GROWTH AND OPENNESS RELATIONSHIP IN THE EU-15: PANEL DATA ANALYSIS

Erginbay Uğurlu*
Hitit University, Turkey

Abstract. *Conventional wisdom suggests that openness of an economy promotes economic growth. There is still argument among economists concerning how a country's macroeconomic variables and its economic growth interact in numerous econometric studies by using panel data. This paper examines the impact of openness on economic growth for the EU-15 area in 1996–2003. In our empirical work, we have used the panel data technique which is also called longitudinal data or cross-sectional time series data. Panel data is generally concerned with choosing among three alternative regressions that are named fixed effects, random effects and pooled model estimation. The variables used are growth, openness, price level, investment and government share of RGDP. We find that openness has had a weak but negative impact on economic growth in this region over this period. Also, we have found that an increase in investment and a decrease in government expenditure have supported economic growth in the EU-15 countries.*

Key words: *panel data, economic growth, openness, EU-15 countries*

Introduction

The European Union has been originally formed by a sequence of several treaties like the treaty of Paris which founded the European Coal and Steel Community (ECSC), the treaty of Rome which founded the European Economic Community (ECC) and the European Economic Energy Community (EEEC) by accession of seven European nations (Belgium, France, Germany, Italy, Luxemburg and The Netherlands). Finally, after five expansion phases, the number of the EU member states reached 27.

For Central and Eastern European Countries, the European Commission has a single budget line called the PHARE Program. This program targets at both institutional restructuring and economic and social adaptation. Beside that program, by 2000 two new financial aid programs, SAPARD and ISPA, have been formed for the benefit of candidate countries until their membership.

The EU grants particular funds to candidate countries to encourage them to make reforms required for membership, to develop sufficient outfit for the union's open market, to furnish them to benefit from the EU accession funds.

* Faculty of Economics and Administrative Sciences, Hitit University, Akkent 3, Cad. No. 3, 19030 Corum, Turkey; e-mail: erginbayugurlu@hitit.edu.tr

The EU makes conditions on the sort of politics, and the criteria include free trade regulations among member countries. Because enlargement countries are less developed than EU member countries, these economic criteria are a major handicap in accession talks. However, economic criteria are not the only problem; also, there are several political conflicts in the EU, which affect accession talks. For example, the Constitution for Europe, signed on 29 October 2004 and planned to come into action on 1 November 2006, was rejected by French referendum on 29 May 2005 and the Netherlands referendum on 1 June 2005.

In this context, our study aims to present how the openness affects growth performance and other controlling variables in the EU-15 countries. The data used in this study are annual observations of the EU-15 for the period 1996–2003 which contains no accession phase.

As is known, economic growth and development has been a very popular subject for economists in all times. Economic development would provide well-qualified products, workforce, and technology, and this would improve productivity. Economic development is a process which improves the living conditions of countries. The relationship between economic growth and foreign trade could be leaned on Adam Smith's absolute theory and David Ricardo's theory of comparative advantages. As mentioned before, the most important purpose of accession countries, and also Turkey as one of them, at least as politicians say, is to provide economic development on the European scale. Economic development would also provide social prosperity as is stated in Smith's and Ricardo's theories. Not only the EU's economic criteria but also lessons taken from worldwide economic crisis obligate countries to control their inflation rate below a proper limit. As a result, many countries, including Turkey, have enacted an inflation targeting policy to overcome the persistently high inflation rates. According to the economic scope given above, this study will cover relationships among growth, openness, inflation for the EU-15 countries, which is an issue generally studied for low-income countries.

This paper organized as follows. Section two discuss theories on growth models and gives brief information on EU. Section three reviews literature. The empirical application and results are shown in section four and finally section five concludes.

Theoretical framework

The neo-classical growth models, such as Solow's (1957), assume that shifts in technology are exogenous and unaffected by a country's trade policy. However, growth theories proposed by Lucas (1988) and Romer (1986) assume that shifts in technology are endogenous. Barro and Sala-i Martin (1995), Grosman and Helpman (1991) discussed the impact of technologic shifts on the openness of economy.[1]

[1] Chen, P. P., Gupta, R. (2006). An Investigation of Openness and Economic Growth Using Panel. University of Pretoria, Department of Economics, Working Paper Series W.P.: 2006–22 http://web.up.ac.za/UserFiles/WP_2006_22.pdf (December 10, 2009), Jin C. Jang. C. (2006). Openness, growth, and inflation: Evidence from South Korea before the economic crisis. Journal of Asian Economics, Vol. 17, p. 738–757.

If the economy is open for international trade, then, especially in exportation industries, domestic technology would increase the competition between import and local products in prices and quality. By using the learning-by-imitating way, less-developed countries could practice high technologies. Liberization in capital markets makes foreign investment enter countries' markets, and this spillover effect develops local technologies. Thereby, in a more open world, local economy will grow more rapidly. Briefly, it could be said that openness positively influences growth. But it is not correct to say that openness influences economic growth directly. The connection between openness and economic growth would be established by investments, and increasing openness would trigger foreign capital investments, and consequently there would be a money flow to a country from outside. On the other hand, competition between local and foreign investments could cause a downturn in local investments. Hence, the effect of these two forces could vary dependeng amount of local and foreign investments.

The relationship between openness and inflation is based on the Barro–Gordon type model. The model assumes that an unexpected monetary expansion could rise inflation. According to the model, there is an adverse relationship between inflation and openness. Barro (1991) measured the variables in this context, for the period 1960–1985, for 98 countries and found a positive correlation between the growth rate of real GDP per capita and human capital. Gallup et al. (1998) have found that well-qualified workforce shows a better production performance than does non-qualified workforce. Another factor that affects growth is government savings. The composition of government savings, and especially the budget share of health and education, are important factors. The major effect on growth is caused by inflation which is believed to have an important adverse effect on long-term growth performance.

The European Union

The origin of the European Union is based on the European Coal and Steel Community founded in 1951. The purpose of this union was to regulate and strengthen the coal and steel industry; these are the most important raw materials in manufacturing industry with an international authority. The European Cole and Steel Community was established on 18 April 1951 by the treaty of Paris, signed by Belgium, Germany, France, The Netherlands, Luxembourg and Italy. The Treaty of Rome, also signed by these six countries, formed the European Atomic Energy Community (EURATOM) and the European Economic Community (EEC).

On 1 January 2007, the EU had 27 member states. The original founding members of the EEC (predecessor of the EU) between 1951–1957 were Belgium, France, Germany(Federal), Italy, Luxemburg and The Netherlands.

The largest expansion phase was completed in 2004, and the previous expansion phase was held in 1995. This study covers the period between these two expansion phases (1996–2003) for 15 EU member countries.

Literature review

In some studies, the convergence effect is discussed in the theoretical framework. The neo-classical Growth Model assumes that the growth rate of developed and undeveloped countries would converge, under the postulate that the technology level would be the same in all countries.

Gylason (1998) studied the relationship among export, inflation and growth. He used income per capita, agricultural sector, primary exports, growth and export variables in this study for 160 different countries for the period 1985–1994 and found that a persistent high level of inflation would cause downturn in exports and growth. This paper concludes that eminent investments don't guarantee sustainable or rapid growth.

Weinhold and Rauch (1999) add specialization as a control variable to their regression and find that it has a strong positive statistically significant relationship with change in production. Gylfason (1998) finds that an increase in investments doesn't always guarantee growth by using export, inflation and growth variables. Edwards and Magendzo (2001) analyze the relationship among inflation, dollarization and growth, and they have tested whether dollarization causes hypoinflation and rapid growth. According to results of their analysis, dolarized countries have higher inflation rates than non-dolarized countries.

Drukker et al. (2005) use a new panel-data methodology which treats the threshold effect of the super-neutrality of money. Their findings suggest that inflation has a nonlinear effect on growth. Bowdler and Malik (2006) find that countries opened to trade could rapidly achieve lower inflation rates.

A considerable part of studies made on this topic is generally on less-developed countries. We have found no study on the economic theory which is referred to in this study for EU member states. In the literature, works on the relationship between growth and integration take the major part for the EU.

Deardorff and Stren (2002) analyze the effect of enlargement and find that because of a strong competition both member countries and enlargement countries would feel destructive economic side-effects of the enlargement process. Brodzicki (2002) finds that being a member of the EU has no significant effect on growth. Nevertheless, Brodzicki (2005) finds that liberalization has a positive effect on growth.

Kaitila (2004) investigates the convergence of real GDP per capita in the EU-15 countries and divides the 1960–2003 period into three parts. The author finds that in the third and the first enlargement phases there was a positive effect on convergence. Kaitila (2005) focuses the effect of conditional convergence and integration on convergence and finds that integration with the EU has a positive effect on growth rates, but the EU membership has no significant effect on them.

Empirical application

Data

As one could see from the literature review, three main variables would be used, which are openness, GDP or GDP per capita, and the Consumer Price Index. In addition to these variables, population, education level or expenses on education, expenses on health, government expenses and direct capital investments are used. Also, some variables employed in our research and their economic meanings are listed in Table 1. In

TABLE 1. **Expected signs of the variables**

Variable	Theory intuition	Expected sign
GOV	Government expenditure increase may have a positive effect on economic growth because government may encourage production by increasing subsidies to producers; public spending on the economy may improve infrastructure and thus education and living conditions.	Positive (+)
INF	Inflation in the economy will cause production to slow down since products are produced at higher prices.	Negative (-)
INV	Domestic investment is linked to the development of human capital. Investments can be seen as a source of the capital stock a country holds.	Positive (+)
OPEN	Openness relative to economic growth is generally positive. As the total trade increases within an economy, economic growth is stimulated.	Positive (+)

Source: Chen and Gupta (e.g.). pp. 10

TABLE 2. **List of Used Variables**

Variable	Definition
INF	Inflation (price level of consumption)
INV	Investment(investment share of RGDPL)
GOV	Government (government share of RGDPL)
GRW	Growth (growth rate of RGDPCH)
OPN	Openness [(exports + imports) / GDP in the total trade as a percentage of GDP]

fact, as is mentioned in the literature survey, the expected signs of variables contradict some researcher's findings. Also, it is a very important remark that findings in the literature survey were mostly on South-African developing countries. However, in this study we focused on the EU member countries.

The aim of this study was to analyse the relationship among openness, inflation and growth for the EU-15 for the period 1996–2003. The variables used in this paper were taken from Penn World Tables (PWT6.2)[2] website and are listed in Table 2.

[2] For a detailed definition, see: http://pwt.econ.upenn.edu/Documentation/append61.pdf. [9], [24], [23], [25], [12], respectively.

Table 3 shows the countries studied and their codes which are used in the models.

TABLE 3. **Countries and codes**

Country	Code	Country	Code	Country	Code
Austria	1	Germany	6	Netherlands	11
Belgium	2	Greece	7	Portugal	12
Denmark	3	Ireland	8	Spain	13
Finland	4	Italy	9	Sweden	14
France	5	Luxembourg	10	United Kingdom	15

The benchmark model is therefore

$$GRW_{it} = \beta_0 + \beta_1 OPN_{it} + \beta_2 INF_{it} + \beta_3 INV_{it} + \beta_4 GOV_{it} + u_{it}.$$

Estimation methodology

Panel Data Analysis employs both time series and cross-sectional data. Since both time series vertical data and cross-sectional horizontal data are joined, panel data have an advantage of a large observation sample. Thanks to the panel data method, we could analyze countries along the time by examining high probability heterogeneous variables. Furthermore, the multicolinearity problem is less severe in panel data methods. Finally, panel data allow us to make econometric analysis with short period of time series data or deficient cross-section data[3].

When the overall homogeneity hypothesis is rejected by the panel data, a simple way to take account of heterogeneity across individuals and/or through time is to use the variable-intercept models[4].

Panel data models are usually estimated using either fixed or random effect techniques. If the individuals are thought to be very similar, then OLS is appropriate; if the individual-specific component is not independent with respect to the explanatory variables or assumed that the countries are very different, the fixed effects estimator is used. The random effect estimator is used if the individual-specific component is assumed to be random with respect to the explanatory variables (Dewan, Hussein, 2001: 27; Giorgioni, Holden, 2003: 215).

In the FEM (Fixed Effects Models) approach, dummy variables are used to account for he effects of omitted variables that are specific to individual cross-sectional units but remain constant over time.

In order to take into account the "individuality" of each cross-sectional unit, it is necessary to let the intercept vary for each individual but still assume that the slope

[3] Baltagi, B. H. (1995). Econometric Analysis of Panel Data. John Wiley & Sons. Gujarati, D. N. (2004). Basic Econometrics, 4th ed., Mcgraw-Hill Companies.

[4] Hsiao, C. (2003). Analysis of Panel data. Cambridge University Press, Cambridge, Massachusetts 2d edn.

coefficients are constant across individuals; to allow for the (fixed effect) intercept to vary among the individuals, we use the dummy variable technique. We use dummies to estimate the fixed effects; in the literature, the model is also known as the least-squares dummy variable (LSDV) model[5].

If the dummy variables do in fact represent a lack of knowledge about the (true) model, we express this ignorance through the disturbance term u_{it} . This is the approach of the random effects model (REM).[6]

The basic idea is to start with equation 1:

$$Y_{it} = \beta_{1i} + \beta_{2i}X_{2i} + \beta_{3i}X_{3i} + u_i \,. \tag{1}$$

In this model, we assume that it is a random variable with a mean value of β_1 (no subscript *i* here), and the intercept value for individuals can be expressed as

$$\beta_{1i} = \beta_1 + \varepsilon_i \quad i = 1, 2, \ldots, N, \tag{2}$$

where

$$\varepsilon_i \sim \tilde{N}(0,\sigma_\varepsilon^2),\ u_{it} \sim \tilde{N}(0,\sigma_u^2),\ E(\varepsilon_i u_{it}) = 0,\ E(\varepsilon_i \varepsilon_j) = 0, \quad (i \neq j),$$

$$E(u_{it}u_{is}) = E(u_{it}u_{jt}) = E(u_{it}u_{js}) = 0, \quad (i \neq j;\ t \neq s).$$

Hausman (1978) provides a test for discriminating between the estimators of fixed and random effects. The two estimators of the coefficient vectors of FEM and REM are compared in the test. The estimator of random effects is efficient and consistent under the null hypothesis and inconsistent under the alternative hypothesis.

The estimator of fixed effects is consistent under both the null and the alternative hypotheses. If the null is true, then the difference between the estimators should be close to zero. The test statistics are distributed as χ^2 and require the computation of the covariance matrix of β_1 (estimator of fixed effects) and β_2 (estimator of random effects).

If the null hypothesis is rejected, the FEM and the pooled model are going to be tested by the poolability test. By this test we have checked whether the slopes are the same across the groups or over time. Thus, the null hypothesis considers the presence of individual effects. The poolability test is undertaken under the assumption of $\mu \sim N(0,\varepsilon^2 I_{NT})$. This test uses the F Statistics, and if the null hypothesis is rejected, the panel data are not poolable.[7]

Results

The Hausman test was used to choose between FEM and REM, and the null hypothesis was rejected (see Appendix 3). Therefore, the FEM and the pooled model were tested

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5 Gujarati (e.g).

6 Gujarati (e.g).

7 Park, Hun Myoung. Winter 2005 Linear Regression Models for Panel Data Using SAS, STATA, LIMDEP, and SPSS, http://www.indiana.edu/~statmath/stat/all/panel/panel8.html (02.01.2008).

by the poolability test, and the null hypothesis could not be rejected (see Appendix 3). Hence, we used the FEM.

The following model was estimated:

$$E(u_{it}u_{is}) = E(u_{it}u_{jt}) = E(u_{it}u_{js}) = 0, \quad (i \neq j; \ t \neq s) .$$

If the qualitative variable had m categories, we introduced only $(m - 1)$ dummy variables. If this rule is not followed, it causes the dummy variable trap. Therefore, we introduced fourteen dummies, and the slope coefficient showed a comparison group which is Austria[8]. Table 4 shows the results of the FEM. In order to simplify the analysis, the coefficient of the dummy variable is omitted in the estimation results presented in this table.

TABLE 4. **FEM estimation results**

Variable	Coefficient	p
INF	-0.014	0.368
OPN	-0.098	0.000***
INV	0.521	0.000***
GOV	-0.256	0.015**
Constant	10.89	0.072*

F prob.	0.000	R square	0.64

*, **, *** denote rejection of the null hypothesis at the 10%, 5%, and 1% levels, respectively.

The model is statistically significant and, except the INF variable, all the coefficients of variables are statistically significant at a 5-percent level of significance or less. The INF variable is not statistically significant and shows that there was no relationship between inflation and openness in the EU-15 countries in the period analyzed in this paper. If the dummy variables are investigated (see *Appendix 2*), one can see that, except the dummy variables of France, Portugal and U.K., all the other dummy variables are statistically significant. Openness and government have a negative and investment has a positive impact on growth.

Conclusions

The objective of the study was to investigate whether growth was affected by openness, inflation, government expenditures and investments in the EU-15 countries during the period 1996–2004. We also aimed at measuring the size and direction of the effects of the explanatory variables on economic growth by using panel data analysis. The FEM estimation of the model has shown that the coefficient in a simple dummy variable has to be positive and statistically significant. However, the coefficient of inflation is not statistically significant.

[8] Dummy variables are coded and ordered using Table 3.

The results show that government expenditures had a negative effect (as was expected), and openness decreased growth in this period, although investment had a positive effect on growth.

Neoclassical economics suggests that openness and privatization of an economy lead to economic growth, although this study did not confirm this claim.

Appendix 1. **Pooled model , LSDV and REM outputs**

Pooled model

Source	SS	df	MS		**Obs**	120
Model	93.1665	4	23.29162		**Prob > F**	0.0002
Residual	454.0777	115	3.9485		R-sq.	0.1702
Total	547.2443	119	4.5986		**Adj R-sq.**	1.9871
Dependent variable: grw						
Variable	Coef.	Std. err.	t	P >|t	95% conf. interval	
Inf	0.0188	0.0112	1.67	0.097	-0.0034	0.0411
Opn	0.0026	0.0036	0.74	0.462	-0.0045	0.0098
Gov	-0.1441	0.0495	-2.91	0.004	-0.2422	-0.0459
Inv	0.2566	0.1014	2.53	0.013	0.0556	0.4576
Cons	-2.7204	2.9616	-0.92	0.36	-8.5869	3.1459

Least squares dummy variable approach

Source	SS	df	MS		**Obs**	120
Model	355.4261	18	19.7458		**Prob > F**	0.0000
Residual	191.8180	101	1.8991		R-sq.	0.6495
Total	547.2442	119	4.5986		**Adj R-sq.**	0.5870
Dependent variable: grw						
Variable	Coef.	Std. Err.	t	P >|t	95% conf. interval	
d_2	9.4408	1.6775	5.63	0.0000	6.1130	12.7687
d_3	4.3851	1.8194	2.41	0.018	0.7758	7.9944
d_4	3.0699	1.0811	2.84	0.005	0.9252	5.2145
d_5	0.0900	1.4081	0.06	0.949	-2.7032	2.8833
d_6	-2.2952	0.8218	-2.79	0.006	-3.9256	-0.6648
d_7	-3.6095	1.2100	-2.98	0.004	-6.0098	-1.2091
d_8	11.4596	1.8455	6.21	0.0000	7.7986	15.1206
d_9	-3.8209	1.0934	-3.49	0.001	-5.9900	-1.6519
d_10	14.5185	3.3983	4.27	0.0000	7.7772	21.2598
d_11	7.8071	1.4950	5.22	0.0000	4.8414	10.7729
d_12	4.3925	2.9610	1.48	0.141	-1.4814	10.2665
d_13	-2.2837	1.0264	-2.22	0.028	-4.3198	-0.24761
d_14	7.6909	2.2480	3.42	0.001	3.2315	12.1504
d_15	0.5919	1.0021	0.59	0.556	-1.3960	2.5798
Opn	-0.0986	0.0173	-5.68	0.0000	-0.1331	-0.0641
Gov	-0.6945	0.28193	-2.46	0.015	-1.2537	-0.1352
Inv	0.52136	0.1102	4.73	0.0000	0.3026	0.7400
Inf	-0.0144	0.0159	-0.9	0.368	-0.0459	0.0171
Cons	10.8987	6.0212	1.81	0.073	-1.0458	22.8433

Random effects model

R-sq				Number of obs		120
Within	93.1665			Number of groups		15
Between	454.0777					
Overall	547.2443					
Dependent variable: grw						
Variable	Coef.	Std. Err.	t	P>|t	95% Conf. Interval	
Inv	0.5055	0.1134	4.45	0.000	0.2831	0.7279
Gov	-0.2562	0.1053	-2.43	0.015	-0.4627	-0.0496
Inf	0.0216	0.0124	1.74	0.082	-0.0027	0.0460
Opn	-0.0122	0.0073	-1.68	0.093	-0.0265	0.0020
_cons	-5.1705	3.8698	-1.34	0.182	-12.7554	2.4142
sigma_u	1.3372		Wald $chi^2(4)$		26.61	
sigma_e	1.3781		Prob > chi^2		0.0000	
Rho	0.4849					

APPENDIX 2. **Model selection**

Hausman test

	Coefficients			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
Variable	fe	re	Difference	S.E.
inv	0.5213	0.5055	0.0158	.
gov	-0.6945	-0.2562	-0.4382	0.2614
opn	-0.0986	-0.0122	-0.0863	0.0157
inf	-0.0144	0.0216	-0.0360	0.0099

b = consistent under Ho and Ha; obtained from xtreg;

B = inconsistent under Ha, efficient under Ho; obtained from xtreg.

Test: Ho: difference in coefficients not systematic

chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 22.76

Prob > chi2 = 0.0001

(V_b-V_B is not definitely positive)

Poolability test

$e'e$, : 454,0774

$e_i'e_i$: 2.692 + 4.07 + 2,176 + 15.838 + 7.565 + 0.512 + 1.103 + 0.404 +
+ 0.303 + 14.749 + 1.342 + 0.66 + 0.587 + 4.291 + 1.683 = 56.001

$$F = \frac{(e'e - \sum e_i'e_i)/(N-1)K}{\sum e_i'e/N(T-K)} = \frac{(454.0077 - 56.001)/(15-1)\times 5}{56.001/15(8-5)} = \frac{398.006/70}{1.24} = 4.58$$

5% significance $F_{(N-1)K,N(T-K)} = F_{70.45} = 1.47$

$F_{hes} > F_{critlo}$ ise H_0 is rejected.

REFERENCES

Barro, R. J. (1991). Economic growth in a cross-section of countries. Quarterly Journal of Economics, Vol. 106(2), pp. 407–443.

Barro, R., Sala-i-Martin, X. (1995). Economic Growth. New York: McGraw-Hill.

Bowdler, C., Malik, A. (2006). Openness and inflation volatility: Panel data evidence, Royal Economic Society's Annual Conference at the University of Nottingham, 18–20 April.

Brodzicki, T. (2002), Economic transition and economic integration. Regional Effects for Poland. Economics Working Paper Archive EconWPA from http://econwpa.wustl.edu:80/eps/it/papers/0310/0310007.pdf (December 12,2009).

Brodzicki T. (2005). New empirical insights into the growth effects of economic integration within EU, Fourth Annual Conference of the European Economic and Finance Society, 19–22 May 2005, Coimbra, from http://econwpa.wustl.edu:80/eps/it/papers/0505/0505014.pdf (December 07, 2009)

Deardorff, V. A., Stern, M. R. (2002). EU expansion and EU growth. RSIE Discussion Paper No. 487, RSIE, Michigan. http://www.fordschool.umich.edu/rsie/workingpapers/Papers476-500/r487.pdf (December.05.2007).

Drukker, D., Porqueras, P. G., Verme, P. H. (2005). Threshold effects in the relationship between inflation and growth: A new panel-data approach, from http://www.imf.org/external/pubs/ft/staffp/2001/01a/pdf/khan.pdf (December 07,2009).

Edward, S., Magendzo, I.I. (2001). Dollarızatıon, inflation and growth, University Of California, Los Angeles and National Bureau of Economic Research.

Gallup, J. L., Sachs, J., Mellinger A. D. (1998). Geography and Economic Growth. Paper prepared for the Annual Bank Conference on Development Economics, Washington, D. C., April 20-21.

Giorgioni, G., Holden K. (2003). Does the Ricardian equivalence proposition hold in less developed countries? International Review of Applied Economics, Vol. 17, No. 2, 2003

Gokal, V., Hanif S. (2004). Relationship between inflation and economic growth. Economics Department Reserve Bank of Fiji, Working Paper 04 from http://www.reservebank.gov.fj/docs/2004_04_wp.pdf (December, 10.2009).

Hausman, J. (1978). Specification tests in econometrics. Econometrica, Vol. 46, No. 6, pp. 1251–1271

Kaitila, V. (2004). Convergence of real GDP per capita in the EU-15; how do the accession countries fit in? ENEPRI Working Paper No. 25, ENEPRI, Brussels, from http://www.enepri.org/Publications/WP025.pdf (April 5, 2008).

Kaitila, V. (2005). Integration and conditional convergence in the enlarged EU area, ENEPRI Working Paper No. 31, ENEPRI, Brussels, from http://www.etla.fi/files/1118_Dp935.pdf (December, 10, 2009).

Lucas, R. E. (1988). On the mechanics of economic development. Journal of Monetary Economics, Vol. 22(1), pp. 3–42.

Romer, P. M. (1986). Increasing returns and long run growth. Journal of Political Economy, Vol. 94(5),pp. 1002–1037.

Solow, R. M. (1957). Technical change and the aggregate production function. Review of Economics and Statistics, Vol. 39, pp. 312–320.

Weinhold, D., Rauch J., (1999). Openness, Specialization, And Productivity growth in less developed countries. The Canadian Journal of Economics / Revue Canadienne D'economique, Vol. 32(4).