The Impact of the COVID-19 Crisis on EU Income Convergence Patterns

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ABSTRACT

The convergence process has been a recurrent topic since the establishment of the European Union. Historically, there have been sizeable income disparities between West and East Europe. When coupled with a global crisis, this gap could have unforeseen implications on regional economies. When COVID-19 hit human society by storm, it led to tremendous damage to health and economic conditions. It begs the important question of how this global crisis impacts regional economies. In this paper, we investigate the effect of the COVID-19 financial recession on the European Union convergence process. The study presents data collected from various sources to introduce the basic idea of convergence. This study quantitatively concretizes the convergence process using GDP per capita as a dependent variable and other socioeconomic parameters as input. Through empirical analysis by using linear regression, we conclude that the recession slows down the convergence process in the European Union, which is consistent with most predictions. The fact that it did not cause further divergence reveals the resilience of the European economy.

Keywords: *COVID-19, EU convergence patterns, Beta factor analysis, Strategies*

1. INTRODUCTION

The Treaty of Rome signed in 1957 established the need to "strengthen the unity of their economies and ensure their harmonious development by reducing the differences among the various regions" [1]. Since then, numerous initiatives such as the subsequent establishment of the European Economic Community and the formation of the European Social Fund (ESF) and European Agricultural Guidance and Guarantee Fund (EAGGF) in the following year have been taken to ameliorate the disparities within the union. Yet, the income gap was conspicuous since the industrial revolution and led to the breakout of the Cold War, which to a large extent hindered economic and political cooperation between West and East Europe [2]. After the collapse of the Soviet Union, the connection was strengthened between the former Soviet states in East Europe and their western friends. In the 2004 European Union Enlargement, 8 former satellite countries joined the EU, seeking to realize the ideal of European integration while new members are being admitted to the union. With its clear objective and high hopes, the effect of the European economic integration and the effectiveness of economic convergence has been a recurrent topic that scholars debate.

The traditional view represented by the neoclassical growth theory holds that countries will tend to grow to a steady income growth rate over time [3]. The countries falling behind tend to grow faster until they reach the steady rate as the leading countries, hence the convergence [3]. This theory has been consolidated by studies in late years [4]. Yet, an inconsistent convergence pattern has been the main theme throughout the late 20th century: from divergence in the 1980s [5-6] and convergence since the 1990s [7-8]. Similarly, Barry identifies three periods of time with different convergence patterns in European Union [9]. The existing literature shows that the convergence pattern changes vis-à-vis the ever-changing global economic climate. The newly evolved situations in the present day would also bear on today's EU convergence pattern.

It is no secret that COVID-19 has reshaped people's way of life and the global economy dramatically within the three years since its breakout. It not only caused

1,788,613 deaths in Europe as of Feb. 13, 2022 but also resulted in the largest global financial recession since the 2008 Global Economic Crisis and is the most imperative issue in today's world. The catastrophic recession has caused the EU real GDP to fall by 6.1%, even higher than the 4.348% decline in 2008 after the GEC [10]. Similar damage has been done to households as a study finds out that with EU discretionary discal policy, the income loss is reduced from -9.3% to -4.3%. Research also suggests that the COVID-19 crisis will widen the income inequality in Europe, with the estimated Gini coefficient increasing by 2.2% in Europe [11]. Therefore, it is vital to study the impact of a recession this damaging on the persistent effort in fostering convergence in the European Union.

In order to investigate the convergence pattern in the EU, a formal definition of convergence needs to be established. The European Union designated four criteria for measuring convergence: price stability, sound, sustainable public finances, exchange-rate stability, and long-term interest rates. This study will center on these four formal criteria for convergence while also considering practical development indicators such as GDP per capita, education level, and political stability. This quantitative research will use empirical analysis on the various parameters that characterize economic convergence. The research will contribute to the existing literature in two ways: 1) we re-examine the convergence pattern with the addition of new EU member states and in a context of ongoing global economic and health crises. 2) this research incorporates variables and factors that capture the issues of heterogeneity and endogeneity, which are rarely represented in previous research.

The structure of this paper is as follows: Section 2 describes the data and the methodology employed in this study. Section 3 discusses the findings and results obtained by the model. Section 4 raises a discussion about the implications of the findings and guides how the income gap could be closed in the current context. Section 5 is a conclusion of everything stated in the previous sections

2. METHOD

2.1 Data

The data used in this research are secondary and collected from reputable sources (As shown in Table 1). The GDP per capita data were collected from World Bank (2021). The population growth rate and employment rate were retrieved from European Commission's website Eurostat (2021). The investment ratio (harmonized index of consumer prices), HICP, long-term interest rate, and national debt ratio data were all retrieved from European Central Bank (2022). Table 1 lists all the 25 member states« of the EU since the last joined in 2012 over the considered period (2012-2021) with their mean values of each variable. The country with the highest GDP per capita in Luxembourg, with $114530.36, and the lowest is Bulgaria's $8690.73.

Table 1. Average of the data collected for the 27 EU countries, 2012-2021.

Country	GDP PC	Population Growth Rate*	Investment Ratio GDP	National Debt Ratio	HICP	Employment Rate Growth	Long-Term Interest Rate
Austria	49133.9960	0.6600	24.7760	80.5383	1.8000	-0.0027	3.1606
Belgium	45607.2743	0.4900	24.1530	105.1334	1.6000	0.0066	6.0825
Bulgaria	8690.7291	-0.6550	20.4360	23.1625	0.9100	-0.0037	4.7918
Croatia	14009.8153	-0.9400	21.8220	78.7601	1.1400	-0.0044	3.6651
Cyprus	27389.1810	0.5600	17.3450	101.0891	0.3700	0.0086	3.8193
Czech Rep.	21275.6997	0.1800	26.5620	38.1287	1.9800	0.0069	3.3857
Denmark	59657.8163	0.4900	21.4410	39.5248	0.8200	0.0140	2.5111
Estonia	20944.9380	0.0000	27.4450	11.5293	2.2100	0.0192	2.8021
Finland	48239.9439	0.2800	23.4300	61.5182	1.2400	0.0125	1.5866
France	40441.9129	0.4000	23.3950	99.6849	1.1400	0.0166	2.1535
Germany	45757.8433	0.3600	20.8330	69.8322	1.4300	0.0163	1.5185
Greece	19613.7450	-0.4000	12.6950	183.1313	-0.0700	0.0129	1.9560
Hungary	14912.8590	-0.2600	23.9990	74.9457	2.5200	0.0203	1.4441
Ireland	69966.7713	0.9200	30.4130	79.9229	0.6300	0.0229	1.5243
Italy	33371.6883	-0.1160	17.7890	137.8184	0.9600	0.0171	1.4987
Latvia	16248.1935	-0.8700	23.9430	40.1373	1.4800	0.0264	1.5798
Lithuania	17526.3809	-0.7700	18.1980	40.1531	1.8700	0.0194	1.1365

Luxembourg	114530.3585	2.1300	18.1440	22.0898	1.4600	0.0176	1.4426
Malta	27701.5248	2.2600	21.0140	54.8627	1.3100	0.0202	1.5641
Netherlands	50931.5332	0.5000	20.6000	59.3085	1.5500	0.0148	0.4288
Poland	14314.3292	-0.1000	19.7280	52.6631	1.7500	0.0133	1.0816
Portugal	21831.0270	-0.2400	16.9710	128.6043	0.8000	0.0009	0.7235
Romania	12036.4111	-0.4900	24.6160	38.9986	2.2000	-0.0104	0.4175
Slovakia	18362.3142	0.1222	21.6730	53.5025	1.5800	-0.0081	0.6789
Slovenia	24324.6798	0.2700	19.9660	73.4434	1.1000	0.0491	0.3167
Spain	28485.3990	0.1300	19.3840	101.4636	1.0000	0.0956	0.4579
Sweden	55388.2222	0.9900	24.4570	39.9038	1.2300	0.0880	0.6287

Note: The symbol * indicates for the regression purposes, we will use population growth = population growth rate + 1. This is to normalize the data in order to take the log for linear regression

Regarding population growth, Malta has the highest annual growth rate of 2.26%, while the lowest was found in Croatia, with a decline rate of 0.94%. The country with the highest investment ratio as a percentage of GDP in Ireland, with an investment ratio of 30.41%, and the country with the lowest ratio is Portugal's 16.97%. In terms of the national debt ratio, not surprisingly, Greece has the highest ratio of 183.13%, Estonia has the lowest at 11.53%. Regarding employment rate, Sweden has the highest rate of 72.27%, and Greece's employment rate is only 53.63%. Bulgaria leads the long-term interest rates with 4.79%, while Slovenia has the lowest at 0.3167. Hungary has the highest HICP of 2.52, and the lowest being Greece's -0.07—the only negative value in this category.

Table 2. Pairwise correlation coefficients

	GDP PC	Pop. Growth Rate	Invest Ratio GDP	Employ. Rate	HICP	Long Term Interest Rate
GDP PC	1					
Pop. Growth	0.728	1				
Invest. GDP Ratio	0.114	0.103	1			
Employ. Rate	0.321	0.342	0.428	1		
HICP	-0.145	-0.080	0.501	0.381	1	
Long-Term Interest Rate	-0.051	-0.073	0.162	-0.111	-0.077	1

Note: GDP PC stands for GDP Per capita; pop. growth rate stands for population growth rate; invest;GDP ratio stands for investment-to-GDP ratio; employ. rate stands for employment rate. HICP stands for harmonized index of consumer prices.

Table 2 presents the correlations between variables used in this experiment. Overall, there is no strong correlation between the variables considered in this study. The pairwise correlations between variables span from 0.10 to 0.50. There is, however, a strong correlation between the population growth rate and the dependent variable GDP per capita. This phenomenon is supported and confirmed in Peterson's (2017) research: If population growth and per capita GDP growth are completely independent, higher population growth rates would lead to higher economic growth rates [12].

2.2 Empirical Models

There are two approaches widely used by international organizations and economists to discuss and evaluate income convergence [13]. The first approach to analyze income convergence is developed by Mankiw et al. [14]. This Mankiw model is exemplified by eq. (1):

$$log(y_{t,i}) = ?_0 + ?_1 \, log??y_{0,i}) + ?_i \qquad (1)$$

where $y_{i,t}$ represents the GDP per capita of country *i* in year *t*, and $y_{0,i}$ represents the GDP per capita of country *i* at the initial year of a period of t years. After running a cross-sectional linear regression analysis using OLS estimator, we will find the estimate of the coefficient β_1. In this model, coefficient β_1 has great significance to determine the income convergence pattern: if $\beta_1 > 0$, then the Mankiw model would suggest income divergence; if $\beta_1 < 0$. then the Mankiw model would suggest income convergence. Additionally, the implicit rate of convergence λ_1, which measures the average speed of income convergence, can be calculated as shown by eq. (2):

$$\lambda_1 = \frac{-log\,(1+\beta_1)}{\tau} \qquad (2)$$

The second approach to analyze income convergence pattern is developed by Islam [15] from the adaptation of the 1956 Solow growth model [3]. This approach is also known for panel analysis; thus, it entails panel data and related econometric skills. This model includes the Solow growth model's traditional variables: production output (*Y*), physical capital (*K*), and human capital (*L*).

So, we use GDP per capita, $y_{i,t}$, to denote production output, investment-to-GDP ratio, $k_{i,t}$, to evaluate physical capital, population growth, $n_{i,t}$, and employment rate, $e_{i,t}$ to quantify human capital. In order to overcome the difference in the original value of each variable, this model uses the log-log specification to emphasize the percentage change. Additionally, u_i and η_t are respectively country effect and time effect. This proposed model can be explained by eq. (3):

$$log(y_{i,t}) = u_i + \eta_t + \beta_1 log(y_{i,t-1}) + \beta_2 log(k_{i,t}) + \beta_3 log(n_{i,t}) + \beta_4 log(e_{i,t}) + \beta_5 CD_{i,t} + \varepsilon_{i,t} \quad (3)$$

In the above equation, $y_{i,t-1}$ is the GDP per capita in country *i* in year *t-1*, With the purpose to analyze the impact of Covid-19 crisis as a shock on the income convergence patterns in European Union, we add dummy variable $CD_{i,t}$ where if the country *i* in year *t* suffers

from Covid-19, the value is one; otherwise, the value is 0. Similar to the first model, we can calculate the implicit rate of convergence, λ_2, measuring the average income convergence speed, for Islam Model by eq. (4):

$$\lambda_2 = \frac{-log\,(\beta_1)}{\tau} \quad (4)$$

Since the Islam model is a dynamic model containing lagged dependent variables that might be correlated with the error term, due to this endogeneity, OLS estimated parameters would be biased. Thus, a system GMM estimator is employed for this model to ensure consistency. Blundell and Bond [16] propose the System GMM model to produce robust estimations if autoregressive processes are persistent. It is common knowledge that GMM estimators are consistent if there is no second-order autocorrelation and the instruments employed are exogenous and valid. To test the validity of our results and correct specification of the system GMM estimator, we will report the Arellano-Bond test of second-order autocorrelation as known as AB(2) and the Hansen test of overidentifying restrictions.

3. RESULTS

We run two OLS linear regressions for the first approach to analyze the cross-sectional data and estimate convergence pattern before and after the Covid-19 shock proposed in eq.1 and eq.2 The cross-sectional estimation and statistical analysis of EU income convergence are shown in Table 3 and Figure 1.

The linear regression model used for Panel (A) and Plot (1) guided by eq. (1) is:

$$diff1 = \beta_0 + \beta_1 x \quad (5)$$

where *diff1* stands for the difference between $log(y_{2019})$ and $log(y_{2012})$ and x stands for $log(y_{2012})$. Column (b) presents the estimated results for β_0 (constant) and β_1 for eq. (5). Plot (1) provides the data points and the linear regression line.

Similarly, the linear regression model used for Column (b) and Plot (2) is:

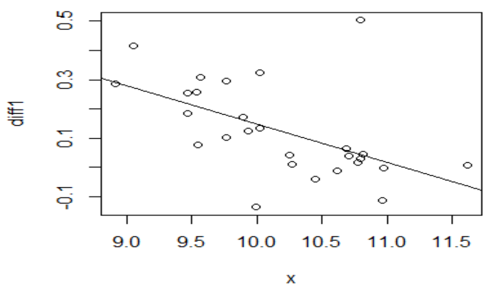
$$diff2 = \beta_0 + \beta_1 x_2 \quad (6)$$

where *diff2* stands for the difference between $log(y_{2021})$ and $log(y_{2019})$ and x_2 stands for $log(y_{2019})$. Column (b) presents the estimated results for β_0 (constant) and β_1 for eq. (6). Plot (2) provides graphical data points and the linear regression line.

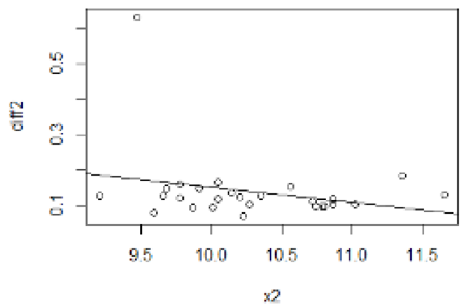
Table 3. Convergence analysis with OLS regression for the 27 EU counties before and after Covid-19 shock

	Pre-Covid Column(a)	Post-Covid Column(b)
Intercept	0.13 *** (0.03)	0.14 *** (0.02)
x	-0.09 ** (0.03)	
X^2		-0.03 ** (0.02)
λ = -[ln(1+β)/t]	1.76%	0.45%
N	27	27
R^2	0.30	0.07

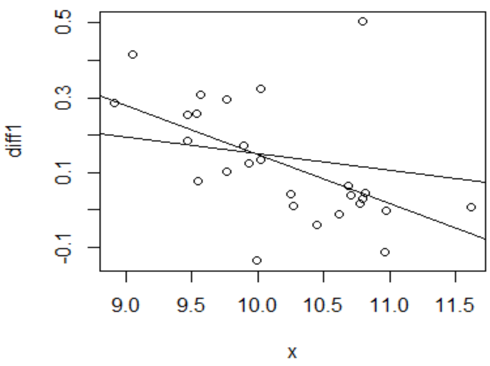
Notes: All continuous predictors are mean-centered and scaled by 1 standard deviation. The symbols *, **, and *** refer respectively to significance levels of 0.1, 0.05, and 0.01.



Plot (1)



Plot (2)



Plot (3)
Figure 1 Plot

According to Hans-Friedrich-Eckey and Matthias Türck, the parameter β_1 is a very significant index to explain the income convergence between countries in the Europe Union [17]. This approach employs two linear regressions to estimate the convergence pattern before and after the Covid-19 shock. The year 2020 is the beginning of the European countries slowly entering the epidemic era. In Column (a) and Plot (1), we observe the estimation of β_1 in eq. (5) has a negative value of -0.13167 and thus the implicit convergence rate, λ = 1.76%. After the Covid-19 shock, we are observed from Column (b) and Plot (2), the estimation of β_1 in eq. (6) has a negative value of -0.04373 and thus the implicit convergence rate, λ = 0.45%. As expected, since β_1 in both eq. (5) and (6) are the slope coefficient of the linear regression lines, from Plot (1), (2), and (3), we observe that the absolute value of slope coefficient β_1 decreases from 0.13167 down to 0.04373, which implying a slowdown caused by Covid-19 from 2020 in the income convergence pattern for 27 EU countries since 2012.

For the second approach, we run two System GMM regression to estimate the Islam model defined in Eq. (3) and calculate the convergence rate of convergence λ defined in Eq. (4). The corresponding regression results are provided in Table 4. Technically, we employ two ways, including country-specific and time-specific effects, System GMM estimation in two steps. In Column (a), from the model described in Eq. (3), we include the traditional variables in the Solow model: the lagged log of the GDP per capita, the log of investment-to-GDP ratio, the log of population growth, and the log of employment rate. Then, Column (b) presents GMM regression of the model with dummy variable Covid to evaluate each shock. In terms of statistical tests, Table 4 reports Hansen tests and AB (2) tests for both Columns (a) and (b) that are consistent with the hypothesis that the model is correctly specified, and we observe no serial correlation of second order.

Table 4. Dynamic estimates are controlling for the Covid-19 shock.

	(a)	(b)
Lagged log(y)	0.801*** (0.019)	0.905*** (0.010)
Log (Investment GDP Ratio)	0.015 (0.051)	0.017 (0.073)
Log (Population Growth)	-0.002 (0.08)	-0.003 (0.09)
Log (Employment Rate)	0.737*** (0.18)	1.413*** (0.31)
Covid		-0.076* (0.04)
Constant	-3.461*** (0.83)	-5.832*** (1.25)
Implied $\lambda = -(\ln(\beta)/t)$	2.22%	1.00%
Observations	236	236
Instruments	15	15
Hansen test	0.72	0.81
AB (2) test	0.54	0.10
Wald $\chi 2$	1618.16	2296.89

Notes: System GMM regressions with standard errors in parentheses. The symbols *, **, and *** refer respectively to significance levels of 0.1, 0.05, and 0.01.

Observing our coefficient estimates in Columns (a) and (b), we see that both regressions produce the expected positive signs for lagged GDP per capita and the investment-to-GDP ratio. Similar to the estimation of the average convergence rate by the first approach, in columns (a) and (b), we see that the implied convergence rate, λ, decreases from 2.22% in the pre-Covid period to 1.00% in the post-Covid period. There was an obvious trend of slowdown. This average convergence rate in EU countries from 2012 to 2019 is consistent with what Matkowski, Prochniak, and Rapacki have estimated [18]. However, Altun also in 2016 predicted that it would take 14.5 years for poorer countries in the EU to catch up with the richer countries at 2016 levels, implying a convergence rate of 6.89% [19]. We can observe a negative change in the implicit convergence rate λ is due to the Covid-19 shock.

4. DISCUSSION

From both approaches to analyze income convergence and our regression results, we can infer that richer EU countries than the poorer EU countries are less affected by COVID-19 in terms of GDP per capita. As the results of both models demonstrate, the convergence between EU member states has been slowed down by

Covid-19. Considering that all member states have increased their budget deficits, it implies that this slowdown is likely the result of the extreme growth of budget deficit in prominent EU member states such as France, Italy, and Spain. This enlarged deficit, coupled with the decrease in trade and tourist activities between countries, has made countries that rely on tourism, international trade, and manufacturing the biggest victims of the COVID-19 crisis. France, for example, suffers a -75% of added value at basic prices in its accommodation and catering industry [20]. Such a sharp decline in the service sector is likely still the case in the foreseeable future until the impact of the pandemic has been exterminated. Meanwhile, it is worthwhile to discuss how countries could better cope with the pandemic by accelerated efforts in other industries to compensate for the losses suffered in the service, manufacturing, and energy industries.

However, the Covid-19 crisis did not cause an obvious divergence in EU member states contrary to most people's expectations. This slowdown in convergence instead of divergence demonstrates the resilience of the EU economy. This is possibly due to the rise in the IT industry after 2010. The new rising IT companies, such as Zoom, Google, and Meta, allow their users to carry out daily business through online platforms and virtual environments. Thus, less disturbance in the economy in EU member states is caused compared to former economic crises such as the 2008 Recession. The decreased human activities have offered an extra boost in the demand for online services and compelled IT workers to come up with more innovative solutions to address the ever-changing needs of their customers to deal with formidable challenges of the same kind in the future. The versatility with which the IT services offer is likely to continue to grow. The pandemic could be seen as an opportunity to accelerate the implementation of technological innovations in the fast-paced economy.

At the same time, we think there is still room for improvement in our models. For the first model, the potential problem is that observations are too few to assume normality. Thus, our second model, the System GMM panel data model, can better deal with potential normality problems. Still, there are problems with the System GMM model. Since most countries still suffer from Covid-19, it might be early to make decisive conclusions. Also, since the Covid-19 shock happened in the year 2020, as to today, we can only collect data of at most 2 years. The few years of observations of this study might undermine the validity and consistency of our results. So, further studies with more data should be conducted to properly evaluate the impact of Covid-19 on the EU income convergence pattern. In addition, from the macro-level to evaluate the variable selection, there are still many factors that can influence the convergence of the EU. For example, it is not enough to study only the economy and the impact of COVID-19 on EU convergence. There are many aspects to consider, such as geographical issues, historical issues, changes in EU internal policies, and other factors that affect the convergence.

5. CONCLUSION

This research investigated the effect of the ongoing COVID-19 crisis on EU countries' convergence patterns. Using linear regression and data analysis concretized the slowing down of EU convergence. It established the ground that countries with a higher initial GDP per capita and stronger fiscal infrastructure are affected less than poorer countries.

The findings in this research confirm that a crisis is likely to slow down the steady rate of convergence between countries and result in different patterns among countries based on their infrastructure soundness and the composition of domestic industries. Policies and initiatives should be made accordingly with these discoveries to ameliorate better the financial predicament in which the countries are suffering the most from the pandemic. It should also provide useful data and methods that can be further specified and optimized in future studies to locate the underlying factors that impact a country's crisis aversion abilities.

Some possible improvements can be made in future research, as the data we worked with were limited due to the relatively short span of the ongoing pandemic. In addition, some further optimization of the model could be made when more data becomes available. A more comprehensive model could then establish the normality between independent variables and GDP per capita in a clearer way.

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