4 THE CATCH-UP EFFECT OF ECONOMIC GROWTH. EVIDENCE FROM THE EUROPEAN COUNTRIES

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Abstract

Using a sample of thirteen European countries (cohesion countries) during twenty-one years, from 2000 to 2020, we employ a Quantile Regression approach to investigate the catch-up effect for the economic growth. According to the reported results, the catch-up effect appears to be more pronounced at the lower end of the conditional economic growth distribution, but also when economic growth is on an upward trend. The results remain robust to a different econometric specification. Additionally, foreign direct investments exhibit a higher impact on economic growth across superior quantile as compared to the lower ones. The impact is also statistically significant irrespective of the selected quantile. The same conclusion is valid for the Political Stability Index, the positive relationship indicating that economic growth is extremely sensitive to political events.
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1. Introduction

The purpose of this paper is to investigate the catch-up effect in terms of economic growth for a series of European countries. Usually, a higher standard of living can only be achieved through a higher production of goods and services, which normally materializes into a higher GDP. As we all know, one of the main goals of the European Commission is to provide a supportive environment for the new member states to reach the developed ones in terms of macroeconomic performance indicators. In this way, the economic convergence can be defined as the process in which the discrepancies between macroeconomic variables within a group of countries diminish in a sustainable way. In other words, the economic convergence, *i.e.*, the catch-up effect, is an economic theory indicating that poorer countries will tend to grow faster than wealthier ones when it comes to the production of goods and services.

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The research papers investigating the catch-up effect are, even nowadays, very interesting for policy makers, since economic growth remains the core objective for government's economic policy. However, up until now, the evidence presented in the literature is mixed. For example, some empirical studies such as Chen (2002) or Felipe (2000) bring strong empirical evidence regarding the existence of the catch-up effect for a series of Asian countries. More to the point, Zhang (2003) argues that some developing countries from East Asia will reach in the long run the same growth rates as Japan, who is the economic leader in the region. However, other studies such as Li (1999) fail to identify significant evidence of the catch-up phenomenon for some low-income countries. A similar conclusion was reported in Wane (2004), based on a sample containing WAEMU countries.

Regarding the catch-up process within the European Union, the existing results are revealing some contradictory aspects, similar to the Asian economies' case. Canova (2004) highlights the existence of some heterogeneity when it comes to European regional per-capita income. More to the point, de Juan and Arroyo (2009) argue that some pairwise inequalities in GDP levels among the European countries still exist, leading to an incomplete catching-up process. On the same line, Soukiazis and Castro (2005) suggest that the rules established on the basis of the Maastricht agreement did not have the expected effects. On contrary, Le Pen (2011), by employing unit root or stationarity tests allowing for structural breaks, conclude that a significant percentage of regions are satisfying this convergence criterion.

Over the last years, a growing body of literature was devoted to exploring the economic convergence phenomenon of the transition countries to the EU level. For example, Kočenda (2001) brings strong empirical evidence regarding the catch-up effect in terms of macroeconomic fundamentals for the CEE countries; the aforementioned paper reveals that macroeconomic policies tend to correlate faster when the degree of convergence is higher. The same conclusion was reached by Kutan and Yigit (2009). According to them, a positive and statistically significant relationship describing the impact of distance from the technological frontier on productivity growth between Central and Eastern Europe towards EU15 exists. However, based on a similar sample, Kasman et al. (2005) suggest that industrial output in the majority of the CEE countries is not cointegrated in a fractional framework with that of the EU.

This paper aims to fill the existing gap in the literature by investigating the convergence process based on the quantile regression approach in a panel data environment. The quantile regression, proposed by Koenker and Bassett (1978), has the capacity to draw inferences regarding the observations that rank above or below the dependent variable conditional mean. Since it does not have any specific hypothesis about the distribution of error terms, the sensitivity to outliers is less significant as compared to the standard linear regression, so it can provide more accurate and robust results. Given its features and advantages, the quantile regression has become a useful tool in financial studies during the last decade. For this reason, we use this econometric procedure in our paper to investigate the catch-up effect in a heterogeneous panel data context.

To the best of our knowledge, no other study has used this methodology in order to investigate the catch-up effect. By using a sample of thirteen European countries during twenty-one years, from 2000 to 2020, we bring strong empirical evidence of the asymmetry characterizing the catch-up effect. This result indicates that the economic convergence is more visible in countries that have already taken important steps in order to reduce the gap with the developed economies in terms of sustainable economic growth.

The remainder of the paper is organized as follows: Section 2 briefly reviews the methodology, Section 3 presents the data, and the empirical results are presented in Section 4, while Section 5 concludes.

2. Methodology

2.1. Panel quantile regression model

In this paper, we use a Panel Quantile Regression model to capture the catch-up effect across European countries. Koenker and Bassett (1978) developed the quantile regression, in order to provide an exhaustive analysis for a full area of conditional quantile functions as an alternative for conditional mean function, which is estimated via OLS. This methodology, alongside threshold models (Hansen, 1999; González *et al*., 2005; Pop *et al*., 2018) and high-frequency models (Cepoi and Toma, 2016; Damian and Cepoi, 2016; Bahna *et al*., 2018) have been intensively used by economists in the last twenty years alongside quantile regression (Cepoi, 2020). Standard linear regression approaches summarize the average relation between a set of covariates and the dependent variable based on the conditional mean function, assuming that this function is drawn from a normal distribution with symmetric characteristics. From this point of view, the quantile regression approach is a very helpful tool when the empirical distribution characterizing the dependent variable is skewed, by avoiding assumptions about the parametric distribution of the error process, as Conley and Galenson (1998) mentioned. Even though the aforementioned methodology remains robust in the presence of outliers and heavy distribution, it does not take into account the unseen heterogeneity given by a country. For this reason, we use a panel quantile with fixed effects, which allow us to estimate the heterogeneous reactions of GDP growth to different variables. We consider the following specification:

$$Q_{y_{i,t}}\left(\tau_k \vee \alpha_i, x_{i,t}\right) = \alpha_i + x_{i,t}^T \beta(\tau_k) \quad (1)$$

with $i = \overline{1,N}$ and $t = \overline{1,T}$, denoting cross-sections (countries) and time (years). In Eq. (1), α_i represents the location shift impact coefficient on the conditional quantile of response while the effects of the covariates, x^T are allowed to vary across a certain quantile of interest.

In order to estimate the coefficients from Eq. (1), we introduced a penalty component leading to the following optimization routine:

$$\min_{(\alpha,\beta)} \sum_{k=1}^{K} \sum_{t=1}^{T} \sum_{i=1}^{n} w_k \, \rho_{\tau_k} \left(y_{i,t} - \alpha_i - x_{i,t}^T \beta(\tau_k)\right) + \lambda \sum_{i}^{N} |\alpha_i| \quad (2)$$

where: K represents the index of a certain quantile, x is the matrix of covariates, ρ_{τ_k} is given by the quantile loss function, while w_k is the relative weight given to the $k-th$ quantile, which is designed to quantify the contribution of the $k-th$ quantile when estimating the impact of the fixed effect.

2.2. Beta-convergence

Beta-convergence describes the process in which low-income or middle-income countries are growing faster than the rich ones and consequently, catch up on them. Moreover, the idea of conditional beta-convergence in EU indicates that a certain member state tends to its own steady state level, based on capital, technology or population growth, etc. The idea of beta-convergence is closely related to the neo-classical theory of Solow (1956) where the main idea is that factors of production, in particular, capital, are subject to diminishing return.

Accordingly, the phenomenon of growth should lead economies to a long-run steady state described by a rate of growth, which is related only with the growth rates of technological progress and labor force. A series of papers devoted to this issue, such as Barro and Sala-i-Martin (1992) or Mankiw *et al*. (1992) have identified a growing body of literature devoted to measure the extent of Beta-convergence inflation based on different samples or econometric methods. More to the point, one of the astonishing results obtained in the majority of the empirical studies is the uniformity of the estimated slope with which national economies converge to their steady state, *i.e*., around 2% per year. The econometric approach devoted to measure beta-convergence normally involves estimating an equation given by:

$$ln\left(\frac{GDPC_{i,t}}{GDPC_{i,t-1}}\right) = \alpha_i + \beta ln\left(GDPC_{i,t-1}\right) + \gamma Z_{i,t} + u_{i,t} \quad (3)$$

where: $GDPC$ is the gross domestic product per capita in country i at time t, $Z_{i,t}$ is the set of covariates supposedly affecting the growth rate, $u_{i,t}$ is the error term, while α, β and γ are the coefficients to be estimated based on the procedure stated in Section 2.1 for $y_{i,t} = \Delta GDPC_{i,t}$.

3. The data

In this study, we consider a balanced panel with annual data for 21 years, from 2000 to 2020, using a sample of thirteen European countries, namely Bulgaria, the Czech Republic, Estonia, Hungary, Lithuania, Poland, Romania, the Slovak Republic, Slovenia, Greece, Spain, Portugal and Ireland. In what follows, we make a detailed description of the variables that are included in the Quantile Regression model.

The dependent variable - GDP growth

The GDP growth rate quantifies how fast the economy is increasing. In our case, GDP growth is defined based on the log difference between GDP per capita in two consecutive years.

3.1. The explanatory variables

a) *GDP per capita (GDPpC)*

GDP per capita divides the country's GDP by its total population. In our opinion, it is the best measurement of a country's standard of living. The data for GDP pe capita comes from World Development Indicators database of the World Bank.

b) *Foreign direct investment (FDI)*

A foreign direct investment takes place when an economic agent (individual or company) establishes operations or acquires foreign business assets in a foreign company. As in the previous situation, the data regarding the level of FDI comes from World Development Indicators database of the World Bank.

c) *Political Stability Index (PSI)*

Political Stability Index is a measure devoted to quantify individuals' perceptions about the likelihood of political instability. Estimate gives the country's score in units of a standard normal distribution, *i.e*., ranging from -2.5 to 2.5. As in the previous situation, the data

regarding the level of PSI comes from World Development Indicators database of the World Bank.

d) *Inflation rate (INFL)*

The inflation rate represents the percentage change in Consumer Price Index (CPI) and comes from the International Monetary Fund database. It is relevant to note that since we defined inflation as growth in the CPI over the last year rather than the last quarter, it is not possible to have seasonal effects in the data that may generate spurious results.

e) *Business Freedom Index (BFI)*

The Business Freedom Index is based on 10 indicators, using data from the World Bank's Doing Business study: Starting a business-procedures (number), time (days), cost (% of income per capita), and minimum capital (% of income per capita); obtaining a license - procedures (number), time (days), and cost (% of income per capita); closing a business - time (years), cost (% of estate), and recovery rate (cents on the dollar).

Before estimating the regression underlined by Eq. (1), it is mandatory to test the existence of some possible correlations (higher than 40%) between the independent variables. The correlation matrix describing the covariates is presented below:

Table 1

Correlation matrix of the explanatory variables

Variables	GDPPC	FDI	PSI	INF	BFI
GDPPC	100%	24%	21%	-28%	31%
FDI	24%	100%	14%	4%	13%
PSI	21%	14%	100%	-14%	24%
INF	-28%	4%	-14%	100%	-28%
BFI	31%	13%	24%	-28%	100%

Source: Own calculations using Eviews 9.

We see from Table 1 that no correlation coefficient exceeds the threshold value of 40%. Under these circumstances, it is less likely that the final results are affected by multicollinearity issues.

4. Empirical results

4.1. Baseline model

Some very influential papers, such as Wen and Chang (2015), argued that is impossible to analyze some interactions between different types of non-stationary variables in a panel data approach. For this reason, in order to avoid the existence of a spurious regression we compute for each variable two standard panel unit root tests developed by Levin *et al*. (2002) – LLC test, Im *et al*. (2003) – and IPS test (we use two tests as a criterion for assessing robustness of results).

The results presented in Table 2 reject the null hypothesis of a unit root at 5% level if we take into account the majority rule. With very few exceptions, all the results highlight a stationary behavior for the variables that were included in the model.

Table 2

Panel unit root tests results

Variables	LLC		IPS	
	Trend	No Trend	Trend	No Trend
GDPpC	-2.9949 (0.0014)	-4.5903 (0.0000)	-1.6320 (0.0513)	-2.4256 (0.0001)
FDI	-1.8353 (0.0332)	-2.6629 (0.0039)	-1.924 (0.0271)	-3.0132 (0.0013)
PSI	-3.1274 (0.0009)	-3.5184 (0.0002)	-1.29983 (0.0968)	-3.8233 (0.0001)
INF	-5.4410 (0.0000)	-5.0358 (0.0000)	-4.3898 (0.0000)	-4.0682 (0.0000)
BFI	-1.38385 (0.0832)	-1.8375 (0.0532)	0.0178 (0.5071)	2.4627 (0.9931)

Note: Null: the series has a unit root; p-values are in parentheses.
Source: Own calculations using Eviews 12.

In this way, we are able to perform the standard Panel Quantile Regression approach without worrying about the existence of some possible cointegrating relations between variables. However, to account for the existence of cross-sectional dependence in the first-generation tests, we also run a robustness check for the presence of a unit root based on Pesaran (2007). The results are presented in Table 3.

Table 3

The Pesaran Panel Unit Root Test with cross-sectional and first difference mean included (Null: unit root) – The specification has a trend

Variables	Test Value	Critical 10%	Critical 5%	Critical 1%
GDPpC	-2.7792	-2.70	-2.82	-3.07
FDI	-2.8248	-2.70	-2.82	-3.07
PSI	-2.7545	-2.70	-2.82	-3.07
INF	-3.2943	-2.70	-2.82	-3.07
BFI	-3.2055	-2.70	-2.82	-3.07

Source: Own calculations using Eviews 12.

As one may see, all the selected variables reported in Table 2 and Table 3 can be used as explanatory factors in the quantile regression specification without worrying too much about the existence of possible cointegrating relations between variables and cross-sectional dependence. More to the point, when performing the Breusch-Pagan LM test, all the results lead to the rejection of the null hypothesis (no-cross section dependence). For this reason, to check the robustness of our results we present the results generated by the Harding and Lamarche (2009) method. The estimates of fixed effects quantile regression are presented in Table 4.

The results presented in Table 4 indicate that the conditional convergence holds under the Panel Quantile Regression restrictions from the 10th quantile to the 75th quantile. These estimates may be viewed as the incremental change in the dependent variable for observations at the $q-th$ conditional quantile implied by the marginal change in a specific dependent variable. The lower quantiles, such as the 10th or 25th, refer to the countries with lower GDP growth in a certain year. Moreover, there is a stable and statistically significant relationship between GDP growth and the initial level of GDP per capita only for quantiles that are lower or equal to 75%. For the rest of the 90th quantile, although the reported coefficients are negative, we fail to identify a significant relationship for the beta-convergence hypothesis. This fact can be observed much better if we estimate the model for 20 quantiles. We present in Figure 1 the evolution of β_{GDPpC} in this context.

Table 4

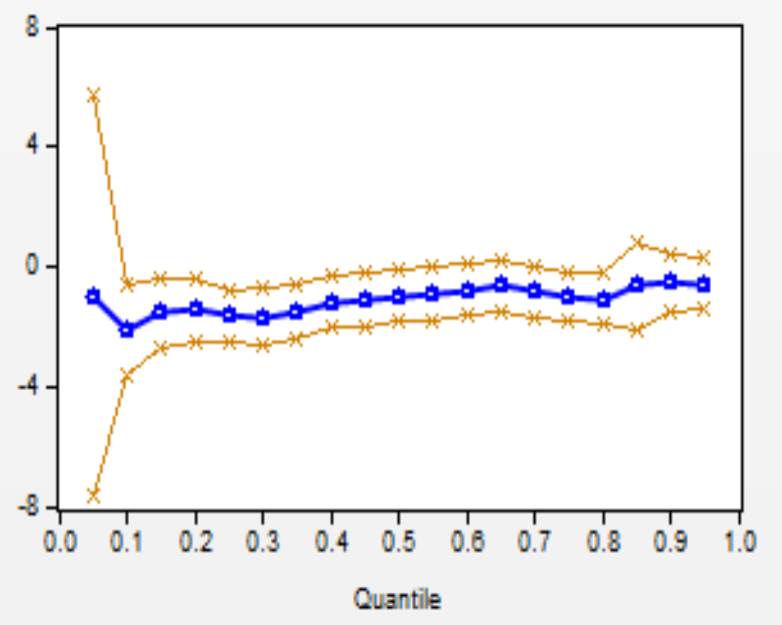
Estimation results for the Quantile Regression

Quantile	10th	25th	50th	75th	90th
GDPpC	-0.0209***	-0.0163***	-0.0096**	-0.0098**	-0.0051
FDI	0.0145**	0.0235***	0.0162***	0.0197**	0.0190***
PSI	0.0145*	0.0235***	0.0162*	0.0197***	0.0190**
INF	-0.2155*	-0.0330	-0.0024	-0.0319	0.2432
BFI	-0.1578**	-0.0609*	-0.0665**	-0.0271	-0.0232
Intercept	0.3023***	0.2021***	0.1594***	0.1447***	0.1022**
R-squared	0.092	0.095	0.110	0.122	0.309
Observation	273	273	273	273	273

Note: ***significance at 1% level; **significance at 5% level; *significance at 10% level.

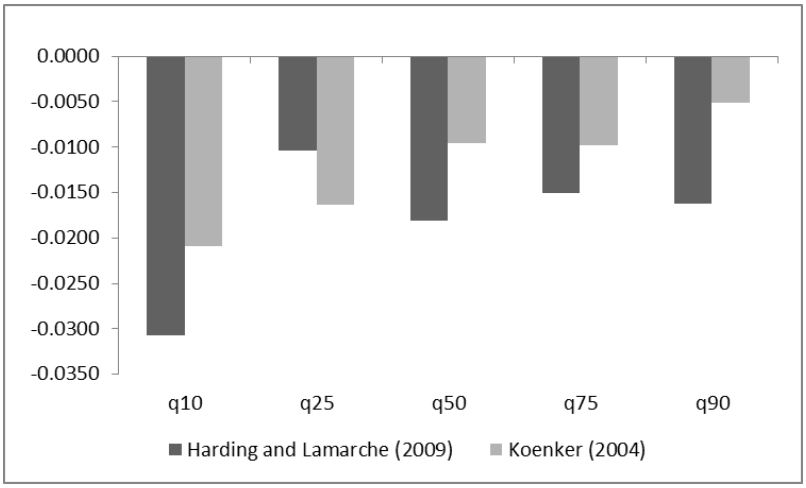
Normally, if the estimated coefficient between growth rate and the initial level of GDP per capita is negative, there are sufficient arguments to approve the existence of a convergence relationship. The estimated value of the beta also indicates the rate at which countries approach their steady state and, furthermore, the speed of convergence. By using these estimates, the half-life can be computed, *i.e.*, the time span that is necessary for the current gaps to be halved. For example, if beta is 2%, this implies a half-life of 28 years. We may see that along the distribution of economic growth, the catch-up effect exhibits an increasing trend up to the 75th quantile. The results remain robust to a different econometric approach controlling for cross-sectional dependence (Harding and Lamarche, 2009), as one may see in Figure 2. Indeed, the negative sign remains unchanged, but also the marginal impact on the lower quantiles under the new specification.

Figure 1. Quantile regression estimates for beta-convergence (5% increase in quantile)



Source: Own calculations.

Figure 2. Robustness checks for the beta-convergence



Source: Own calculations using Stata 17.

In addition, foreign direct investments exhibit a higher impact on economic growth across superior quantiles compared with the lower ones. The impact is also statistically significant irrespective of the selected quantile. The same conclusion is valid for the Political Stability

Index, the positive relationship indicating that economic growth is extremely sensitive to political events.

To control for economic sentiment, we included in the regression a variable measuring the level of freedom in the business area. As one may see in Table 3, the highest the business freedom, the higher the economic growth. However, the impact is statistically significant across lower and medium quantiles. This implies that countries with a higher level of economic growth are rather restrictive of the business freedom.

The link between the catch-up effect and inflation could be related to the Balassa-Samuelson effect. However, Dedu and Dumitrescu (2010) concluded that its impact on inflation was limited in the case of Romania. Also, numerous countries included in the sample have in place inflation targeting regimes, but this had limited impact on the recorded inflation rate, as argued by Străchinaru and Dumitrescu (2019).

5. Conclusions

In this study, we investigate the catch-up phenomenon for a series of European countries during 21 years. Despite the growing body of literature aimed at stating absolute and conditional convergence in the EU at different stages of its enlargement, the evidences regarding the convergence are still limited and mixed at some points. Because of this reason, we tried to fill the gap in the literature by investigating for the first time the issue of convergence based on a Quantile Regression approach.

The reported results have revealed some interesting facts. First of all, the catch-up effect appears to be more pronounced at the lower end of the conditional economic growth distribution, but also when economic growth is on an upward trend. This partially confirms the findings of Soukiazis and Castro (2005) or Dumitrescu (2013). More specific, we could identify a stable and statistically significant relationship between GDP growth and the initial level of GDP per capita only for quantiles that are lower or equal to 75%. This finding is confirmed by the robustness tests that we performed. Second, foreign direct investments exhibit a higher impact on economic growth across superior quantiles as compared to the lower ones. The impact is also statistically significant irrespective of the selected quantiles. The same conclusion is valid for the Political Stability Index, the positive relationship indicating that economic growth is extremely sensitive to political events. Third, for the business freedom, the impact is statistically significant across lower and medium quantiles. We postpone a quarter-by-quarter analysis under quantile regression specification for the future research. Our results are relevant for researchers in this field, as well as for professionals involved in designing and adjusting economic convergence policies.

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