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HIGHER EDUCATION AND ECONOMIC GROWTH: SWEDISH EVIDENCE FROM MULTIVARIATE FRAMEWORK

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Abstract. *In this article, we investigate the long and short term relationship between higher education and economic growth in multivariate framework for Sweden, for the period from 1971 to 2013, by using ARDL approach. Toda-Yamamoto procedures of Granger non-causality test were applied to detect the direction of causality in the relationship between economic growth and higher education. We found that unidirectional causality between higher education and real GDP per capita exists. This relationship is positive, but not mutually reinforcing.*

Key words: *education, economic growth, ARDL, Toda-Yamamoto, Sweden*

INTRODUCTION

In this research, the long term and causal relationships between higher education and economic growth in Sweden were investigated using ARDL co-integration and Toda Yamamoto causality test. The mutual interaction between higher education and economic growth was investigated in the presence of different variables, in the case of developed and developing countries, considering previous researches. Theory of endogenous growth suggests importance of the human capital as one of the main sources of the economic growth. Apart from theoretical aspects, numerous empirical studies have focused on the issue of education and economic growth. In that sense, great number of empirical researches used education level to measure the level of human capital. The positive impact of education on the economic growth is confirmed in a lot of studies (Barro 1991; Mankiw et al. 1992; Barro i Sala - Martin 1995; Hanushek i Kimko 2000, Zivengwa 2012, Hussin, et al 2012, Pegkas, 2014). Furthermore, De Meulemeester and Rochat (1995), analyzed the relationships between higher education and economic development for various developed countries using the Johansen co-integration and the Granger causality approach,. Their results show that there

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is unidirectional causality running from higher education to economic development for four countries: Sweden (1910-1986), UK (1919-1987), and France (1899-1986). Khorasgani (2009) demonstrates by using ARDL model that long and short-term relationship exists between higher education variable and economic growth of Iran. His results suggest that higher education had positive influence on the economic growth.

Katircioğlu et al. (2014) investigate the higher education-led growth hypothesis in the case of Northern Cyprus. They found that unidirectional causality from higher education to real income growth exists. There is also long-term equilibrium relationship between economic growth and higher education sector in Northern Cyprus. Narayan and Smyth (2006) analyzed the causality between real income, real investment and higher education for the Republic of China in the period of 1952-1999. The obtained results show evidence of co-integration when real investment is the dependent variable. Their findings suggest that tertiary education and economic growth have major role in propelling real investment. The interrelationship between higher education and economic growth has been subject of Danacica et al. (2010) research. The authors examined this relationship in Romania for the period 1980-2008 using the bivariate causality analysis,. Their results showed unidirectional causality running from GDP to higher education.

Huang et al. (2009) discovered that co-integration relationship exists between enrollment of higher education and actual GDP per capita in China for the period 1972-2007. Empirical result from this study reveals the long-term positive interaction. Lin (2004) investigates the effects of higher education on economic growth in Taiwan over the time period 1965–2000. Results reveal that higher education provided a positive and significant effect on Taiwan's economic growth. On the otherhand , increasing education at all levels, except tertiary has a significant effect on growth, according to Pereira and Aubyn (2009). Considering the higher education and growth performance of Pakistan, for the period 1980-2011, Wasim et al. (2014) discovered bidirectional causal relationship between these two variables. This result is in accordance with Asteriou and Agiomirgianakis (2001), Omojimite (2010) and Yakubu and Akanegbu (2015). The conducted empirical research in a number of countries around the world showed that the causal link between higher education and economic growth as a rule, should exist.

The rest of the paper is as follows: after the introduction, we present the methodology used, followed by the empirical results and causality test. Finally, the concluding observations include a brief discussion of the results.

1. Methodology

To test the relationship between economic growth and the observed variables, ARDL bounds testing approach was used (Pesaran et al., 2001). The advantages of this approach are reflected in the fact that it is not necessary to accurately identify the order of the underline series (Hsiao, 1997). This is an advantage, if we consider a standard co-integration analysis that requires classification variables of the same order of integration. In tests by ARDL model, the relation between the variables is possible regardless of whether the variables are I (1), I(0) or mixed order of integration. This approach is particularly suitable for a given sample, because it can be applied to the variables that have a different order of integration. The only previous requirement for applying ARDL testing approach is that no variable is of the order of integration I (2). This approach is extremely suitable for small sample data, because it can get reliable results. The following empirical model describes the relationship between economic growth (GDP), life expectancy (LEX), higher education (EDU) and health expenditure (HEC):

$$GDP_t = f\,(edu_t, lex_t, hec_t) \tag{1}$$

Table 1 Clemente–Montanes-Reyes structural breaks trended unit root test

Variable	At level			At first difference		
	T-statistic	TB1	TB2	T-statistic	TB1	TB2
LEX	-1.891 (3)	1979	1992	-7.567^{*} (4)	1975	1993
EDU	-4.503 (2)	1991	1997	-5.212^{***}(4)	1994	2003
LHEC	-5.829 (1)	1997	2004	-5.734^{**} (3)	1981	1993
LGDP	-3.956 (1)	1982	1996	-6.332^{*} (4)	1992	2006

Note: The *, ** and *** indicates significant at 5 and 10 % level respectively.
Lag length of variables are shown in small parenthesis.
Source: Author's calculation

In general, structural breaks test suggests that all variables have maximum order of integration of 1. Formatting Unrestricted Error Correction Modela (UECM) involves short run dynamics and the long run information based on ARDL testing approach. It can be expressed like this:

$$\begin{aligned}\Delta LnGDP_t &= \alpha_0 + \alpha_{GDP} LnGDP_{t-1} + \alpha_{LEX} LEX_{t-1} + \alpha_{EDU} EDU_{t-1} + \alpha_{LHEC} LnHEC_{t-1} \\ &+ \sum_{i=1}^{p} \alpha_i \Delta LnGDP_{t-i} + \sum_{j=1}^{q} \alpha_j \Delta LEX_{t-j} + \sum_{l=1}^{m} \alpha_l \Delta EDU_{t-l} + \sum_{z=1}^{n} \alpha_z \Delta LnHEC_{t-z} + \mu_1\end{aligned} \tag{2}$$

Co-integrating relationship among the variables in the equation is tested using the Wald Coefficient test. F-test for joint significance of the coefficients is performed to test the null hypothesis of no long term relationship between the variables against the alternative hypothesis of co-integration. It is as follows:

H_o: $\alpha_{lngdp} = \alpha_{lex} = \alpha_{lnhec} = \alpha_{edu} = 0$ (no co-integration);
H_a: $\alpha_{lngdp} \neq \alpha_{lex} \neq \alpha_{lnhec} \neq \alpha_{edu} \neq 0$ (co-integration);

In the case that the computed value of F statistics exceeds the upper critical bound, we need to establish long and short run models. There is also need to check the robustness of ARDL model through the diagnostic tests. It includes checking of normality (J-B test), serial correlation (LM test), heteroscedasticity (ARCH test) and the functional form of the model (Ramsey RESET test). It is also necessary to test the stability of the ARDL approach by applying the CUSUM and CUSUMsq tests.

For further verification of connection between observed variables, we employed Granger non-causality test. This is based on the alternative method proposed by Toda-Yamamoto (1995). In this procedure, the augmented VAR $_{(k+dmax)}$ system is based on Seemingly Unrelated Regression (SUR) at the level which improves the power of the Wald test (Rambaldi and Doran, 1996). The model is valid only if $k > d_{max}$ where k is the number of lags and d_{max} is the maximum order of integration among all time series. The advantage of this model is suitability of performance even when the order of the integration is mixed. There is no need for pre-testing of co-integration of the time series in order to obtain reliable results, which is another advantage of this model. The model can be specified as follows:

$$LnGDP_t = a_0 + \sum_{i=1}^{k+d\max} a_{1i}\ LnGDP_{t-i} + \sum_{i=1}^{k+d\max} b_{1i} EDU_{t-i} + e_{\ln gdp_t} \quad (3)$$

$$EDU_t = c_0 + \sum_{i=1}^{k+d\max} c_{1i}\ EDU_{t-i} + \sum_{i=1}^{k+d\max} d_{1i} LnGDP_{t-i} + e_{edu_t} \quad (4)$$

Where LnGDP and EDU are the variables, a_0 and c_0 are the constants a_{1i}, b_{1i}, c_{1i} and d_{1i} are parameters of the model and e_{lngdpt} and e_{edut} are the error terms with the distinction of white noise.

2. Data and Empirical Results

In this study, we employed annual data from two different sources. Data covers 1971-2013 period. The value of real GDP per capita was taken for the economic growth. Higher education is proxied by Gross enrollment rate, tertiary, both sexes (%). These two variables were taken from the World Development Indicators available online (World Bank). We used health expenditure per capita and life expectancy from OECD Health Statistics.

Table 2 The Results of ARDL Co-integration Test

Panel I: Bounds testing to co-integration		
Estimated models	F_{gdp}(LnGDP/LnHEC,LEX, EDU)	
Optimal lag structure	(4,4,5,3)	
F statistics	4.833**	
Significant level - Critical values (T=43)		
	Lower bounds	Upper bounds
1% level	4.983	6.423
5% level	3.535	4.733
10% level	2.893	3.983
Panel II: Diagnostic tests		
R^2	0.750	
Adjusted-R^2	0.439	
Breusch-Godfrey LM test	3.170(0.073)	
Jarque-Bera normality test	0.691(0.707)	
ARCH test for heteroscedasticity	3.466(0.071)	
RAMSEY reset test	0.953(0.344)	

Note: Asymptotic critical values are obtained from Narayan (2005);
the bounds test: case III: unrestricted intercept and no trend.
The ** indicates significant at 5 % level, respectively.
Source: Author's calculation

ARDL procedure requires appropriate lag to calculate F statistics. The lag length is selected by using Akaike information criteria. In the next step, the calculation of F statistics should reveal whether there is co-integration among economic growth, education, healthcare expenditures and life expectancy. We have used critical bounds provided by Narayan (2005) which are more suitable for small sample data (between 30 and 80 observations). Our empirical evidence reveals that upper critical bound is less than calculating F statistics at 5% level. This implies co-integration confirming long run relationship between the observed variables. Post-estimation diagnostics confirms the robustness of the model. Jarque-Bera normality test reports that the estimated residuals are normally distributed. Also, there is no heteroscedasticity problem and residuals are not serially correlated. The functional form of the model is well specified.

Table 3 Long and short run results

Long run analysis - Dependent variable LnGDP		
Variable	Coefficient	t-statistic
C	5.22	4.91
LnHEC	-0.011	-0.204
LEX	0.066	3.806
EDU	0.002	3.012
Short run analysis - Dependent variable ΔLnGDP		
C	0.015	0.744
ΔLnHEC	0.054	0.429
ΔLEX	0.074	0.839
ΔEDU	0.002	1.656
ECM(-1)	-0.987	-2.841
Short run diagnostic test		
R^2	0,606	
Adjusted- R^2	0.235	
F-statistics	1.632	
	Statistic	Prob. value
Breusch-Godfrey LM test	1.884	0.184
Jarque-Bera normality test	1.796	0.202
ARCH test for heteroscedasticity	2.880	0.099
RAMSEY reset test	2.756	0.093

Source: Author's calculation

Based on the results, it can be noted that a 1% increase in higher education is linked with an increase in GDP by 0.002%, considering the long run elasticity and keeping all other things constant. The coefficient of the error correction term, $ECM_{(-1)}$ shows the speed of equilibrium adjustment from short to long run. This is confirmation of the integrity of the long termrelationship (Bannerjee et al., 1998). It is statistically significant and negative. The value of $ECM_{(-1)}$ implies that the economic growth is corrected from the short to long run equilibrium almost perfectly by 98%. Sensitivity analysis shows satisfactory results which are shown in lower segment of Table 3.

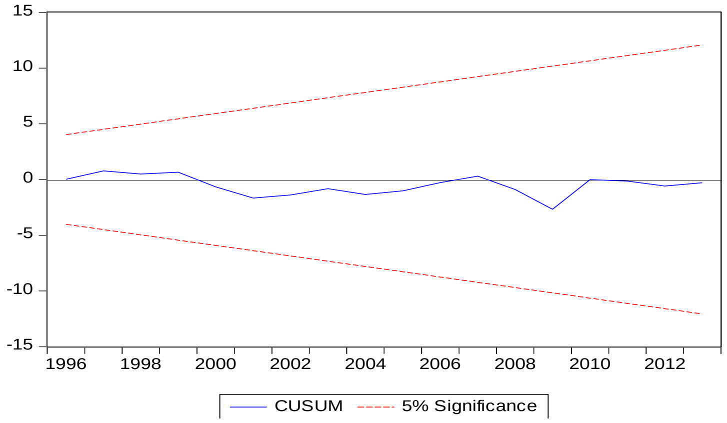

Fig. 1 CUSUM test

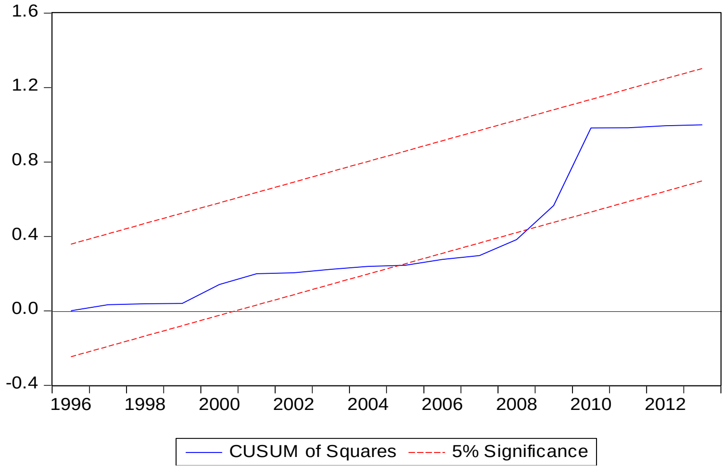

Fig. 2 CUSUM of Squares
Source: Author's calculation

Short term stability is investigated by CUSUM and CUSUMsq tests. According to the CUSUMsq test, the plots fall outside the critical bands at the 5 % level. This means possible instability of the parameters and it happens around the year 2004. We also examine significance and check for structural break in the data using Chow test which is more reliable than graphs. Plots of graphs often tend to present dissimilar and misleading results (Leow, 2004). Chow test does not indicate any significant structural break, because the p-value of the F-statistics is more than 0.05, so the null hypothesis is not rejected. In other words, ARDL estimates are efficient.

Table 4 Chow forecast test

Forecast period	F-statistics	Probability of F-statistics
2004 - 2013	2.790	0.079

Source: Author's calculation

3. Causality test

Since the focus of our attention is the relationship of the higher education and GDP, for further testing and verification of the relation between these two variables the causality test procedure is used. Before the access to testing by Toda Yamamoto procedure, it is necessary to make a minimum diagnostics of the model. According to the test results, The VAR model is stable (stationary) because all the roots are within the unit circle. VAR Residual Normality tests satisfies the null hypothesis that residuals are multivariate normal with p-value (0.3497). The test of serial correlation is also with adequate p-value (0.8525). Finally, we conduct the test of causality. Test results of the Toda-Yamamoto model are shown in the Table 5. The null hypothesis that the higher education does not cause GDP is rejected, which means that there is a causal relation in Granger terms from the direction of higher education to the economic growth, at the 10 % level, respectively. Otherwise, the results indicate that there is no unidirectional causal relation that goes from the direction of economic growth to higher education based on the results of the testing. Results of the analysis indicate the existence of the unidirectional causality.

Table 5 Results of the Granger Non-Causality Test

Null Hypothesis	Chi-square	df	Probability
EDU does not Granger cause GDP	9.49	5	0.09
GDP does not Granger cause EDU	5.72	5	0.33

Source: Author's calculation

Conclusion

This paper examines the co-integration and causal relationship between higher education and real GDP in Sweden within a multivariate framework that includes healthcare expenditure and life expectancy during the time period 1971-2013. The specified speed of adjustment to long-term equilibrium is very high and unidirectional relationship has been determined. Multivariate co-integration analysis provided in the paper shows that co-integration exists in the relations which include real GDP, healthcare expenditure, life expectancy and higher education. A unidirectional causality is found that runs from higher education to real GDP per capita. Considering the future research, it may be interesting to explore the multivariate causality between the observed variables and economic growth in comparison with other EU member states.

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VISOKO OBRAZOVANJE I EKONOMSKI RAST: MULTIVARIJANTNI OKVIR NA PRIMERU ŠVEDSKE

U ovom radu, ispitujemo kratkoročnu i dugoročnu povezanost visokog obrazovanja i ekonomskog rasta na primeru ekonomije Švedske koristeći multivarijantni pristup u periodu 1971-2013, primenom ARDL metoda. Toda-Yamamoto procedura Grendžerove neuzročnosti je primenjena za ispitivanje pravca kauzalnosti varijabli ekonomskog rasta i visokog obrazovanja. Rezultati su potvrdili jednosmernu uzročnost visokog obrazovanja i bruto domaćeg proizvoda po glavi stanovnika. Ova veza je pozitivna, ali se uzajamno ne pojačava.

Ključne reči: *visoko obrazovanje, ekonomski rast, ARDL, Toda-Yamamoto, Švedska*