

# INTERNATIONAL JOURNAL OF REVIEWS AND STUDIES IN ECONOMICS AND PUBLIC ADMINISTRATION VOLUME 3, ISSUE 3, 2015

## A comparative analysis of predicted and registered economic convergence in European Union during the economic crisis

Mihaela Simionescu

Institute for Economic Forecasting of the Romanian Academy, Romania

[mihaela\\_mbl@yahoo.com](mailto:mihaela_mbl@yahoo.com)

mihaela.simionescu@ipe.ro

**Abstract:** *The main aim of this research is to make a comparative analysis of actual and predicted GDP convergence in European Union countries over the economic crisis (2008-2013). Using the growth rate forecasts made by the European Commission, a higher degree of variation in GDP is anticipated compared to the actual values. This shows that European Commission has anticipated a higher divergence during the economic crisis compared to the registered divergence, the coefficient of variation associated to GDP per capita increasing from 55.37% in 2008 to 66.23% in 2013. According to concentration coefficients and Lorenz curve, the actual and predicted disparities in output have grown in 2013 compared to 2008. However, a higher level of divergence was forecasted than the registered one. The divergence speed for predicted GDP rates were slowly higher (0.099%) compared to registered divergence speed (0.083%). However, Harris-Tzavalis unit root test showed in both cases that the GDP rate divergence is not significant at 5% level of significance.*

**Keywords:** convergence, forecasts, GDP, panel data unit root test

**JEL Classification:** C23, F43, F62

### 1. Introduction

The financial and economic crisis influenced the economic convergence process within the European Union. The main aim of this study is to compare the actual convergence during the economic crisis and the predicted convergence using European Commission GDP rate forecasts for European Union countries. Two approaches were used to assess the convergence process: the use of coefficient of variation and concentration coefficients and the panel data approach.

The economic convergence is characterized by the decrease of the development gap between less developed economies compared to developed countries. The process is very well analyzed in the economic literature, the interest for convergence becoming higher in the context of the extension of the European Union in the last 10 years, according to Angeloni, Flad and Mongelli (2005). Geppert and Stephan (2008) assessed the overall convergence and the spatial concentration in the European Union using methods like Markov chain, cross-sectional regressions and Kernel density estimation. The concentration of economic activities increased the disparities between the EU countries. El ouardighi and Somun-Kapetanovic (2009) obtained a weak convergence of contributions to inequality when they analyzed the international income inequality of 32 countries from Europe during 1989-2002. The convergence test of inequalities based on the variation of Gini index was developed later by Ravallion (2003).

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Alternative scenarios of predictions for 2011-2050 were made by OECD for its countries, showing that each country converges to own steady-state in GDP per capita. The convergence is determined by particular structural conditions and policies that are related to the technological developments. For the mentioned horizon OECD concludes that poor economies will experience a stronger convergence. Bouis, Duval and Murin(2011) predicted a convergence speed of 6% between OECD and non-OECD members on 1996-2006.

The recent economic crisis has affected directly the economic convergence in the European Union. The real convergence and the trends of real GDP rate were evaluated by Halmai and Vásáry(2012) for the recent crisis started in 2008. The recession has influenced in a different way the countries, resulting four groups: 'Catch-up' countries, 'Developed' ones, 'Mediterranean' countries and 'Vulnerable' countries. Excepting the developed countries, the other groups experienced convergence.

Archibugi and Filippetti(2011) showed evidence of convergence in EU from the innovative potential perspective in the years before the crisis (2004-2008), but after it the disparities in innovative capabilities have grown.

Albu (2012a) proved that there is a general tendency of structural convergence in the EU during 2000-2011 using the Lorenz curve. Even if the actual economic crisis has a negative effect on convergence process, Albu (2012b) used the Lorenz curve and Gini coefficients to show that there is still significant convergence across EU countries.

Beyaert and García-Solanes (2014)assessed the effects of economic conditions like crisis period on the long term economic convergence. They showed that the output per capita convergence is not the same in the entire business cycle.

The paper is structured in several sections. In the second section there is a description of the methodology that has been employed in this study. The next section is dedicated to the analyseof degree of convergence in EU during the economic crisis, by emphasizing two directions: actual convergence and predicted convergence. The last part concludes.

### **1. Methodology**

The model proposed by Solow had a huge impact on the new models by reducing the existent gap between real economy and different version of its evolution. The economic growth in a country is determined by investments, improvements in technologic process and the high quality of capital (physical or human capital).

Usually, the convergence at a moment in time is evaluated using a variability indicator which reflects how far the components of an entire are from the average towards the values of the variable converges.

If the variability measure decreases in time there are enough proof to conclude that we havea convergence process. The most used indicator in convergence analysis is the coefficient of variation, because of its advantage of being used in comparisons. This happens because it independent of the unit of measurement.In order to determine it, we have to start from the variance that is computed as:

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$$\sigma^2 = \frac{1}{n} \sum_{i=1}^n (y_i - \bar{y})^2 \quad (1)$$

$y_i$ - variable

i-index for spatial unit

$\bar{y}$ - arithmetic average ( $\bar{y} = \frac{1}{n} \sum_{i=1}^n y_i$ )

The variance shows the values degree of variation compared to the average, depending on the unit of measurement. The standard deviation ( $\sigma = \sqrt{\sigma^2}$ ) is computed using the variance while the coefficient of variation is based on the standard deviation and the average ( $CV = \frac{\sigma}{\bar{y}}$ ).

If the standard deviation decreases in time, we have convergence for the variable, which is called  $\sigma$  convergence. The coefficient of variation could be also computed using the population weight:

$$CV' = \frac{\sqrt{\sigma'^2}}{\bar{y}} \quad (2)$$

$$\sigma'^2 = \frac{1}{n} \sum_{i=1}^n (y_i - \bar{y})^2 (p_i - 1)$$

$p_i$ - weight of population

In the analytical approach of convergence we observe the decrease of differences with respect to the average or of differences between two or more time series:

$$\lim_{t \rightarrow \infty} (x - y) = c \quad (3)$$

The sigma convergence refers to convergence level and it supposes the evaluation of the GDP per capita variation for one year. In order to study the convergence trend, the time series are employed on a discrete interval  $[t; t+T]$ . The convergence is realized when at a certain time  $(t+T)$  the variance decreases compared to a previous moment  $(t)$ :  $\sigma_{t+T} < \sigma_t$ . The divergence is realized when the variance increases:  $\sigma_{t+T} > \sigma_t$ .

The theoretical assumption to be tested for a representative sample is:

$$\frac{1}{T} \log \left( \frac{y_{i,t_0+T}}{y_{i,t_0}} \right) = c - \left( \frac{1-e^{-\beta T}}{T} \right) \log(y_{i,t_0}) + \varepsilon_{i,t_0,t_0+T} \quad (4)$$

A random walk model is proposed for the real GDP rate (growth rate- gr):

$$gr_{i,t} = \alpha + \beta \cdot gr_{i,t-1} + \varepsilon_{i,t} \quad (5)$$

The average growth rate for a group of countries in a certain period  $t$  is determined as:

$$\overline{gr}_t = \alpha + \beta \cdot \overline{gr}_{t-1} + \varepsilon_t \quad (6)$$

average growth is :  $\overline{gr}_t = \frac{1}{n} \sum_{i=1}^n gr_{i,t}$

n- number of spatial units

we make the difference between the last equation and the previous one:

$$gr_{i,t} - \overline{gr}_t = \beta \cdot (gr_{i,t-1} - \overline{gr}_{t-1}) + \varepsilon_{i,t} \quad (7)$$

In case of convergence we have a decrease in time of the variable differentials. This implies that a parameter  $\beta$  value less than 1, this parameter being the convergence coefficient.

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The estimate of  $\beta$  is determined to evaluate the actual convergence rate within a certain group of countries. If  $gr_{i,t} - \overline{gr}_t$  is denoted by  $d_{i,t}$ , the differentials diminish in time as:

$$d_{i,t} = d_0 \cdot e^{-rt} \quad (8)$$

r- rate of convergence

The convergence rate is based on the convergence coefficient:

$$r = -\ln(\beta) \quad (9)$$

The convergence speed is known as annual convergence rate, being computed as:

$$speed = -\frac{\ln(1+r\beta)}{T} \quad (10)$$

The panel data unit root tests are employed in order to check the convergence assumption.

Harris and Tzavalis(1999) used the unit root test for fixed time periods (T) and large number of groups (N). A homogeneous panel is considered:

$$y_{it} = \varphi \cdot y_{it-1} + v_{it} \quad (11)$$

The coefficient  $\varphi$  is zero under the null hypothesis. The, we consider a unit root process with non-homogenous drift:

$$y_{it} = \alpha_i + \varphi \cdot y_{it-1} + v_{it} \quad (12)$$

The last model has linear trend and heterogeneous drift:

$$y_{it} = \alpha_i + \beta_i \cdot t + \varphi \cdot y_{it-1} + v_{it} \quad (13)$$

For the null hypothesis  $\varphi = 1$  and  $\beta_i = 0$ .

The OLS estimator is computed as:

$$\hat{\varphi} - 1 = [\sum_{i=1}^N y'_{i,-1} Q_T y_{i,-1}]^{-1} [\sum_{i=1}^N y'_{i,-1} Q_T v_i] \quad (14)$$

$Q_T$  – projection matrix

$$y_{i,-1} = (y_{i0}, \dots, y_{iT-1})$$

$$v_i = (v_{i1}, \dots, v_{iT})$$

The Harris-Tzavalis unit-root test was applied for inflation (number of panels=28 and number of years=12). The assumptions for this test are:

Ho (null hypothesis): Panels have unit roots

Ha (alternative hypothesis): Panels are stationary

In the convergence economic approach, there is convergence in a group of countries with respect to income (GDP, output), if the proportion of each country in the population group has a closer and closer correspondent as measure in outcome proportion of that country in the overall outcomes of group. The concentration indicators close to zero show the equilibrium state or the proportionality between resources (population, surface, number of organizations etc.) and results (income, production, access to funds etc.) registered by group's components. A simple indicator is the Gini indicator:

$$C_G = \sqrt{\sum_{i=1}^n g_i^2} \quad (15)$$

$g_i$ - element's weight (country i)

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$$g_i = \frac{x_i}{\sum_{i=1}^n x_i} \quad (16)$$

The maximal value of this coefficient is 1; the minimum value of the coefficient is  $\sqrt{\frac{1}{n}}$  which is obviously different from zero.

**2. The evaluation of economic convergence in EU-27 during the economic crisis**

In this study the GDP convergence in European Union countries (EU-27) is studied in parallel with the GDP forecasts convergence, when the predictions are provided by the European Commission (EC). The recent economic crisis period is considered. The data set is represented by the GDP per capita, real GDP rate and one-year-ahead forecasts made by EC during 2008-2013. The registered/actual data are provided by Eurostat, while the predictions are taken from the reports of the European Commission. EC anticipates the continuation of moderate economic growth in EU-27 in 2014. The Commission publishes the economic predictions in spring and autumn but also interim predictions in September and February only for several countries: England, France, Italy, Germany, Spain, Netherlands and Poland. In this study we used the spring forecasts for the next year.

**Table 1- The coefficient of variation for actual and predicted GDP per capita during the economic crisis in EU-27 (2008-2013)**

Variability measure	Value in 2008	Value in 2013
CV actual values	40.02%	41.3%
CV predicted values	53.87%	66.23%

Source: authors' computations

The coefficient of variation is greater than 35%, which shows that there is no evidence of convergence in the two years. According to coefficient of variation values, there is evidence of GDP per capita divergence in EU-27 during 2008-2013. Moreover, the European Commission predicted a higher divergence than the registered one in 2008 and 2013. The forecasted divergence has increased in time more than the actual divergence did.

The Harris-Tzavalis unit root test was employed to test the actual and predicted economic growth convergence in EU-27. The values of all the statistics indicate that we have to reject the null hypothesis. This implies that the panels are stationary for actual and predicted values of GDP growth rate and the convergence is achieved at 5% level of significance.

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**Table 2- The results of Harris-Tzavalis unit root test for economic growth convergence in EU-27 over 2008-2013**

Rho for:	Statistic	z	p-value
Actual values	0.1603	-5.0625	0.000
Predicted values	0.1012	-5.7902	0.000

Source: own computations

Even if the convergence assumption is accepted the panel data models were estimated for heteroskedastic panels and there is evidence of slow divergence that from the statistical point of view is neglected. The results of estimations are described in Appendix 1. The divergence speed for the registered GDP growth in EU-27 countries was about 0.083%. However, according to predictions analysis, the forecasted divergence speed was 0.099%. Actually, the accentuation of divergence was wrongly predicted.

The concentration coefficients values indicate a higher inequality in output for predicted values compared to registered values. Moreover, the inequalities have grown in time in both causes, but a higher divergence is reflected by the EC forecasts.

**Table 3- Gini index and concentration coefficient for predicted and actual output in EU-27 during 2008-2013**

Indicator	Actual values		Predicted values	
	2008	2013	2008	2013
Gini index	0.196	0.207	0.2909	0.309
Concentration coefficient	0.203	0.214	0.302	0.321

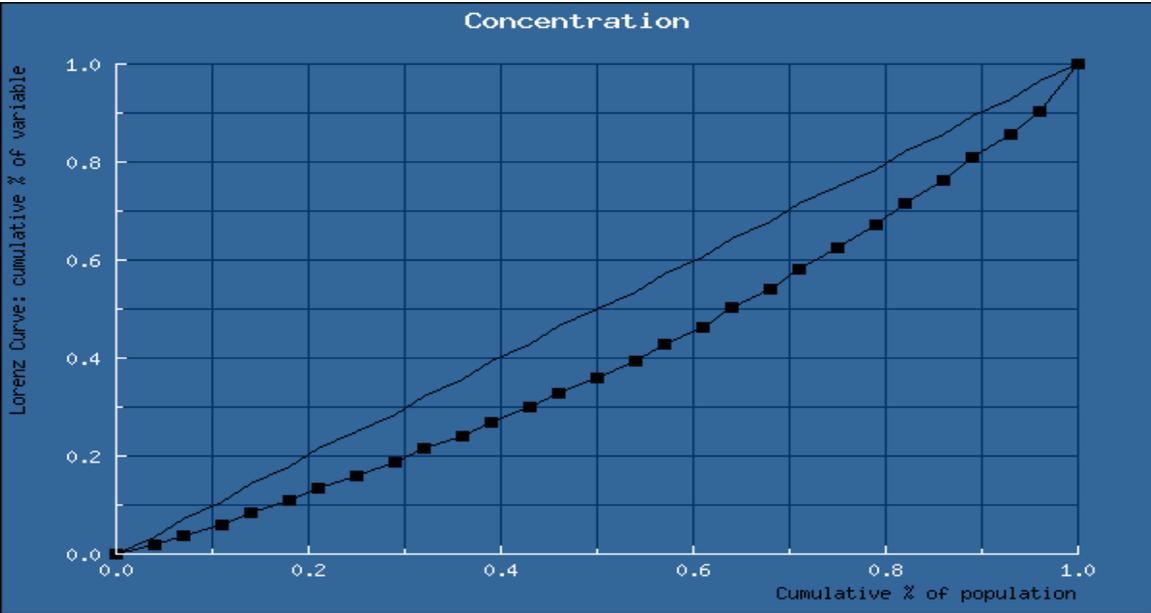
Source: own computations

The Lorenz curves for actual and predicted values show clearly an increase in GDP inequalities in 2013 compared to 2008, the area under the curve being larger in 2013. So, the crisis has grown the output disparities in time. The EC predicted a higher inequality because of the different strategies to face the crisis applied in various countries depending on the economic and social state.

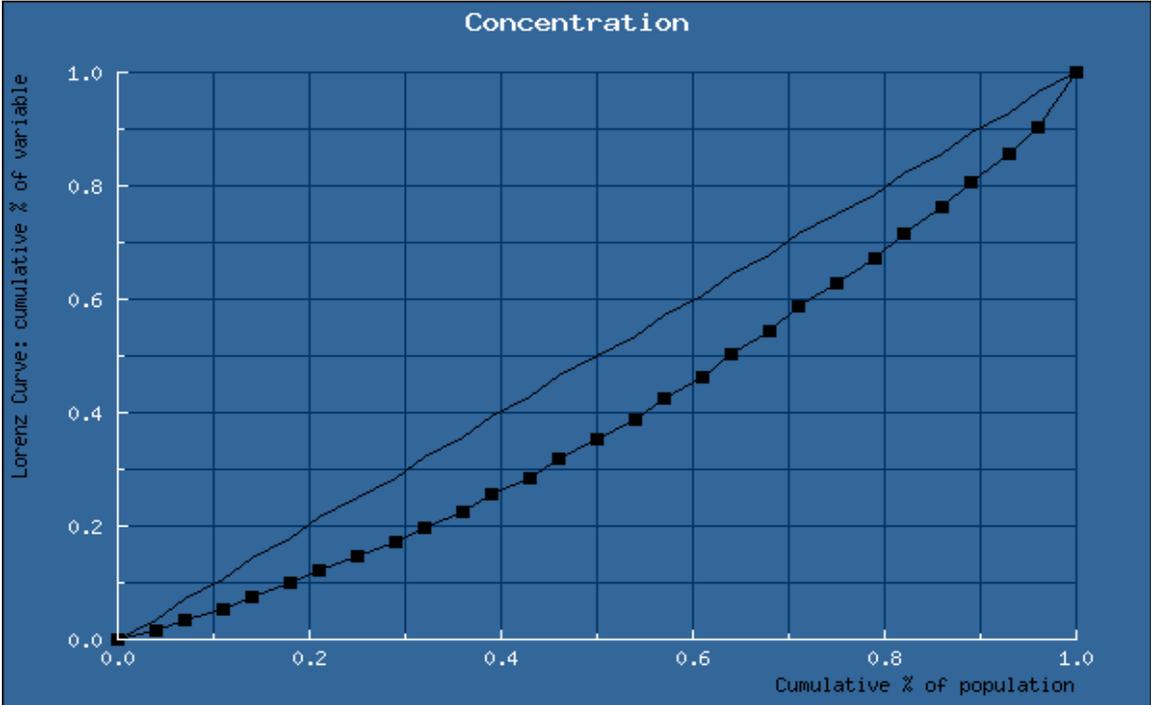
**Figure 1- Actual and predicted Lorenz curve in 2008 and 2013**

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Actual Lorenz curve in 2008

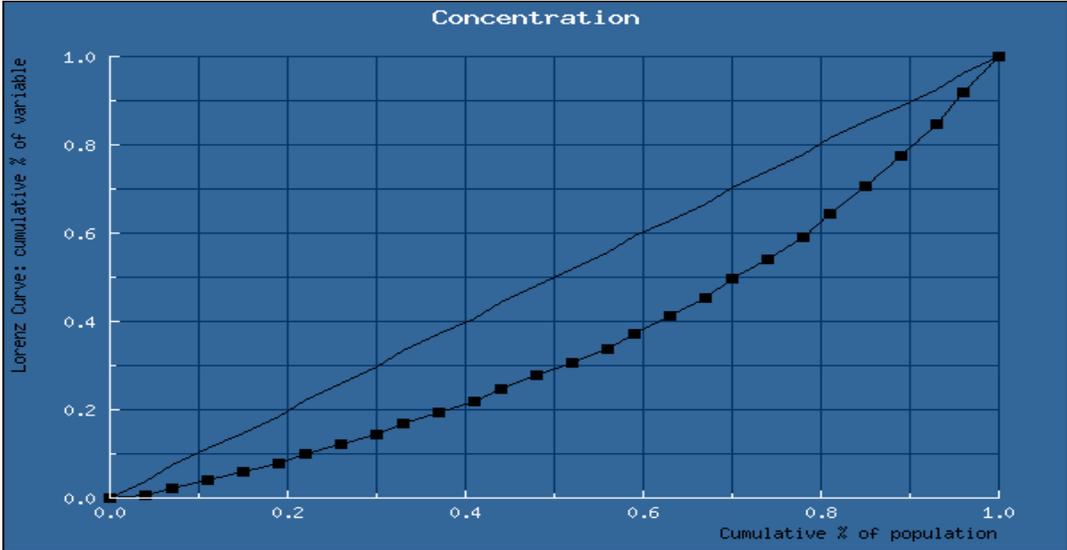


Actual Lorenz curve in 2013

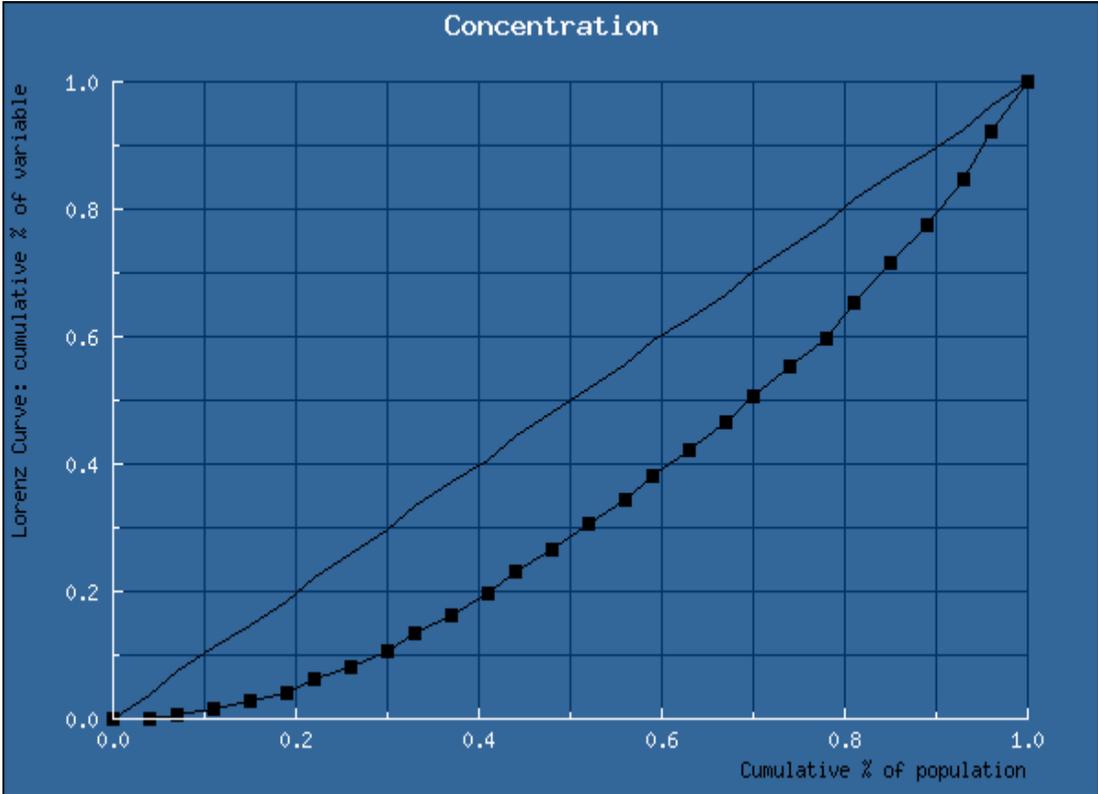


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Predicted Lorenz curve in 2008



Predicted Lorenz curve in 2013



Source: authors' computations

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The convergence perspective brings that fact that the process of development levels closeness between regions is under hypothesis. According to Solow theory, the assumption of high rates of growth for the low developed countries is based on statistical data and on the economic theory.

**4. Conclusions**

According to the coefficients of variation in 2008 and 2013 and to panel data models, during the economic crisis in EU the divergence process has increased, the forecasts made by European Commission for real GDP rate reflecting a higher degree of divergence. However, the panel unit root tests show that the divergence process is not significant, at 5% level of significance, the panels being stationary.

According to concentration coefficients and Lorenz curve, the actual and predicted disparities in output have grown in 2013 compared to 2008. However, a higher level of divergence was forecasted than the registered one.

The pessimistic anticipations regarding the convergence in the crisis context were entertained by the difficulties in country like Spain, Greece and Portugal, where the effects of crisis were more intense compared to other EU countries. In a future research the study could be extended to check the inflation and unemployment rate convergence.

**APPENDIX 1**

***Fixed-effects model for actual growth rate***

Cross-sectional time-series FGLS regression

Coefficients: generalized least squares  
Panels: heteroskedastic  
Correlation: no autocorrelation

Estimated covariances	=	27	Number of obs	=	162
Estimated autocorrelations	=	0	Number of groups	=	27
Estimated coefficients	=	2	Time periods	=	6
			Wald chi2(1)	=	24.05
Log likelihood	=	375.6967	Prob > chi2	=	0.0000

y_actual	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
x_actual	.3216708	.0655984	4.90	0.000	.1931003	.4502414
_cons	-.0004296	.0015082	-0.28	0.776	-.0033855	.0025264

***Fixed-effects model for predicted growth rate***

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Cross-sectional time-series FGLS regression

Coefficients: generalized least squares  
Panels: heteroskedastic  
Correlation: no autocorrelation

Estimated covariances	=	27	Number of obs	=	135
Estimated autocorrelations	=	0	Number of groups	=	27
Estimated coefficients	=	2	Time periods	=	5
Log likelihood	=	-194.1483	Wald chi2(1)	=	42.94
			Prob > chi2	=	0.0000

y	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
x	.5105202	.0779078	6.55	0.000	.3578237	.6632167
_cons	-.0910784	.0712294	-1.28	0.201	-.2306854	.0485286

## References

- Albu, L.-L.(2012 a).Structural Convergence in European Union.*Annals of the „ConstantinBrâncuși” University of TârguJiu, Economy Series*, Issue 4/2012, 2-15.
- Albu, L.-L.(2012 b).The Convergence Process in the EU Estimated by Gini Coefficients.*Romanian Journal of Economic Forecasting*, 4, 5-16.
- Angeloni, I., Flad, M., Mongelli, F. (2005). Economic and Monetary Integration of the New Member States: Helping to Chart the Route. *European Central Bank Occasional Paper* No. 36, 30-45.
- Archibugi, D., Filippetti, A. (2011), Is the economic crisis impairing convergence in innovation performance across Europe?.*JCMS: Journal of Common Market Studies*, vol. 49, no. 6, pp. 1153-1182, accessed on May 2014 at <http://www.danielearchibugi.org/downloads/papers/economic%2520crisis.pdf>.
- Beyaert, A., &García-Solanes, J. (2014).Output gap and non-linear economic convergence.*Journal of Policy Modeling*, 36(1), 121-135.
- Bouis, R., Duval, R., Murtin, F. (2011), The Policy and Institutional Drivers of Economic Growth Across OECD and Non-OECD Economies: New Evidence from Growth Regressions, *OECD Economics Department Working Papers*, No. 843, accessed on May 2014 at [http://www.oecd-ilibrary.org/economics/the-policy-and-institutional-drivers-of-economic-growth-across-oecd-and-non-oecd-economies\\_5kghwnhxwkhj-en](http://www.oecd-ilibrary.org/economics/the-policy-and-institutional-drivers-of-economic-growth-across-oecd-and-non-oecd-economies_5kghwnhxwkhj-en).
- El ouardighi, J. &Somun-Kapetanovic, R. (2009), Income inequality convergence in the development of European countries. *Review of Applied Economics*, Vol. 5, No. 1-2, (January-December 2009)

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PUBLIC ADMINISTRATION VOLUME 3, ISSUE 3, 2015**

Geppert, K., & Stephan, A. (2008). Regional disparities in the European Union: Convergence and agglomeration. *Papers in Regional Science*, 87(2), 193-217.

Halmai, P., Vásáry, V. (2012), Convergence crisis: economic crisis and convergence in the European Union, *International Economics and Economic Policy*, vol. 9, no. 3-4, pp. 297-322, accessed on May 2014 at <http://link.springer.com/article/10.1007%2Fs10368-012-0218-3>.

Harris, R. D., Tzavalis, E. (1999). Inference for unit roots in dynamic panels where the time dimension is fixed. *Journal of econometrics*, 91(2), 201-226.

Ravallion, M. (2003). Inequality Convergence. *Economics Letters*, 80, 351-356.