DOI: 10.7251/EMC1902298N
Datum prijema rada: 5. oktobar 2019.
Datum prihvatanja rada: 12. decembar 2019.

UDK: 339.564:338.124.2(439)
Časopis za ekonomiju i tržišne komunikacije

Godina **IX** • broj **II**
str. 298-310

ORIGINALNI NAUČNI RAD / ORIGINAL SCIENTIFIC PAPER

NONLINEAR ADJUSTMENTS IN THE EXPORT-LED GROWTH HYPOTHESIS: RE-EXAMINING THE HUNGARIAN CASE

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Abstract: *This paper aims to examine the non-linear adjustments between exports and gross domestic product (GDP) in Hungary. In order to test the export-led growth hypothesis in the Hungarian economy this research analyses data from 1996Q1-2016Q4. Applying relatively novel approach to export-led growth hypothesis likely nonlinear asymmetric effect of exports and GDP toward their long-run equilibrium is tested. The results disclose a threshold cointegrating connection between the selected variables providing more insights into export led growth hypothesis. Unlike previous studies, research results reveal unidirectional and bidirectional causality in the long-run Hungarian exports-growth nexus which depends on the regime process with significantly different error correction adjustments in normal and stress regimes. Exports is found to be an engine of economic growth in Hungary for entire period but in times of stress when domestic demand contracts the role of exports in economic growth becomes more prominent and takes the basic form of export led growth hypothesis. Empirical results in this paper clearly points that threshold cointegration approach offers deeper insights than the linear error-correction model and might be the proper model specification to examine export led growth hypothesis.*

Keywords: *export-led growth, Hungary, time series analysis, threshold vector error correction*

JEL Classifcation: *C01; C34; F1; F4*

INTRODUCTION

Exporting performance of the country and its effects on the economic wellbeing has been in the focus of scholars since the age of mercantilism. Importance of export as one of the key factors in stimulating economic growth is based in the foundations of classical trade theories (Franc, 2017). Since exporting has been recognized as an important driver of growth many countries already included various incentives in their national strategies (Bilas, Šupuković, 2017).

Development of quantitative methods resulted in numerous empirical evidence from many countries, emphasizing country specific differences and conditioned interconnections between exports and economic growth making this topic interesting and challenging. Additionally, globalization process and other changes in the economic environment of the country make this issue evergreen. Literature examining export-led growth hypothesis mostly relies on the linear models. On the other hand economic theory points that the assumption of linearity may not hold. The reason behind might be the transaction costs, interventions in macroeconomic policy after the economy reach some point being considered as a critical or just the asymmetric pattern behavior of the variables under concern. Example of nonlinear models application can be found in Chevallier (2011). Furthermore, nonlinearities might be speciously prominent in examining the relationship between small open economy and rest of the world like the case presented in this paper. Therefore, this research moves ahead in this direction and also provides the case of the export-led growth in Hungary.

This paper is divided in six sections. Second section of the paper offers systemic overview of the existing literature on the export-led growth hypothesis. Third section of the paper explains research data and empirical strategy. Fourth section of the paper presents matching methodology. Fifth section of the paper describes research results enclosing short discussion. The final section delivers an overview of the main conclusions of the following research.

BRIEF RELATED LITERATURE OVERVIEW

Trošt and Bojnec (2016) using Johansen cointegration test and Granger causality test were used to explore the export-led growth hypothesis in two candidates, open and export-oriented economies: Estonia and Slovenia. The results indicated arguments to support the export-led growth hypothesis in Estonia and Slovenia both. Relationship between export growth and economic (GDP) was confirmed for both countries. Sampathkumar and Rajeshkumar (2016) examined the relationship between export and economic growth on the South Asian Association-for Regional Cooperation (SAARC) member countries. The results out of linear cointegration and Granger Causality tests revealed that there is unidirectional causation from the economic growth to export for Bangladesh and India while bidirectional causation was found for Afghanistan and Sri Lanka and no causation was obtained for Bhutan, Maldives, Nepal and Pakistan. Bilas et al. (2015) applied Granger Causality tests and using Engle Granger linear error correction

established and confirmed unidirectional causality from exports to growth in Croatia. Chia (2016) applied generation panel data approach such as panel unit root, panel cointegration, Fully Modified OLS (FMOLS) and Dynamic Ordinary Least Square (DOLS) to test the export-led growth hypothesis in selected Sub-Saharan African (SSA) countries for the period from 1985-2014 and results proved that export-oriented growth strategy is valid in the SSA countries. Zahonogo (2016) by means of pooled mean group estimates for 42 sub-Saharan African countries suggests that trade openness may positively impact growth in the long run but the effect is not linear and the trade openness has a positive and significant effect on economic growth only up to a certain level of trade openness (threshold effect), above which the effect declines. Pop-Silaghi (2009) has found growth led exports but no export led growth pattern in Hungary. Dreger and Herzer (2013) applied cross-sectional regressions for a sample of 45 developing countries and found that cross-country differences in the long-run effect of exports on the non-export GDP are significantly negatively related to cross-country differences in primary export dependence and business and labor market regulation. Furthermore, they found no significant association between the growth effect of exports and the capacity of a country to absorb new knowledge. Al-Assaf and Al-Abdulrazag (2015) applied the autoregressive distributed lag model (ARDL) to cointegration approach and confirmed the export led growth pattern for Jordan. Empirical literature directed towards examining export-led growth hypothesis that relies on varieties of linear model specifications is extremely large and ongoing (Narayan, 2007; Tsegaye, 2015; Malhotra and Kumari, 2016; Gatawa and Dalhatu, 2017). Ongan and Demiroz (2005) examined the relationship between tourism and growth. Nevertheless some papers were found to tackle nonlinear effects in a variable. Foster (2007) accommodates the threshold regression analysis on African economies and claimed that reaching either certain level of development or exporting is not a prerequisite for export-led hypothesis to hold. Nevertheless the connection is more intense for countries with higher export growth. Leyaro (2015) tested for a threshold in inequality for the effect of exports on growth on a panel data of 100 countries (including Hungary) over 30 years (1980 to 2010) and applied standard econometric techniques and the Hansen (2000) endogenous threshold regression technique that located the thresholds in income inequality. Leyaro (2015) found that, though trade openness supports economic growth, the relatively high income inequality reduces economic growth. Seabra and Galimberti (2012) accommodated threshold regression technique on a panel data, covering sample of 72 countries and two sub-samples over the period from 1974 to 2003, focusing on conditioning effects from countries initial level of GDP per worker, human capital stock,

and exports share in GDP. Seabra and Galimberti (2012) confirm the export-led growth hypothesis pointing out that the relationship between exports and growth was found to be not as trivial as linear specifications would indicate. Bošnjak et al. (2018) examined the nonlinearity regarding the adjustment of exports and GDP in Croatia. Results revealed threshold cointegrating relationship with regime dependence. Export-led growth was confirmed only for extreme regime reflecting the influence of tourism and its seasonal effect.

EMPIRICAL STRATEGY AND DATA SELECTION

Testing of the research hypothesis is based on the quarterly data of exports and gross domestic product in the period 1996Q1 – 2016Q2 gathered from the Hungarian Bureau of Statistics. Time series of the original data is shown in the appendix (Table 6). In order to avoid the problem of seasonality data is adjusted by X-13-ARIMA and provided in natural logarithm values (see Appendix, Figure 1).

First step in any time series analysis is a stationarity diagnostics since economic time series often exhibit non-stationarity properties. Stationarity of time series is tested by traditional unit root diagnostics (ADF, PP, KPSS). Additionally in order to avoid spurious regression results time series are tested by unit root test provided by Zivot and Andrews (1992). According to linear Johansen (1995) cointegration test results confirm the bivariate long-term relationship for exports and gross domestic product. Furthermore following Johansen (1988, 1991) and Johansen and Juselius (1990) vector error correction model (VECM) is being estimated. Linear VECM modelling assumes that the speed of correction to equilibrium level is independent of time. Nevertheless it is possible for the adjustment to happen only when a certain threshold is reached and therefore linearity relationship does not hold (Balke and Fomby, 1997). With the same premise for export-led growth hypothesis calculations use test robust for threshold and non-stationarity relying on the error correction dependent on threshold. Finally, estimates are calculated for threshold cointegration of exports and GDP in Hungarian economy with regime switching properties dependent on error correction size (Hansen & Seo, 2002).

METHODOLOGY

Procedure is adjusted according to study by Bosnjak (2018). In the case of two or more underlying time series having a long-run stochastic trend first step is to estimate VECM. VECM model with two time series of which both are integrated of the same order is noted by the expression (1):

$$\Delta x_t = Z' X_{t-1}(\beta) + u_t \quad (1)$$

Where:

$x_t - n$ - dimensional I(1) cointegrated time series with n x 1 cointegrating vector β

Z - coefficient matrix m x n | m = n + 2

$(X_{t-1}(\beta))$ - regressor and a m x 1 matrix given by the expression (2):

$$X_{t-1}(\beta) = [1 \quad w_{t-1}(\beta)\, \Delta x_{t-1} \cdots \Delta x_{t-l}]' \quad (2)$$

$w_{t-1}(\beta) = \beta' x_{t-1}$ - stationary error correction term

u_t - vector martingale difference sequence with finite covariance matrix

as presented in following expression (3):

$$\sum = E(u_t u_t') \quad (3)$$

Hansen and Seo (2002) threshold cointegration model is presented by expression (4):

$$\Delta x_t = \begin{cases} Z_1' x_{t-1}(\beta) + u_t, w_{t-1}(\beta) \leq \gamma \\ Z_2' x_{t-1}(\beta) + u_t, w_{t-1}(\beta) > \gamma \end{cases} \quad (4)$$

Where:

Z_1 and Z_2 – coefficient matrices for different regimes

x_t - n - dimensional I(1) cointegrated time series with n x 1 cointegrating vector β

$w_{t-1}(\beta) = \beta' x_{t-1}$ - stationary error correction term

γ – threshold parameter

This research examines bivariate ($n = 2$) relationship of exports and gross domestic product in Hungary $\Delta x_t = [\Delta \log(EXP) \quad \Delta \log(GDP)]$

Coefficients in expression (4) except β are allowed to alternate between the regimes. If condition of $0 < P(w_{t-1}(\beta) \leq \gamma) < 1$ is satisfied threshold effect has content and if not there is linear cointegration. Assumption is that $\pi_0 < P(w_{t-1}(\beta) \leq \gamma) < 1 - \pi_0$ where π_0 is triming parameter set to 0.05. To maintain the assumption that the residuals are independent and identically distributed maximum likelihood (ML) is applied to obtain the model estimation. Using Hansen and Seo (2002) exports and gross domestic product are tested for the presence of linear against threshold cointegration

$$SupLM = \sup_{\gamma_L < \gamma < \gamma_U} LM(\tilde{\beta}, \gamma) \quad (5)$$

While $[\gamma_L, \gamma_U]$ present the search region where γ_L is the π_0 percentile of $\tilde{w}_{t-1}$ and γ_U is the $(1 - \pi_0)$ percentile. According to Hansen and Seo (2002) threshold cointegration $SupLM$ test is used with 73 grid points and p-values are calculated by the parametric bootstrapping. Using the AIC and BIC criteria applied to VECM

suggested two lags. Model estimates for threshold cointegration are calculated by the following Hansen and Seo (2002) procedure. Aiming to provide maximum likelihood estimation (MLE($\tilde{\beta}, \tilde{\gamma}$)) best fit is the model with the lowest value of $log|\Sigma(\beta, \gamma)|$ provided by the grid-search algorithm. Considering $\tilde{A}_1 = \tilde{A}_1(\tilde{\beta}, \tilde{\gamma})$ and $\tilde{Z}_2 = \tilde{Z}_2(\tilde{\beta}, \tilde{\gamma})$, with MLE($\tilde{Z}_1, \tilde{Z}_2$) from the grid-search algorithm parameter calculations are obtained and the results are summarized in Table 5.

RESEARCH RESULTS AND DISCUSSION

Following the empirical strategy described in the previous section traditional unit root test (ADF, PP, KPSS) are summarized in Table 1.

Table 1. Unit root test results for Hungarian exports and GDP

Name of the variable and test	Level test		First difference test	
	Constant	**Constant & trend**	**Constant**	**Constant & trend**
ADF test	**t-stat.**			
log(EXP)	-2.586351	-3.239683	-4.412924	-5.098763
log(GDP)	-2.301680	-3.159780	-3.517847	-4.816661
PP test	**Adj. t-stat.**			
log(EXP)	-2.586103	-3.325069	-4.412924	-5.098763
log(GDP)	-2.953172	-3.159780	-4.769077	-7.274089
KPSS test	**LM-stat.**			
log(EXP)	1.199359	0.281107	0.714196	0.136562
log(GDP)	1.177870	0.312661	0.709029	0.132050

Source: Author' calculation

The results in Table 1 show that Hungarian exports and GDP are difference stationary. Zivot Andrews (1992) unit root test results are shown in Table2.

Table 2. Zivot Andrews (1992) unit root test results for Hungarian exports nad GDP

Alternative	Variable	Test statistic
Slope of the trend	log(GDP)	-5.5338
	log(EXP)	-5.6119
Level and the slope of the trend	log(GDP)	-4.4391
	log(EXP)	-4.2806
Level and the slope of the trend	Δlog(GDP)	-9.4413
	Δlog(EXP)	-6.0128

Source: Author' calculation

Following Zivot Andrews (1992) unit root test results in Table 2, Hunagrian exports and GDP are both trend stationary process with a break in the trend (detected break in the first quarter of 2008 for both series) or difference stationary series (if the alternative is break in level and slope of the trend). But nonetheless both series show similar results for each test. So, weather the both series are trend stationary with break or differenced stationary next step is the cointegration tests and results are given in Table 3.

Table 3. Johansen test for non cointegration (trace and maxmum eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	p –value
None	0.250892	29.65684	15.49471	0.0002
At most 1	0.082893	6.835919	3.841466	0.0089
		Max-Eigen Statistic		
None	0.250892	22.82092	14.26460	0.0018
At most 1	0.082893	6.835919	3.841466	0.0089

Source: Author' calculation

Since the results in Table 3 indicate cointegration relationship between exports and GDP in Hungary VECM is estimated and tested. The linear VECM estimates are summarizes in Table 3

Table 4. Linear VECM estimates

Variables	$\Delta\log(\mathrm{EXP})_t$	$\Delta\log(\mathrm{GDP})_t$
Intercept	0.4327*** (0.1858)	0.4808*** (0.0967)
w_{t-1}	-0.0010*** (0.0004)	-0.0011*** (0.0002)
$\Delta\log(\mathrm{EXP})_{t-1}$	0.4010*** (0.1238)	-0.0174 (0.0644)
$\Delta\log(\mathrm{EXP})_{t-2}$	0.0747 (0.1214)	0.0481 (0.0632)
$\Delta\log(\mathrm{GDP})_{t-1}$	0.1372 (0.2327)	0.0371 (0.1212)
$\Delta\log(\mathrm{GDP})_{t-2}$	-0.3199 (0.2305)	-0.0477 (0.1200)
AIC: -1226.932	BIC: -1196.129	SSR: 0.07396039

Notes: Estimations are done by Maximum Likelihood (ML); standard errors are given in brackets; *** reflects 1%, ** reflect 5% significance

Source: Author' calculation

The results in Table 3 indicate that there is a significant error-correction term in both (exports and GDP) expressions. Slightly higher error-correction coefficient is found in the GDP expression indicating faster GDP adjustment towards the exports in the long-run equilibrium than the other way around. According to the AIC, BIC and HQ appropriate number of lag is two ($l = 2$). Diagnostics from ARCH, Ljung–Box and Jarque–Bera test indicate estimates of the model to be valid. Furthermore to test the nonlinearity in the relationship of Hungarian exports and growth, occurrence of threshold in the error correction term is tested and estimates of threshold error correction model are given below in Table 4.

Table 5. Threshold VECMs exports –growth estimates

	1st regime - (83.5% obs) $w_{t-1}(\beta) \leq \gamma = 0.1691934$		**2nd regime - (16.5% obs)** $w_{t-1}(\beta) > \gamma = 0.1691934$	
Variables	$\Delta\log(\mathrm{EXP})_t$	$\Delta\log(\mathrm{GDP})_t$	$\Delta\log(\mathrm{EXP})_t$	$\Delta\log(\mathrm{GDP})_t$
Intercept	0.0178*** (0.0042)	0.0133*** (0.0002)	0.1289 (0.1363)	0.1202*** (0.0132)
w_{t-1}	-0.1048*** (0.0003)	-0.0711*** (1.3e-05)	-0.2980 (0.4085)	-0.3855** (0.0557)
$\Delta\log(\mathrm{EXP})_{t-1}$	0.4597*** (0.0003)	-0.0015 (0.9823)	-0.2802 (0.6179)	0.2334 (0.4526)
$\Delta\log(\mathrm{GDP})_{t-1}$	-0.0418 (0.8534)	0.0469 (0.7073)	-1.2711 (0.4504)	-1.2617 0.1772)

$\Delta\log(\mathrm{EXP})_{t-2}$	0.1073 (0.3654)	0.0945 (0.1510)	-0.3480 (0.5281)	0.1420 (0.6412)
$\Delta\log(\mathrm{GDP})_{t-2}$	-0.5138*** (0.0254)	-0.0576 (0.6444)	-0.7725 (0.6987)	-0.9223 (0.4039)
SSR: 0.06212902		AIC : -1220.365	BIC: -1161.129	

Threshold Value (γ): 0.1691934

Cointegrating vector: (1, - 0.9812477)

Test of linear versus threshold cointegration of Hansen and Seo (2002):
Test Statistic: 15.39995 (Maximized for threshold value: 427.6866)
P-Value: 0 (Fixed regressor bootstrap)

Notes: Estimations are done by Maximum Likelihood (ML); standard errors are given in brackets; *** reflects 1%, ** reflect 5% significance.

Source: Author' calculation

Table 5 gives linear versus threshold cointegration test results and threshold vector error correction model estimates. The multivariate LM test with a test statistic equal to 15.39 leads to the conclusion of threshold cointegration between $\log(\mathrm{GDP})$ or $\log(\mathrm{EXP})$. This result provides a strong rejection of the null hypothesis of linear cointegration in favor of threshold cointegration at the 1% significance level. The threshold model in the expression (4) has two regimes, resulted from the value of the error-correction term in regards to estimated threshold $\tilde{\gamma}$ amounting 0.1691934. The error-correction term could be described by the expression (6):

$$w_t = \log(EXP)_t - 0.9812477 \cdot \log(GDP)_t \tag{6}$$

The first regime expression explains 83.5% of the observations and it is valid when expression holds (7):

$$\log(EXP)_t \leq 0.9812477 \cdot \log(GDP)_t + 0.1691934 \tag{7}$$

The second regime expression (here referred as the stress regime) explains 16.5% of the observations and is valid when expression holds (8):

$$\log(EXP)_t > 0.9812477 \cdot \log(GDP)_t + 0.1691934 \tag{8}$$

It is reasonable that the error-correction may occur in one regime only or that the error-correction occurs in both regimes but at different speeds of adjustment on the $\log(\mathrm{GDP})$ side or on the side of the $\log(\mathrm{EXP})$. Following the results in Table 5, exports governs the most of the adjustment from the short-run to the long-run equilibrium in the model explaining the first regime since the absolute value of error correction term in exports expression is higher than error correction term in GDP expression ($|w_{t-1}|_{EXP} = 0.1048) > (|w_{t-1}|_{GDP} = 0.0711$). Regarding second regime the results lead in the oposite direction and the adjustment is governed by GDP, while error correction term in exports expression is not significant with usually accepted significance level. The magnitude of the GDP adjustment in regime two is sizable and amounts 0.3855 indicating that 38.55% of disequilibrium occurred in being adjusted in a preceding quarter. Therefore the complete disequilibrium is expected to be adjusted in less than three quarter. To get deeper in-

sight and enable putting the results in context and enrich the conclusions, occurrence of regime one and two is detected and illustrated. Figure 2 in the appendix illustrates regime change and visual inspection of these data series in Figure 2 suggests that irregular or stress conditions in Hungary occurred during and after recent global financial crises. So exporting performance of the Hungary might be speciously important in times of crises. The empirical results found in this paper are quite intuitive and can be summarized as follow: exports is found to be an engine of economic growth in Hungary during the whole sample period, but in times when domestic demand records contractions the role of exports in economic growth become more prominent and takes the basic form of export led growth hypothesis. Empirical results in this paper clearly points that threshold cointegration approach offers deeper insights than the linear error-correction model and might be the proper model specification to examine export led growth hypothesis speciously for the small and open economy like the Hungarian one.

CONCLUSION

Several important deductions could be made as the result of this research. Nonlinear threshold cointegrating model shows occurrence of nonlinear adjustments between exports and GDP in Hungarian economy. Empirical literature dealing with export-led growth hypothesis relies on linear vector error-correction model that might be miss-specified. Nonlinear threshold cointegrating model approach provides richer insights into export led growth hypothesis. Furthermore unlike previous studies, research results reveal unidirectional and bidirectional causality in the long-run Hungarian exports-growth nexus which depends on the regime process. The proposed model identified the speed of exports adjustment by 10.48% of disequilibrium correction quarterly for reaching long run equilibrium steady state, while the speed of GDP adjustment to steady state amounts 7.11% of disequilibrium correction quarterly. However, the results explain the regular conditions or 83.5% of the observed period. Model estimates for the irregular or stress conditions (identified as 16.5% of the observed period) points on the unidirectional causality from exports to GDP with the sizable speed of GDP adjustment amounting 38.55%. So the results clearly points - the bigger disequilibrium occurred the higher speed of adjustment in the afterwards. Conclusively, nonlinear threshold cointegration model might be proper specification to examine exports-growth nexus or export led growth hypothesis in the small and open economy like the Hungarian.

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APPENDIX

Table 6. Descriptive statistics of the original variables –exports (EXP) and gross domestic product (GDP)

	EXP	GDP
Min.	10342	27909
1st Qu.	17670	46087
Median	25395	70369
Mean	24029	62984
3rd Qu.	28693	81273
Max.	36937	91656

Source: Author' calculation

Figure 1. X-13-ARIMA seasonally adjusted series in (natural) log values

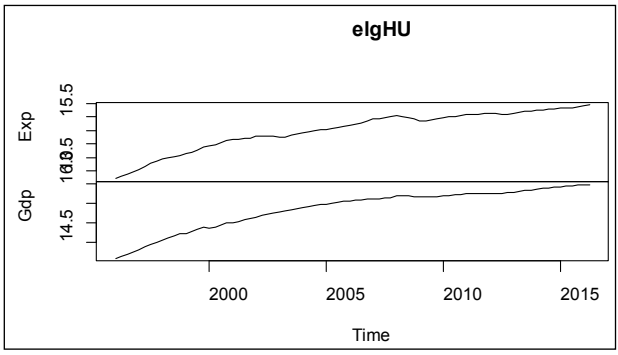

Figure 2. Regime change