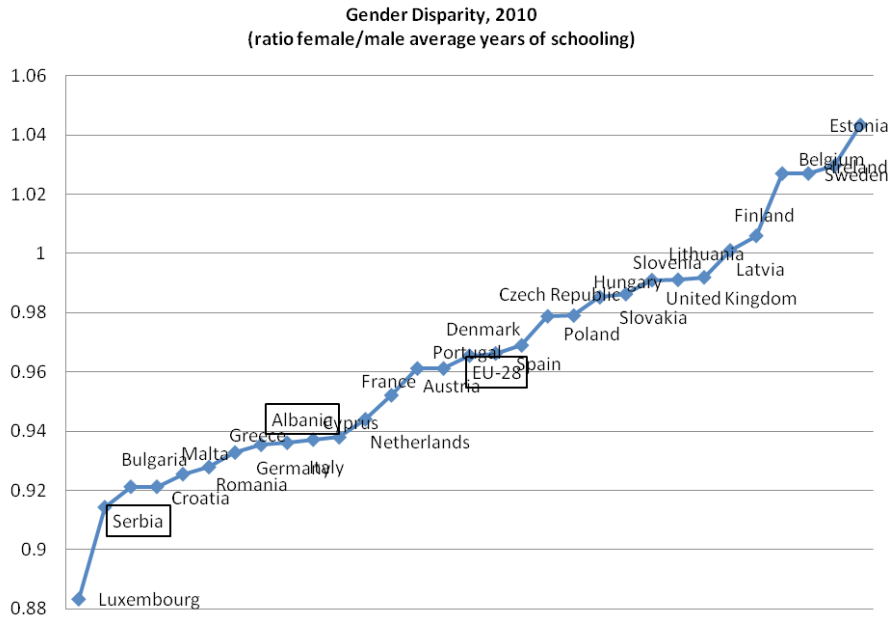


Source: Author's calculations based on Barro and Lee's (2010) data set.

Figure 3. presents gender disparity in each of the EU member countries (EU-28) as well as in Albania and Serbia. The countries have been arranged in ascending order in terms of gender disparity. A total of six countries are found to have a gender disparity greater than 1, which means that the female population has higher average years of schooling than male population. Estonia is the top country representing the

widest gap of about 1.04 between females and males regarding gender disparity. Other countries having females' education higher than males' one are: Ireland, Sweden, Belgium, Finland and Latvia. Meanwhile, the rest of the countries have relatively high average years of schooling for males comparing to females. The highest gender disparity is found to be in Luxemburg, showing a ratio of about 0.88. Regarding Albania and Serbia, even though Serbia has a higher average years of schooling comparing to Albania, Albania fairs better in terms of gender disparity. The gender disparity is 0.94 in Albania and 0.91 in Serbia whereas this ratio is around 0.97 for the EU-28.

Figure 3.: Gender Gap in Average Years of Schooling, 2010

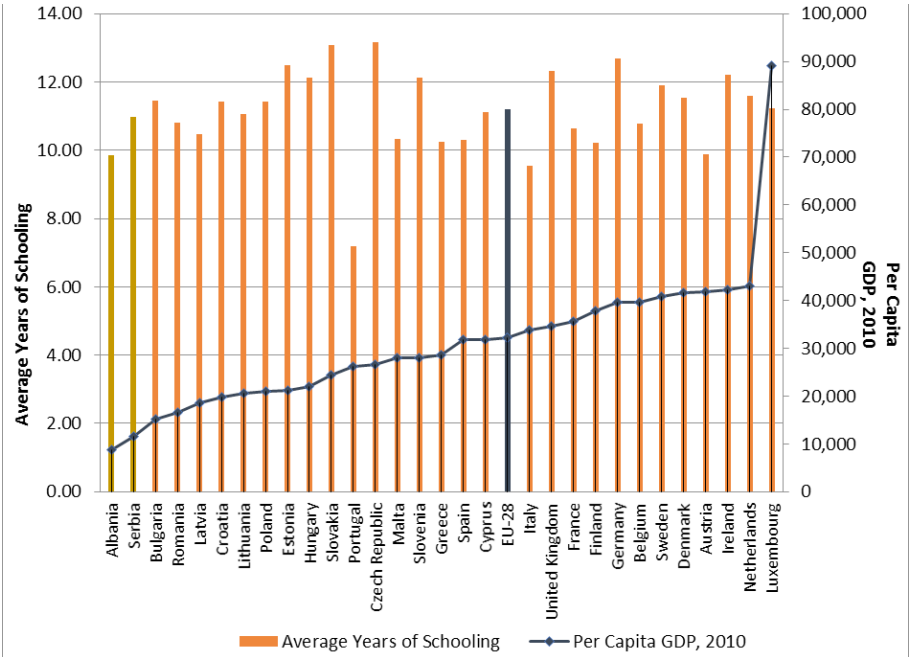


Source: Author's calculations based on Barro and Lee's (2010) data set.

The relationship between economic growth and human capital can be seen in Figure 4. The countries have been arranged in ascending order regarding their per capita gross domestic product (GDP). Figure 4. plots average years of schooling for each corresponding country. As expected and based on the previous works, gross domestic product should increase because of an increase of the education level. Contrary to the expectations, the trends of these two variables do not support this direct link. The reason of this result most probably is because the there are other important factors that influence the GDP. Dellink et al. (2017) also have come to some conclusion that countries such as Tanzania have more scope to boost economic growth by improving education levels than e.g. the United States (of course, in level terms, higher education levels still imply higher income levels, ceteris paribus).

Even though Albania and Serbia are the countries having the lowest per capita GDP, Serbia has been thriving in catching up the performance of most of the EU countries with regard to the average years of schooling. Within the group of the EU countries, Portugal and Luxemburg are listed as the outliers. Portugal, having a middle per capita GDP in the group of EU countries, has an average years of schooling of about 7.20. This is the lowest level of average years of schooling in EU zone. Portugal rests even behind the two WB countries, respectively Albania and Serbia. Meanwhile, Luxemburg represents the other extreme case. It has the highest per capita GDP in the EU, but the performance of average years of schooling is not in line with that of per capita GDP.

Figure 4.: Average Years of Schooling by Distribution of per capita GDP, 2010



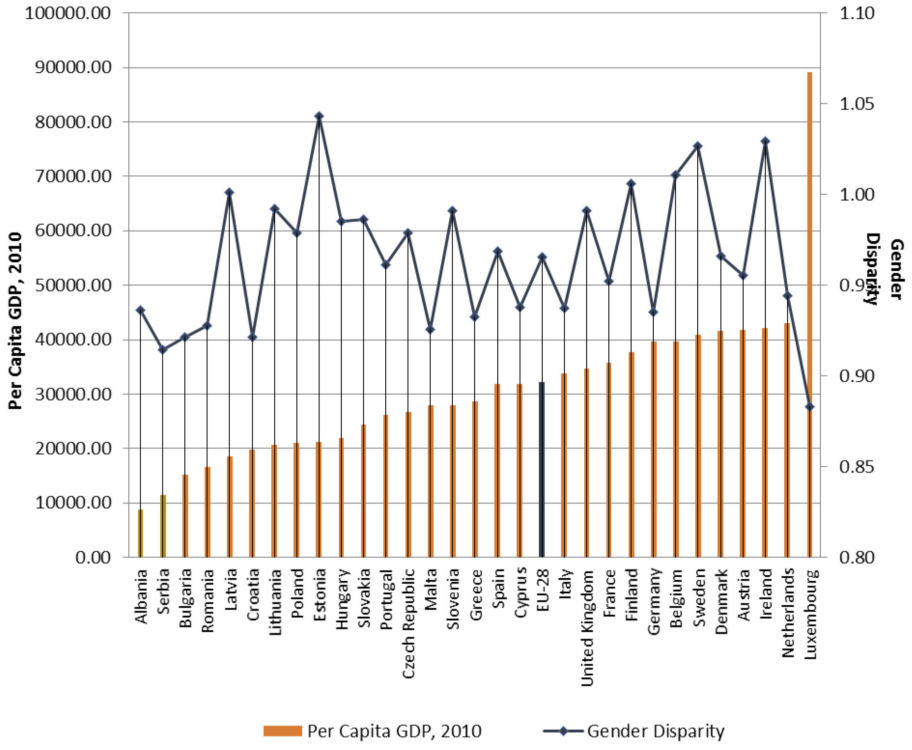
Source: Author's calculations based on Barro and Lee's (2010) data set.

Figure 5. depicts the relationship of economic growth and gender disparity. As in the previous chart, the countries have been arranged in ascending order regarding their per capita gross domestic product. Additionally, gender disparity has been plotted for each corresponding country. In the EU group, Latvia is the only country representing a gender disparity equal to one, even though it is the third country listed at the end regarding low level of per capita GDP in the European Union.

Luxemburg, Croatia, Greece and Malta show large gender disparities; males having higher average years of schooling females: 0.88, 0.92, 0.93 and 0.93, respec-

tively. Luxemburg, as seen at the previous figure, seems to have high per capita GDP but a significant gap between males' and females' education level. This finding appears to be contrary to the observation made by Klasen (2002), who indicated that gender disparity in education may slow down economic growth.

Figure 5.: Gender Disparity by Distribution of per capita GDP, 2010



Source: Author's calculations based on Barro and Lee's (2010) data set.

Whereas Estonia, Ireland, Belgium and Finland represent the countries that have a gender disparity greater than one (1.04, 1.03, 1.01 and 1.01, respectively), meaning that the females are more educated than males in terms of average years of schooling. Even in these cases, it is difficult to conclude that there is a direct relation between economic growth and gender disparity in education since these four countries have different per capita GDP.

On the other hand, although Serbia does better in the average years of schooling, Albania fairs better in terms of gender disparity. Albania has a gender disparity in education of about 0.94 in 2010, whereas Serbia has gender disparity in education of about 0.91.

4. ESTIMATED CONVERGENCE PERIOD OF ALBANIA AND SERBIA WITH EUROPEAN COUNTRIES

As indicated above, there is a gap between Western Balkan Countries such as Albania and Serbia and European Countries in terms of years of schooling. The aim of this section is to look at the possibility of convergence and estimate the time needed to close this gap. The exponential trend method was used to calculate the annual growth rate. Albania shows a higher growth rate, of about 2.8%, followed by Serbia and EU-28 with a growth rate of 1.7 and 1.4, respectively. These growth rates are found to be relatively high in the countries having a lower average years of schooling. This is consistent also the diminishing returns concept. Backward economies are at an advantage compared to rich countries because of diminishing returns to the accumulation of capital per head (Soukiazis, 2000). Gerschenkron (1962) was the first to present the idea that the poor countries imitate and rich countries innovate, naming this phenomena as " the advantages of relative backwardness". Elmslie and Milberg in 1996, further develop this phenomena by arguing that diminishing returns characteristics might also come from the services and education sectors. In this case too, the educational attainment is conform to the diminishing returns concept. Siljak and Nagy (2018) in their empirical study done for time interval 2004 - 2013 have found that the Western Balkan countries converge towards the EU-28 Member States in economic aspects.

Comparing growth rates, as expected, the females' growth rates are higher that males' growth rates. This is because females have fewer number of schooling years.

Table 1.: Annual Growth Rate in Years of Schooling, 1950-2010 (in percentage)

Countries	Total	Male	Female
EU-28	1.4	1.3	1.5
Albania	2.8	2.5	3.1
Serbia	1.7	1.3	2.1

Source: Author's calculations based on Barro and Lee's (2010) data set.

As noted in Table 1. and in Figure 5., countries with lower per capital GDP such as Albania, having a very low human capital in 1950s, (about 2.32), have made remarkable progress increasing years of schooling. Obviously, countries starting with high years of schooling find it more challenging to significantly further increase years of schooling, thus experiencing lower growth rates. Convergence in human capital can thus be expected because the time spent for schooling has an upper limit - people cannot study forever (Hyun H. Son, 2010).

Table 2.: Convergence Year to EU-28 based on Annual Growth Rate of Years of Schooling, Base Year 2017

Countries	Convergence Year	Years to catch up EU-28
Albania	2019	+2 years
Serbia	2021	+4 years

Source: Author's calculations based on Barro and Lee's (2010) data set, the UIS database and UN population database.

To estimate the time needed for the convergence, it is assumed that the countries will continue to have the same growth rate they have experienced in the last 60 years, as calculated in Table 1. However, during the years, as countries are experiencing increases in the years of schooling, the calculated real growth rates can be even lower. Therefore, the results found in Table 2. are better to be considered as the lower limit time needed to convergence of Albania and Serbia to EU-28. Table 2 show that Albania will need at least 2 more years to catch up the EU-28 level, whereas Serbia needs at least 4 years, seen its' low growth rate. The result seems to be surprising because Serbia is having higher average of years of schooling, but Albania is showing a rapider growth rate than Serbia.

5. CONCLUSIONS

Human capital is found to be one of the main inputs such as capital and land of Economic growth. Human capital, defined as education level (human capital refers to more than education level), which can include quantitative and/or qualitative indicators, essentially represents the production capacities of the people. Given the various proxies proposed to measure the human capital, this study uses the average years of schooling. This study used the data set (1950-2010) retrieved from Barro and Lee (2010) and for the years 2010-2015 from the UIS database and UN population database.

The research compared Albania and Serbia with the European Countries regarding human capital and the performance of these two countries in approaching their human capital level to the average of EU countries. Albania, having the lowest average years of schooling and the lowest GDP level, coupled with a lower gender disparity in education, is expected to have a higher growth rate of education. Assuming that the growth rate of education will continue to remain the same, the results show that Albania may catch up the average of EU countries education level by 2019. As for Serbia, the convergence may occur no earlier than 2021. Even though Serbia has a better performance in education level and GDP, its growth rate of education, approximately 1.7 percent, is lower than that of Albania. At the same time, the gender disparity in Serbia is found to be much higher than Albania but the females impact in this country's convergence to the average of EU countries will be much more significant.

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ANALYSIS OF CLASSIFICATION ALGORITHMS ON DIFFERENT DATASETS

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ABSTRACT

Purpose. *Data mining is the forthcoming research area to solve different problems and classification is one of main problem in the field of data mining. In this paper, we use two classification algorithms J48 and Sequential Minimal Optimization alias SMO of the Weka interface.*

Methodology. *It can be used for testing several datasets. The performance of J48 and Sequential Minimal Optimization has been analyzed to choose the better algorithm based on the conditions of the datasets. The datasets have been chosen from UCI Machine Learning Repository.*

Findings. *Algorithm J48 is based on C4.5 decision-based learning and algorithm Sequential Minimal Optimization uses the Support Vector Machine approach for classification of datasets. When comparing the performance of both algorithms we found Sequential Minimal Optimization is better algorithm in most of the cases.*

Originality. *This is the first implemented research work up to my knowledge, data sets classification problem handled in data mining using SMO with Weka interface.*

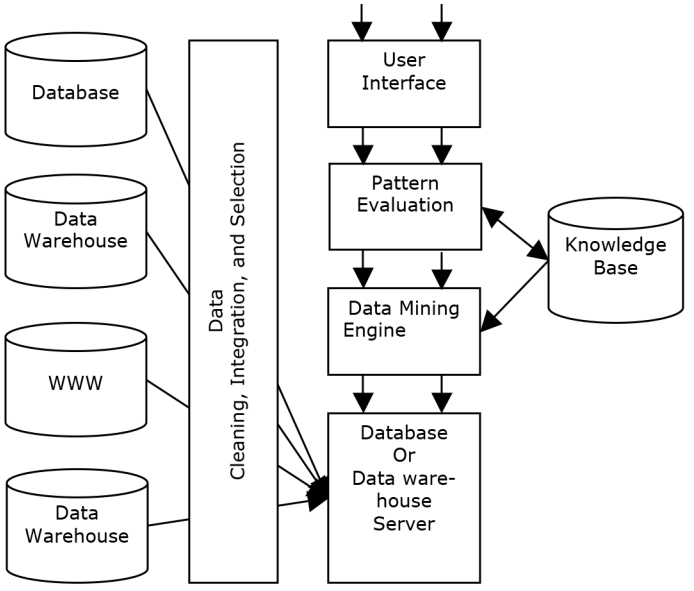
1. INTRODUCTION

Data mining is the process to pull out patterns from large datasets by joining methods from statistics and artificial intelligence with database management. It is an upcoming field in today world in much discipline. It has been accepted as technology growth and the need for efficient data analysis is required. The plan of data mining is not to give tight rules by analyzing the data set, it is used to guess with some certainty while only analyzing a small set of the data.

In recent times, data mining has been obtained a great attention in the knowledge and information industry due to the vast availability of large amounts of data and the forthcoming need for converting such data into meaningful information and knowledge. The data mining technology is one comprehensive application of technology item relying on the database technology, statistical analysis, artificial intelligence, and it has shown great commercial value and gradually to other profession penetration in the retail, insurance, telecommunication, power industries use (Haiyang, 2011).

The major components of the architecture for a typical data mining system are shown in Figure 1. (Han, 2006). Good system architecture will make possible the data mining system to make best use of the software environment. It achieves data mining tasks in an effective and proper way to exchange information with other systems which is adaptable to users with diverse requirements and change with time.

Figure 1.: Architecture of a Typical Data Mining System



Source: Authors.

2. RELATED WORK

Recently studies have been done on various performance of decision tree and on back propagation. Classification is a classical problem in machine learning and data mining (Agrawal, 1993). Decision trees are popular because they are practical and easy to understand. Rules can also be extracted from decision trees easily. Many algorithms, such as ID3 (Quinlan, 1986) and C4.5(Quinlan, 1993), have been devised for decision tree construction.

In (Bengio, 2000) neural networks are suitable in data-rich environments and are typically used for extracting embedded knowledge in the form of rules, quantitative evaluation of these rules, clustering, self-organization, classification and regression. They have an advantage, over other types of machine learning algorithms, for scaling. The use of neural networks in classification is not uncommon in machine learning community (Michie, 1994). In some cases, neural networks give a lower classification error rate than the decision trees but require longer learning time (Quinlan, 1994., Shavlik, 1991). A decision tree can be converted to a set of rules, each one corresponding to a tree branch. Algorithms have been proposed to learn directly sets of rules (Clark, 1989) or to simplify the set of rules corresponding to a decision tree (Quinlan, 1993). The alternating decision tree method (Freund, 1991) is a classification algorithm that tries to combine the interpretability of decision trees with the accuracy improvement obtained by boosting (Sharma, 2013).

Devendra Kumar Tiwari (2014), have comparatively tested four classification algorithms to find the optimum algorithm for classification. The Credit Card Approval dataset has been used for experimental purposes that contain 690 instances with 15 attributes and 1 class attribute to test and justify the differences among classification algorithms. Gupta (2016) explains the analysis of classification and clustering using some terms like Kappa Statistics, Mean Absolute Error, Confusion Matrix, Classification Accuracy correctly classified, incorrectly classified, root mean square error for different algorithms of classification and clustering. This paper considers the most extensively used tools, WEKA tool for this analysis purpose.

Kapur (2017) compared well performing classification algorithms such as Naïve Bayes, decision tree (J48), Random Forest, Naïve Bayes Multiple Nominal, K-star and IBk. Data that they have used is Student dataset and gauge students' potential based on various indicators like previous performances and in other cases their background to give a comparative account on what method is the best in achieving that end. They discussed about various statistical measure used to calculate the performance of each classifier. Neelamegam (2013) overview of several major kinds of classification method including decision tree, Bayesian networks, k-nearest neighbor classifier, Neural Network, Support vector machine are discussed.

Several major kinds of classification algorithms including C4.5, k-nearest neighbor classifier, Naive Bayes, SVM, and IB3 (Archana.S., 2013). This paper pro-

vides a general survey of different classification algorithms and their advantages and disadvantages.

In this paper, different kinds of classification techniques are discussed such as Association Rule Mining, Bayesian Classification, and Decision Tree Classification, nearest neighbor classifier, neural Networks and Support Vector Machine (Bharathi,2014).

3. METHODOLOGY

3.1. Datasets

Data pre-processing, classification, clustering, association, regression and feature selection these standard data mining tasks are supported by Weka. For classification purpose classify tab in Weka Explorer is used (Sudhir, 2013). Advantages of Weka tool:

- Available freely under the GNU General Public License.
- It is portable, as it is implemented in the Java programming language and thus runs on almost any platform.
- It is easy to use due to its graphical user interfaces.

There are four datasets we have used in our paper taken from UCI Machine Learning Repository (ml-repository). The details of each datasets are shown in Table 1.

Table 1.: Details of 4 datasets

Datasets	Instances	Attributes	No. of Classes	Type
Diabetes	768	9	2	Numeric
Iris	150	5	3	Numeric
Tic-Tac-Toe	958	10	2	Nominal
Yuta-Selection	265	26	2	Numeric

Source: Authors.

In the diabetes dataset (Weka) several constraints were placed on the selection of instances from a larger database. All patients here are females at least 21 years old of Pima Indian heritage.

In the iris dataset contains 3 classes of 150 instances each, where each class refers to a type of iris plant. One class is linearly separable from the other 2; the latter are NOT linearly separable from each other.

The tic-tac-toe dataset encodes the complete set of possible board configurations at the end of tic-tac-toe games, where "x" is assumed to have played first

The overview of all products by designer Takiro Yuta. Refine your Designer Takiro Yuta selection and filter the overview by product group, manufacturer or theme.

3.2. Weka interface

Weka (Waikato Environment for Knowledge Analysis) is a popular suite of machine learning software written in Java, developed at the University of Waikato, New Zealand (Witten, 2011). The Weka suite contains a collection of visualization tools and algorithms for data analysis and predictive modeling, together with graphical user interfaces for easy access to this functionality.

The original non-Java version of Weka was TCL/TK front-end software used to model algorithms implemented in other programming languages, plus data preprocessing utilities in C, and a Make file-based system for running machine learning experiments.

This Java-based version (Weka 3.7.7) is used in many different application areas, for educational purposes and research. There are various advantages of Weka:

- It is freely available under the GNU General Public License
- It is portable, since it is fully implemented in the Java programming language and thus runs on almost any architecture
- It is a huge collection of data preprocessing and modeling techniques
- It is easy to use due to its graphical user interface

Weka supports several standard data mining tasks, more specifically, data preprocessing, clustering, classification, regression, visualization, and feature selection. All techniques of Weka's software are predicated on the assumption that the data is available as a single flat file or relation, where each data point is described by a fixed number of attributes (normally, numeric or nominal attributes, but some other attribute types are also supported).

3.3. Classification algorithm J48

J48 algorithm of Weka software is a popular machine learning algorithm based upon J.R. Quilan C4.5 algorithm. All data to be examined will be of the categorical type and therefore continuous data will not be examined at this stage. The algorithm will however leave room for adaption to include this capability. The algorithm will be tested against C4.5 for verification purposes (Quinlan, 1993).

In Weka, the implementation of a learning algorithm is encapsulated in a class, and it may depend on other classes for some of its functionality. J48 class builds a C4.5 decision tree. Each time the Java virtual machine executes J48, it creates an instance of this class by allocating memory for building and storing a decision tree classifier. The algorithm, the classifier it builds, and a procedure for outputting the classifier is all part of that instantiation of the J48 class.

Larger programs are usually split into more than one class. The J48 class does not actually contain any code for building a decision tree. It includes references to instances of other classes that do most of the work. When there are several classes as in Weka software they become difficult to comprehend and navigate (Werbos, 1990).

3.4. Classification function Sequential Minimal Optimization

Sequential Minimal Optimization (SMO) is used for training a support vector classifier using polynomial or RBF kernels. It replaces all missing the values and transforms nominal attributes into binary ones. A single hidden layer neural network uses the same form of model as an SVM.

Training a Support Vector Machine (SVM) requires the solution of a very large quadratic programming (QP) optimization problem. SMO breaks this large QP problem into a series of smallest possible QP problems. These small QP problems are solved analytically, which avoids using a time-consuming numerical QP optimization as an inner loop.

The amount of memory required for SMO is linear in the training set size, which allows SMO to handle very large training sets. Because large matrix computation is avoided, SMO scales somewhere between linear and quadratic in the training set size for various test problems, while a standard projected conjugate gradient (PCG) chunking algorithm scales somewhere between linear and cubic in the training set size.

SMO's computation time is dominated by SVM evaluation; hence SMO is fastest for linear SVMs and sparse data sets. For the MNIST database, SMO is as fast as PCG chunking; while for the UCI Adult database and linear SVMs, SMO can be more than 1000 times faster than the PCG chunking algorithm.

4. RESULTS

For evaluating a classifier quality, we can use confusion matrix. Consider the algorithm J48 running on iris dataset in WEKA, for this dataset we obtain three classes then we have 3x3 confusion matrix. The number of correctly classified instances is the sum of diagonals in the matrix; all others are incorrectly classified. Let TPA be the number of true positives of class A, TPB be the number of true positives of class B and TPC be the number of true positives of class C. Then, TPA refers to the positive tuples that were correctly labeled by the classifier in first row-first column i.e. 49. Similarly, TPB refer to the positive tuples that were correctly labeled by the classifier in second row-second column i.e. 47. And, TPC refer to the positive tuples that were correctly labeled by the classifier in third row-third column i.e. 48 shown in Table 2.

Table 2.: Confusion matrix of three classes of Iris

		Predicted class			
		A	B	C	Total
Actual Class	A	49	1	0	50
	B	0	47	3	50
	C	0	2	48	50
	Total				150

Source: Authors.

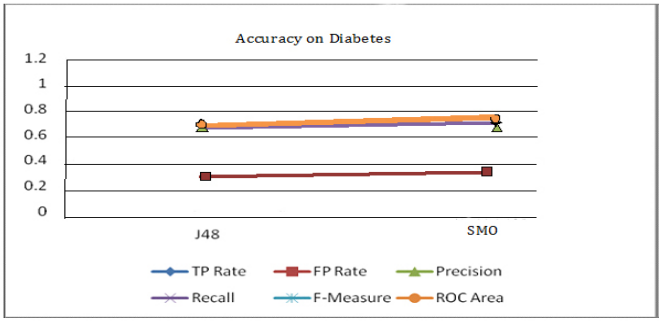
Accuracy = (TPA+TPB + TPC)/(Total number of classification)
i.e. Accuracy = (49+47+48)/150 = 96
The confusion matrix helps us to find the various evaluation measures like Accuracy, Recall, and Precision etc.

Table 3.: Accuracy on Diabetes

S.No	Parameter	J48	SMO
1	TP Rate	0.73	0.77
2	FP Rate	0.32	0.33
3	Precision	0.73	0.76
4	Recall	0.73	0.77
5	F-Measure	0.73	0.76
6	ROC Area	0.75	0.79

Source: Authors.

Figure 3.: Accuracy chart on Diabetes



Source: Authors.

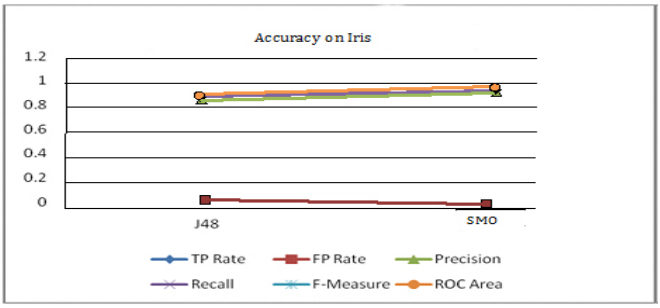
In diabetes dataset the accuracy parameters have shown in Table 3. and Figure 3. The above chart shows that it has almost equal accuracy measures except ROC Area measure in which SMO has higher accuracy on the diabetes dataset. So, SMO is better method for diabetes.

Table 4.: Accuracy on Iris

S.No	Parameter	J48	SMO
1	TP Rate	0.98	0.99
2	FP Rate	0.01	0.00
3	Precision	0.98	0.99
4	Recall	0.98	0.99
5	F-Measure	0.98	0.99
6	ROC Area	0.98	0.99

Source: Authors.

Figure 4.: Accuracy chart on Iris



Source: Authors.

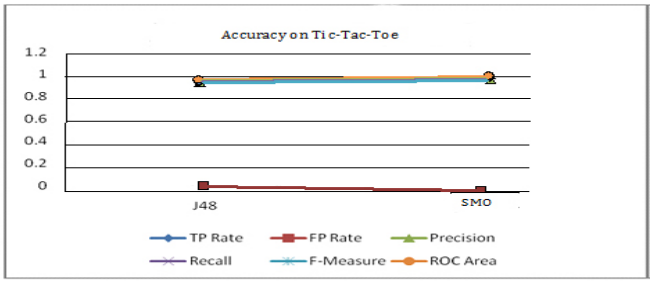
In iris dataset accuracy parameters have shown in Table 4. and Figure 4. Algorithm J48 having lower value than SMO. So, SMO is better method for iris dataset.

Table 5.: Accuracy on Tic-Tac-Toe

S.No	Parameter	J48	SMO
1	TP Rate	0.99	1
2	FP Rate	0.00	0
3	Precision	0.99	1
4	Recall	0.99	1
5	F-Measure	0.99	1
6	ROC Area	0.99	1

Source: Authors.

Figure 5.: Accuracy chart on Tic-Tac-Toe



Source: Authors.

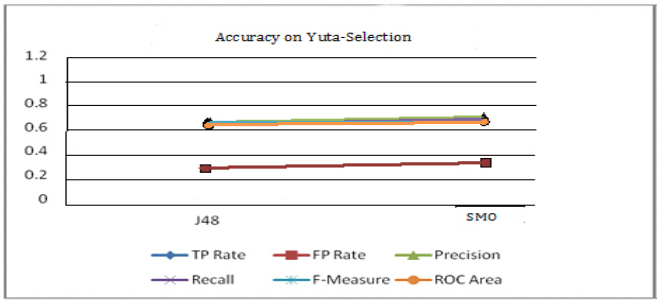
In tic-tac-toe dataset accuracy parameters have shown in Table 5. and Figure 5. The above chart shows that it has almost equal accuracy measures except ROC Area measure in which SMO has higher accuracy on the tic-tac-toe dataset. So, SMO is better method for tic-tac-toe dataset.

Table 6.: Accuracy on Yuta-Selection

S.No	Parameter	J48	SMO
1	TP Rate	0.67	0.68
2	FP Rate	0.36	0.43
3	Precision	0.67	0.69
4	Recall	0.67	0.68
5	F-Measure	0.67	0.65
6	ROC Area	0.65	0.66

Source: Authors.

Figure 6.: Accuracy chart on Yuta-Selection



Source: Authors.

In Yuta-Selection dataset accuracy parameters have shown in Table 6. and Figure 6. SMO has better accuracy measures except FP rate. So, SMO is better method for Yuta-Selection dataset.

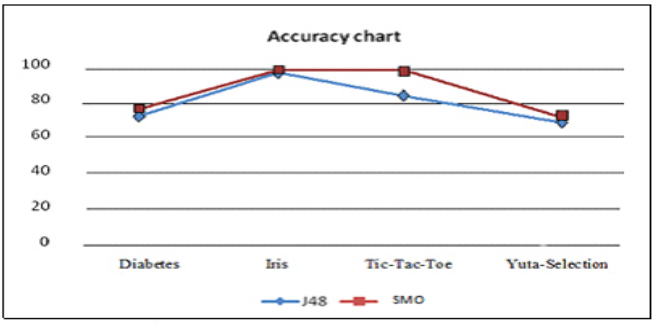
Table 8.: Accuracy measure of J48 and MLP

S.No	Datasets	J48	SMO
1	Diabetes	73.828	77.343
2	Iris	96	96
3	Tic-Tac-Toe	84.551	98.329
4	Yuta-Selection	67.924	68.679

Source: Authors.

From the values of Table 8 and the chart shown in Figure 8., the accuracy measures are calculated on J48 and SMO algorithms.

Figure 8: Accuracy chart of J48 and MLP



Source: Authors.

The J48 and SMO classification algorithm applies on all the datasets for accuracy measure. From the above chart in Figure 8. it is clear that SMO gives better results for almost 3 datasets and approximate equal accuracy for iris dataset. Hence, we can clearly say that SMO is better algorithm than J48 for the given 4 datasets.

5. CONCLUSION

In this paper, we evaluate the performance in terms of classification accuracy of J48 and Sequential Minimal Optimization algorithms using various accuracy measures like TP rate, FP rate, Precision, Recall, F-measure and ROC Area. Accuracy has been measured on each dataset. On diabetes, and tic-tac-toe datasets Sequential Minimal Optimization is clearly better algorithm. On iris and yuta-selection datasets accuracy is almost equal and Sequential Minimal Optimization is slightly better

algorithm. Thus, we found that Sequential Minimal Optimization is better algorithm in most of the cases. Generally neural networks have not been suited for data mining but from the above results we conclude that algorithm based on neural network has better learning capability hence suited for classification problems if learned properly.

6. FUTURE SCOPE

For the future work new algorithms from classification can be integrated and much more datasets should be taken or try to get the real dataset from the industry to have the actual impact of the performance of algorithms taken into consideration.

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BOOK REVIEW: CONTEMPORARY LABOR MARKET

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The book „Contemporary Labor Market" written by Marija Bušelić, PhD, was published by Juraj Dobrila University of Pula. The book represents a scientific work accessible to experts, students, but also to a wider circle of readers.

In today's society of knowledge, with human labor, knowledge and creativity being key drivers of all social and economic changes, the presented text is of special significance. Human labor formed as a meaningful action of people, impacting their environment in a way so that they could live, becomes the central space of economic activities and the foundation of a social reality. The book is possibly a continuation of an earlier work by the same author - Labor Market - A Theoretical Approach in a way that it is refreshed and supplemented with new and current areas and topics, which is particularly important in the complex area of research of the dynamic phenomenology of human labor.

The book has been published in today's world when scientific and professional literature is lacking written texts about this topic, especially those that cover these issues broadly and comprehensively, as it is done by the author of this book. With this book Bušelić confirms once more that she is a prominent scientist with excellent knowledge of opportunities and relationships within the domestic and international labor market. The methodical value of the book should also be highlighted, more precisely the way that the author has successfully introduced a depth of analysis of the studied phenomenon within the text.

At one point, the author explains complex fundamental theories in the field of labor economics, and then immediately, with incredible ease, actualizing the same theories and linking them to the latest phenomena and trends within the labor market. Apart from this skillful connection between theory and practice, the author successfully vertically links the international level - the conventions and recommendations of international organizations (ILO, United Nations declarations, OECD, IOM) with the Directives of the European council, the Recommendations of the European Commission, and the institutional and other frameworks of activities in the Republic of Croatia. This gains significance in today's world when one of the most important goals of sustainable development as defined by the United Nations is DECENT WORK - honest or dignified work, which this book contributes to through all the presented topics.

The author very skillfully structures the complex labor market issues over ten chapters, in which she shows all the most significant theoretical, legislative, practical and other aspects of human labor phenomenology by starting with a theoretical background, continuing by presenting the supply and demand on the labor market, and then defining the institutional framework of the labor market, concluding the first part of the book with the chapter about salary and its determination.

Although not explicitly separated, in the second part of the book the author describes two key negative phenomena present in today's labor market - discrimination and the types and measurement of unemployment. This represents a kind of crescendo of the entire work that "resolves" itself through the last two chapters

- Possibilities of reducing unemployment and Contemporary trends on the global labor market, through a positive message. By structuring the work in such a way, the author emphasizes the extraordinary importance of current occurrences related to human labor, together with its measurements, evaluation and other phenomena on the labor market that change the world dramatically today and shape the destinies of individuals, families, and even nations as a whole.

The 21st century is a time of change in the field of labor, occurring and changing through extraordinary dynamics. It is therefore necessary to observe labor and related phenomenon in a wider and interdisciplinary way.

We live in a time when the world polarizes, and the differences between people and communities deepen, among other things because of the eternal, more or less explicitly stated, written or silent struggles between employers and workers regarding the eternal theme of profits and wages, but also regarding other, fundamental human rights that arise from labor or are related to labor. Although the author addresses issues that are both difficult and related to the general social, demographic, and above all, political trends and phenomena she does not fall into ideology or an ideological debate in any segment of the text, but instead strongly relies on scientific principles.

It is interesting to note that the book does not end with the conclusion, allowing in such a way to the reader to make his own conclusion and to apply the knowledge within the area in which he/she lives and works in. Therefore, we consider this book a valuable contribution to be used not only by the scientists belonging to different scientific areas as well as students, but also practitioners, especially managers of all levels in companies and other organizations, experts, human resources managers, as well as the general reader, given that it is a topic that represents the basis of knowledge regarding human labor, as well as organizations and institutions related to labor, employment and unemployment. This also leads to the idea of introducing a segment dedicated to the human curriculum into the secondary and other vocational schools.

Furthermore the book in question, being a kind of manual of the most relevant scientific and professional knowledge, but also regarding labor related issues, labor market, employment, unemployment, etc., it can be also recommended to experts working in public and private institutions and organizations related to labor, trade unions, public services and similar organizations, such as, for example, agencies and employment agencies, social services, etc. The book is definitely a valuable contribution to the work of public sector officials of all levels, from the lowest to the highest, since familiarity with science and professional work is essential for making crucial decisions, especially concerning issues related to labor and employment rights.

The book starts with a Foreword, followed by the first chapter titled Concept and development of the labor market, in which the author discusses labor issues from the beginnings of its scientific study until now. The second chapter presents the theo-

retical approaches to the labor market, its historical analysis and the development of its theoretical studies, from the theory of a perfectly competitive labor market, the theories emerging in the era of an imperfect competitive environment in the market economy, with a particular reference to Keynes' theory, to the eradication of Keynesianism, created in the early 1970s. What follows is the description of neoliberal theories and post-Keynesians, together with a detailed description of key factors that have influenced this shift in the paradigm of the labor theory, but also the principles according to which a new economic policy should be developed, based on full employment and the elimination of unemployment and discrimination in the labor market. The third chapter describes labor market as an „inversion of the goods and services market" by analyzing in details job offers, with reference to individual job offers and the indifference curve, the effect of income and substitution, the household model (Becker's model), the elasticity of labor and other factors affecting labor supply such as wage level, education costs, but also the particularly current issue of migration. In describing labor demands particular attention has been dedicated to the analysis of short and long term demand, showing the optimal employment and demand for work in conditions of imperfect competition, as well as the elasticity of demand for labor. The fourth chapter shows core labor market institutions ranging from the global, European and national levels. The International Labor Organization has been described (ILO), the International Organization for Migration (IOM), and the emergence and functioning of trade unions from their beginnings to the present. This is followed by the description of other relevant organizations and bodies such as the Workers Council, the International Employers' Organization (IOE), the Economic and Social Council, Public Employment Offices, Employment Agencies and Labor Inspection. The fifth chapter describes the institutional framework of the labor market in the Republic of Croatia, giving an overview and a brief description of the most important provisions of labor law and labor relations law - the Labor Act, with reference to the Labor Code, the collective agreement and employment contract, the Employment Mediation Act and Unemployment Rights, with particular reference to the unemployment rights, the Occupational Safety Act, the Pension Insurance Act and the Health Insurance Act. The sixth chapter deals with wages as the dominant source of resources for workers and the associated factors affecting their level. When deciding on wages some of the key issues are the laws and other regulations, collective and individual labor contracts, salaries specified by labor regulations, with particular emphasizes being placed on the notion of adequate wages in relation to the Labor Act which prohibits any form of discrimination. This includes the definition of parts that represent the structure of the wages, the issue and the purpose of the minimum wage, the right to wages during a period when the person does not work, other material rights of the employed worker, such as cash receipts and receipts in kind, measures and activities for the protection of wages and severance pay in case of a termination of the employment contract that provides a detailed description of individual fac-

tors that have an impact on the formation of level of the wages. The seventh chapter deals with the forms of discrimination in the labor market and the related indicators of discrimination, the theories regarding discrimination on the labor market, the segmented labor markets, and specific names of individuals in relation to different collar colors according to their complexity, job characteristics and earnings. Since within the labor market there are many dimensions of discrimination, the role and importance of battling discrimination within the market is being emphasized. Because of the many dimensions of discrimination, it does not surprise that there are different indicators of discrimination and relating discrimination theories, among which the most relevant are Becker's model of discrimination, the market power model / monopsony model, statistics of discrimination and the pattern of accumulation. A segmented labor market involves the subdivision of the market on a primary and secondarily one due to the differences in wages, working conditions, career advancement and employment security.

The unemployment issue as one of the greatest social and economic problems has been addressed in the eighth chapter which is focused on the types and ways of measuring unemployment and the causes of unemployment by emphasizing its complexity. At the end of the chapter, the author defines the economic and socio-psychological consequences of unemployment, alluding to the role and importance of battling unemployment, which is being discussed in Chapter 9. The ninth chapter Possibilities of reducing unemployment presents a detailed overview of direct and indirect measures for battling unemployment, employment opportunities for problematically employable groups, self-employment as a way out from unemployment, flexible and contemporary forms of work, and finally the consequences of working within an informal economy. The last chapter titled Contemporary trends on the global labor market deals with the attitudes towards labor within the contemporary global labor market in terms of new jobs and the repeal of existing ones, the issue of guaranteed income, job allocation - outsourcing and the role and importance of the flexicurity policy. In addition to that the chapter deals with child labor issues, youth unemployment and very low earnings of employees, lifelong learning, and the mobility of people in the global labor market, world migration and asylees, brain drain and employment opportunities in the EU. The structure and scope of contemporary trends within the global labor market indicates that the author is excellently acquainted with contemporary global labor market issues.

It seems that today we live in era where all issues somehow gravitate around human labor and its values. It almost seems that the economy is becoming an economy of labor as well as of human knowledge and competences, with social changes being largely influenced by changes in labor. Therefore a question arises - is there a change in the paradigm of human labor as announced by Drucker with the division of work on blue and white collars (within the book the author describes this theory and supplements it with pink, gold and green collars)? Are the complexity and the

prominent dynamics of the phenomenology of human labor leading towards a new way of observing the phenomena and relationships characteristic for human labor? These issues are present throughout the book, making its contribution particularly important since it describes current and highly relevant topics such as discrimination, flexicurity, lifelong learning, outsourcing, and others.

For any author who would place himself in the position of writing a book on such a demanding, complex and dynamic subject such as human labor and the labor market, one of the key questions would probably be the selection of topics and the method to present them without leaving out fundamental theories and relevant knowledge on which labor theory is based, while at the same time updating the theme with the presentation of all relevant issues and areas that are present on the global, as well as on the European and national labor market "scene". We are convinced that Bušelić succeeded in that task entirely through her very specific and praise worthy contribution to the already published domestic and international scientific works dedicated to human labor. Furthermore, her work can serve as an incentive and basis for further research of a number of particular topics covered in this book.

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