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Research Article

The impact of physical capital, industry value added and foreign direct investment on economic growth: Evidence from EU countries

Fiziksel sermaye, sanayi katma değeri ve doğrudan yabancı yatırımların ekonomik büyüme üzerindeki etkisi: AB ülkelerinden kanıtlar

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Abstract

This study examines the relationships among economic growth, physical capital, industry value added, foreign direct investment, and the labour force in a panel of European Union (EU) countries over the period 1995-2024, using panel data analysis. First, a cross-sectional dependence test was applied across the series, revealing a strong interdependence structure across countries. Unit root tests were then conducted, and the Panel ARDL method was deemed appropriate based on the series' stationarity. However, due to the strong cross-sectional dependence and heterogeneity identified in the panel, it was ultimately decided to use the CS-ARDL model to obtain more reliable results. The findings indicate that the industry value-added variable has an adverse, statistically significant effect on economic growth in the short-term analysis. In contrast, the short-term effects of the other variables are not significant. The long-term analysis results indicate that industry value added and physical capital variables positively affect economic growth. In contrast, the long-term coefficients for the foreign direct investment and labour force variables were not statistically significant. Overall, these results indicate that physical capital and value-added creation in industrial production are the primary determinants of economic growth sustainability in a sample of EU countries. However, the failure of foreign direct investment and labour supply to make a significant long-term contribution to growth suggests a need to revise structural policies in these areas.

Keywords: Economic Growth, Physical Capital, Industry Value Added, Foreign Direct Investment, Labour Force, CS-ARDL Model

Jel Codes: O40, E22, C33

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Öz

Bu çalışmada, 1995-2024 döneminde Avrupa Birliği (AB) ülkeleri örnekleminde ekonomik büyüme ile fiziksel sermaye, sanayi katma değeri, doğrudan yabancı yatırımlar ve işgücü arasındaki ilişki panel veri analiziyle incelenmiştir. Öncelikle seriler arasında yatay kesit bağımlılığı testi uygulanmış ve ülkeler arasında güçlü bir bağımlılık yapısının varlığı ortaya konmuştur. Daha sonra birim kök testleri gerçekleştirilmiş ve serilerin durağanlık düzeylerine göre Panel ARDL yönteminin uygun olduğu tespit edilmiştir. Ancak nihai olarak panelde belirlenen güçlü yatay kesit bağımlılığı ve heterojenlik nedeniyle daha güvenilir sonuçlar elde edebilmek amacıyla CS-ARDL modelinin kullanılmasına karar verilmiştir. Elde edilen bulgular, kısa dönem analizlerinde sanayi katma değeri değişkeninin ekonomik büyüme üzerinde negatif ve istatistiksel olarak anlamlı bir etkiye sahip olduğunu, diğer değişkenlerin kısa vadeli etkilerinin ise anlamlı olmadığını göstermektedir. Uzun dönem analiz sonuçlarına göre ise sanayi katma değeri ve fiziksel sermaye değişkenlerinin ekonomik büyüme üzerinde pozitif yönde etkiler ürettiği belirlenmiştir. Buna karşın, doğrudan yabancı yatırımlar ve işgücü değişkenlerinin uzun dönem katsayıları istatistiksel olarak anlamlı bulunmamıştır. Bu sonuçlar genel olarak değerlendirildiğinde, ekonomik büyümenin sürdürülebilirliği açısından fiziksel sermaye ve sanayi üretiminde katma değer yaratımının AB ülkeleri örnekleminde temel belirleyici unsurlar olduğunu göstermektedir. Bununla birlikte, doğrudan yabancı yatırımların ve işgücü arzının uzun vadede büyümeye anlamlı katkı sağlamaması, bu alanlarda yapısal politikaların gözden geçirilmesi gerektiğine işaret etmektedir.

Anahtar Kelimeler: Ekonomik Büyüme, Fiziksel Sermaye, Sanayi Katma Değeri, Doğrudan Yabancı Yatırımlar, İşgücü, CS-ARDL Modeli

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Introduction

One of the main factors influencing economic growth is physical capital, which plays a critical role in increasing productivity by directly affecting production processes. Solow (1956) emphasised that the accumulation of physical capital enables businesses to use the same amount of labour to create more, thereby increasing productivity. In his later work, Solow (1996) highlighted the importance of technological progress and physical capital in the economic growth process.

Because it may boost production capacity and fortify economic infrastructure, physical capital accumulation is regarded as one of the primary drivers of economic growth (Sen, 2013). Investments in infrastructure, machinery, and technology increase the efficiency of production processes and support the structural transformations necessary for sustainable development. Additionally, physical capital contributes to creating a favourable economic environment for both local and international investors, thereby encouraging capital inflows (Casi and Resmini, 2017). This is particularly important for developing countries, where physical capital plays a critical role not only as a factor of production but also in terms of technology transfer and adaptation (Hacıimamoğlu and Sungur, 2024). Physical capital investments facilitate the adoption and diffusion of technological innovations, thereby increasing total factor productivity. In light of this, analysing how physical capital affects economic growth in European Union (EU) countries is a crucial topic for a deeper understanding of growth dynamics. In this context, the study's first research question is: What is the impact of physical capital on economic growth in EU countries?

Foreign direct investment (FDI) has become a strategically important tool for many countries due to the external resources it provides for financing economic growth, as well as its contribution to advanced technology transfer and the development of corporate management skills (Alfaro, 2017). In particular, developing countries are prioritising policies to improve the investment environment to take advantage of the potential benefits of FDI in today's world, where economic, commercial, and technological barriers have been reduced by globalisation (Demirsel, Adem, and Mucuk, 2014). The impact of FDI on economic growth is frequently emphasised in the literature, as it not only accelerates capital accumulation but also promotes technological development, improves the quality of human resources, and increases efficiency through interactions with local firms (Feeny, Iamsiraroj, and McGillivray, 2014; Simionescu and Naroş, 2019). Furthermore, FDI contributes to the establishment of direct, stable, and long-term relationships between economies as part of global economic integration (Giammanco and Gitto, 2019). In this context, many countries prioritising economic growth view FDI as a tool for both attracting investment and supporting the development process (Vo, Vo, and Zhang, 2019). Within this framework, the second research question of the study is: What is the impact of FDI on economic growth in EU countries?

FDI promotes industrialisation by directing capital flows to industry, thereby supporting sustainable economic prosperity (Mehmood, Iqbal, Bashir, and Ahmad, 2022). One of the main forces for economic expansion is acknowledged to be the industrial sector, especially in low- and middle-income nations. Countries with well-developed, competitive industrial infrastructure increase production capacity and achieve a stronger economic position in both domestic and foreign markets, thereby demonstrating faster growth rates (Azolibe, 2022). Industrial activities support economic development through their multidimensional effects, such as job creation, increased national income, technical progress, and reduced price-level pressures (Maroof, Hussain, Jawad, and Naz, 2019). Additionally, the industry sector indirectly contributes to the development of other economic sectors, such as transportation, agriculture, mining, trade, and services, thereby laying the groundwork for comprehensive growth. In this context, the third and final research question of this study is: What is the impact of industry value added on economic development in EU countries?

The sustainability of economic growth has long been a key topic of debate among policymakers and researchers. Effective policymaking in this setting depends on identifying the factors that influence growth and assessing their immediate and long-term impacts. In countries with a high level of economic integration, such as the EU, the analysis of the effects of macroeconomic variables such as physical capital accumulation, industry value added, and FDI on growth is of particular importance for understanding regional development dynamics and developing standard policies. Despite their varying levels of development, EU countries operate within a common economic framework, making them a meaningful and representative sample for examining the effects of capital accumulation, industry value added, and FDI on economic growth. This study has a strong motivation to understand how these variables operate in EU countries by comparatively examining the effects of physical capital, industry value added, and FDI on growth.

The main purpose of this study is to examine the dynamic relationships among economic growth, physical capital, industry value added, FDI, and the labour force in EU countries over the period 1995-2024 using panel data analysis methods. In this context, the study makes significant contributions to the literature in three respects. First, a holistic framework is presented by jointly examining the effects of physical capital, industry value added, FDI, and the labour force on economic growth across a sample of EU countries. Second, advanced panel data analysis techniques such as Panel ARDL and CS-ARDL increase the reliability of the results, especially under conditions of strong cross-sectional dependence. Third, by decomposing short- and long-term effects, the paper presents practical implications for policymakers, providing empirical evidence on how short-term costs should be balanced with long-term growth targets.

The study is structured into interconnected sections. The second section systematically examines prior research in the relevant field and provides a comprehensive literature review. The third section explains the study's methodology in detail, presents the data sources and the econometric methods applied, and presents the empirical findings from the analysis. The fourth and final section provides an overall assessment of the findings, summarises the results, and offers policy recommendations and implications for future research.

Literature review

In this study, relevant studies are categorised to provide a more systematic understanding of the literature and to more clearly identify gaps. First, studies examining the relationship between physical capital and economic growth; second, studies addressing the relationship between FDI and economic development; and third, studies analysing the relationship between industry value added and economic growth are presented under separate headings. The fourth section examines research on EU countries that includes the variables used in this study; it also evaluates methodological and contextual gaps in the existing literature, highlighting the potential contributions of this research.

The relationship between physical capital and economic growth

Various empirical studies using time-series analysis reveal that physical capital has a significant, positive effect on economic growth. In this context, Li, Wang, Westlund, and Liu (2015) emphasised the contribution of physical capital to growth in the Chinese economy in their study covering the 1981-2010 reform period, and their empirical findings confirmed the positive relationship. Similarly, Pomi, Sarkar, and Dhar (2021) conducted an analysis using the Vector Autoregression (VAR) model for Bangladesh between 2000 and 2019, finding that physical capital contributed to economic growth across different time periods. Another study on the Bangladesh economy, Bhattacharjee, Akter, and Jahan (2022), showed that the effect of physical capital on growth was positive and significant in both the short and long term, using the ARDL bounds test approach for the period 1990-2021.

Bunyamin (2022) examined the relationship between physical capital and economic growth in Indonesia between 1970 and 2017 using the ARDL model, and the findings revealed that physical capital played a stable and effective role in shaping economic growth in the long run. Similar results were reached in two different studies on the Pakistani economy. Asad, Bibi, and Akhtar (2023) emphasised the decisive effect of physical capital on economic expansion in their analysis covering the period 1990-2020, while Ishfaq, Rasool, Asghar, Karim, and Ahmad (2024) identified a positive relationship between physical capital and economic growth in their study using various econometric methods for the period 1971-2020. In a survey conducted by Agbolosoo, Septya, and Hutagoal (2025), covering the period 1970–2023, the impact of physical capital on Indonesia's economic growth was analysed. The Johansen cointegration test indicated that physical capital has a statistically significant, positive impact on economic growth. In the study by Hacıimamoğlu and Sungur (2024), the effect of physical capital on economic growth in Turkey was examined using the Bootstrap Fourier Granger Causality Percentages (BFGC-Q) method, based on data for the period 1970–2017. The analysis revealed a positive and significant causal relationship between physical capital and economic growth. These findings generally suggest that physical capital accelerates growth by increasing production capacity and is a strategic element for long-term development goals.

However, some empirical studies reveal that the effect of physical capital on economic growth is either insignificant or weak. For example, Shah, Ahmad, Aslam, and Subhani (2020) analysed the relationship between physical capital formation and economic growth in their study covering the period 1976-2015 for the Pakistani economy using the Johansen cointegration test and the Vector Error Correction Model (VECM). However, they found that physical capital formation had no significant effect on economic growth. Similarly, Islam and Alhamad (2023) examined the impact of physical capital on economic growth in their study covering the period 1985-2019 for Saudi Arabia using the nonlinear ARDL

(NARDL) model, cointegration regressions, and VEC Granger causality tests. They concluded that, despite a cointegration relationship between the variables, physical capital did not affect economic growth at the 5% significance level. These findings suggest that the effect of physical capital on growth may vary across countries and by method.

Some panel data studies have found that the effect of physical capital on economic growth varies across country groups. Joshua (2016) used a fixed-effects model in his analysis of 74 developing and 47 developed countries over the period 2005-2011, finding that physical capital had a significant and positive effect on economic growth in developed countries. Still, this effect was not statistically significant in developing countries. Similarly, Uddin, Sadik, and Rahman (2025) applied advanced econometric methods to panel data analysis in their study covering the period 1990-2019, specifically for BIMSTEC countries, and found that physical capital had a positive effect on economic growth in the long run. Still, this effect was limited in the short run.

The relationship between FDI and economic growth

FDI has positive, statistically significant benefits for economic growth, according to several empirical studies based on time-series analysis. Using conventional analytical techniques and a set of macroeconomic variables, Noori (2019) concluded that FDI had a beneficial impact on economic growth in his research of Jordan from 2000 to 2017. Similarly, Nguyen (2020) used the least squares method to find a significant and favourable influence of FDI on economic growth in his study of the Vietnamese economy spanning 2000–2018. Using an ARDL model, Raihan (2024) examined the economy of the same nation from 1990 to 2021 and showed that FDI boosted economic growth over the long run. An ARDL model-based analysis of the Nigerian sample for the 1990–2020 period was conducted by Elrasheed and Muhammad Abdullahi (2022), who found a long-term positive correlation between FDI and economic growth. Similar findings were made by Mose and Kipchirchir (2024) in their analysis of the Kenyan economy, which used data from 1990 to 2021. The ARDL model and causality tests showed that FDI had both short- and long-term beneficial effects on economic growth. Lastly, using a variety of econometric techniques, including DOLS, FMOLS, and CCR, in addition to the ARDL method, Raihan et al. (2025) carried out a study on the Egyptian economy for the 1990–2021 period, confirming that FDI has positive and statistically significant effects on economic growth in both the short and long term.

Contrary to predictions, some empirical research using time-series analysis suggests that FDI may have a detrimental impact on economic growth. In this regard, Mawutor et al. (2023) used data from 1980 to 2018 using an autoregressive distributed lag (ARDL) model to examine the effect of FDI on economic growth in the Ghanaian economy. The results demonstrate that FDI has a statistically significant and adverse impact on economic growth over the long and short terms. Similarly, Mamun and Kabir (2023) examined the impact of FDI on economic growth in Bangladesh between 1976 and 2019. FDI has a substantial and detrimental impact on economic growth, according to the analysis, which used the ARDL bounds test. These results imply that FDI's ability to boost economic growth in developing nations may differ across a range of variables, including institutional architecture, sectoral distribution, and investment orientation.

These findings can be elucidated through theoretical mechanisms, such as the distinction between brownfield and greenfield investments. Brownfield investments, which involve the acquisition of existing local firms, may lead to adverse effects by crowding out domestic enterprises, reducing local competition, or disrupting established economic structures. Additionally, the nature of horizontal FDI investments within the same industry can exacerbate these effects by intensifying competition and potentially displacing local firms, thereby hindering overall economic growth. These mechanisms highlight the context-specific challenges that may undermine the anticipated benefits of FDI in certain economies.

Various studies using panel data show that the impact of FDI, one component of physical capital, on economic growth varies across country groups and development levels. In this context, Iamsiraroj (2016) examined the relationship between FDI and economic growth using a simultaneous equation system approach using data covering 124 countries for the period 1971-2010. The findings reveal that FDI has a positive and bidirectional relationship with economic growth. Similarly, Okwu, Oseni, and Obiakor (2020), in a panel data analysis of 30 leading economies worldwide for the period 1998-2017, found that FDI has a significant and positive impact on economic growth. Banday, Murugan, and Maryam (2021) investigated the long-run relationship between FDI, trade openness, and gross domestic product in the BRICS countries using data from 1990 to 2018. Their analysis, using an autoregressive distributed lag (ARDL) model, showed that FDI has a positive impact on long-term economic growth. Furthermore, Darwin, Wulan Sari, and Heriqbaldi (2022) conducted a panel-data study using dynamic GMM methods across 21 developing Asian countries from 2005 to 2019, demonstrating that FDI has a significant and positive impact on economic growth. Finally, Kusairi, Wong, Wahyuningtyas, and Sukemi (2023) examined data from 16 developed countries over the period 2006 to 2019 and empirically demonstrated that FDI supports economic growth in these countries.

This relationship varies across country groups, income levels, and cyclical conditions, as indicated by the literature on the effect of FDI on economic growth. For instance, in their panel data analysis of 19 Latin American nations from 1980 to 2014, Alvarado, Iñiguez, and Ponce (2017) found that the overall impact of FDI on economic development was not statistically significant. FDI had an inconsequential and unequal effect in upper-middle-income nations, an adverse, statistically significant effect in lower-middle-income countries, and a positive, statistically significant impact in high-income countries, according to analysis by country group. Similarly, Dinh, Vo, The Vo, and Nguyen (2019) used the FMOLS approach, the Vector Error Correction Model (VECM), and the Johansen cointegration test to analyse the effects of FDI in lower-middle-income countries from 2000 to 2014. The results of the study indicate that while FDI can have adverse short-term consequences, it generally fosters long-term economic growth. FDI is often linked to stronger economic growth, though this influence is neither evident, consistent, nor directional, according to Acquah and Ibrahim's (2020) review of data from 45 African nations spanning 1980–2016. The findings from the two-stage system generalised method of moments (System-GMM) indicate that the context moderates the effect of FDI on economic growth.

Theoretical mechanisms, including differences between brownfield and greenfield investments, can explain these outcomes. Brownfield investments, by acquiring existing local assets, may limit job creation and innovation, thus stifling economic dynamism. Furthermore, vertical FDI, which involves investments along the supply chain, may fail to generate positive spillovers if local firms lack the absorptive capacity to benefit from such linkages, potentially leading to a net negative effect on growth. These insights underscore the importance of considering cross-sectional heterogeneity and institutional factors when assessing the economic implications of FDI.

The relationship between industry value added and economic growth

The impact of industry value added on economic growth has been the subject of numerous empirical studies, with varying findings across nations and historical times. In their research, Jelilov, Iheoma, and Isık (2016) used the F-test and the OLS method to examine the relationship between industry value addition and economic growth using Nigeria as an example for the years 2000–2013. The results show that industrialisation has a long-term detrimental effect on the Nigerian economy. Similarly, Akpan and Eweke (2017) used data from 1981 to 2015 and the VAR model with Impulse-Response Functions and Variance Decomposition techniques to investigate the impact of FDI and industry-sector performance on economic growth in Nigeria. The study found that while the industry sector can occasionally hurt economic growth, FDI has a small but statistically significant positive impact on GDP. Additionally, the results of variance decomposition show that FDI shocks account for a major portion of economic growth, with the industry sector's contribution remaining comparatively small. However, Mehmood et al. (2022) used Pakistani data from 1980 to 2020 to examine the effects of FDI and industry value addition on economic growth using the ARDL model. The empirical results show that industry value added and FDI both contribute to economic growth over the long run.

Studies on EU Countries

In the context of the study's factors, numerous studies on EU member states have been conducted. Simionescu (2016) investigated the connection between FDI inflows and economic development in EU-28 nations during the 2008–2014 financial crisis. The short data set issue was resolved using Bayesian techniques and a panel data methodology. Analysis using the Panel Vector Autoregressive (PVAR) model and the Bayesian random effects model showed that FDI and economic growth in the EU-28 nations during the post-2008 era were positively and reciprocally correlated. Similarly, from 1997 to 2014, Sen and Saray (2019) examined how physical capital affected economic growth across a sample of EU nations and Turkey. Physical capital expansion was found to be positively and significantly associated with economic development, as indicated by both static and dynamic panel data analyses.

Literature gap

The literature review highlights the limited number of studies conducted on EU countries. The majority of existing studies address key macroeconomic variables such as physical capital, industry value added, and FDI separately; however, holistic approaches that jointly analyse the effects of these variables on economic growth are insufficient. Traditional methods such as fixed-effects models, simultaneous equation systems, ARDL models, GMM, VECM, and FMOLS are generally preferred in panel data analysis. However, the CS-ARDL approach, one of the advanced methods that account for heterogeneity and cross-sectional dependence in panel data, is not sufficiently covered in the literature.

This is considered a significant methodological shortcoming, especially for samples with high levels of economic integration, such as EU countries.

Methodology

Data and sources

This study uses an annual panel dataset covering the period 1995-2024 for 27 EU member states (EU27)[1]. The World Bank's World Development Indicators (WDI) database provided the variables used in the study. Table 1 presents the variables and their descriptions. In line with the theoretical framework, gross fixed capital formation is employed as a proxy for the theoretical capital stock. It is important to note that gross fixed capital formation represents a flow variable rather than a stock measure. This common simplification is widely adopted in empirical growth analyses because long-term capital stock data are limited. All econometric analyses in this study were performed using EViews 13 and Stata 17.

Table 1: List of Variables

Variable Abbreviation	Variable Name	Explanation of Variables	Source
LGDP	Economic Growth	GDP per capita (constant 2015 US$)	World Bank Database
PHC	Physical Capital	Gross fixed capital formation (% of GDP)	World Bank Database
FDI	Foreign Direct Investment	Foreign direct investment, net inflows (% of GDP)	World Bank Database
IND	Industry, Value Added	Industry, value added (% GDP)	World Bank Database
LLAB	Labour	Labour, Total	World Bank Database

Descriptive statistics of variables

Descriptive statistics for the dependent and independent variables used in this study are summarised in the table below. The basic distributional properties of the variables are presented by providing the mean, median, minimum, maximum, and standard deviation.

Table 2: Descriptive Statistics

Statistics	LGDP (GDP per capita)	IND (Industry, value added % GDP)	PHC (Gross fixed capital formation % of GDP)	FDI (Foreign direct investment, net inflows % of GDP)	LLAB (Labour, Total)
Mean	10.0252	23.8727	22.3144	11.8311	15.0683
Median	10.0164	24.1477	21.8551	3.4237	15.2520
Maximum	11.6300	40.6817	53.2220	452.2210	17.6029
Minimum	8.1711	9.0098	4.4522	-444.7069	11.8957
Standard Deviation	0.7192	5.6486	4.1439	50.9158	1.3482

Model

The main objective of the study is to analyse the relationships among economic growth, physical capital, FDI, industry value added, and the labour force. The logarithm of economic growth and total labour force data is used. Therefore, the model is:

$$LGDP_{it} = \alpha_i + \beta_1 PHC_{it} + \beta_2 FDI_{it} + \beta_3 IND_{it} + \ \beta_3 LLAB_{it} + \varepsilon_{it} \quad (1)$$

It is established as follows. In the equation, i represents the countries (EU-27) and t represents the years (1995-2024).

Before starting the analyses, we tested for multicollinearity among the explanatory variables using the VIF criterion. High multicollinearity among variables can lead to instability of coefficient estimates and misleading significance tests by inflating standard errors.

[1] Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden

Table 3: Multicollinearity Results

Variable	VIF	Tolerance (1/VIF)
IND	1.44	0.6932
PHC	1.35	0.7428
FDI	1.10	0.9053
LLAB	1.17	0.8562
Average VIF	**1.27**	–

Multicollinearity was assessed using VIF statistics. According to Table 3, VIF values for all variables ranged from 1.10 to 1.44 (average VIF = 1.27), well below common thresholds (VIF < 5). Tolerance values also ranged from 0.69 to 0.91. These findings indicate that the model does not exhibit significant multicollinearity.

Cross-sectional dependence (CSD)

In panel data analysis, independence among the units that comprise the panel (countries, firms, etc.) is a fundamental assumption. If the impact of a shock or change in one unit on another is ignored in the face of a possible choice, cross-sectional dependence is assumed to be absent. However, in panel data sets, particularly those related to the economy, common shocks are expected to create dependence across panels. In this context, cross-sectional dependence testing is necessary. Table 4 presents cross-sectional dependence tests for variables.

Table 4: Cross-Section Dependency Test

Test Type	Statistics	p-value	Source
CD	22.44	0.000	Pesaran (2015, 2021)
CDw	12.30	0.000	Juodis and Reese (2022)
CDw+	993.71	0.000	Fan, Liao, and Yao (2015)
CD*	0.81	0.416	Pesaran and Xie (2021)

When Table 4 is examined, the classical CD test proposed by Pesaran (2015, 2021) tests whether the inter-unit correlations in the series are zero. The test result was statistically significant (CD = 22.44, $p < 0.01$); therefore, there is cross-sectional dependence in the panel.

The CDw test developed by Juodis and Reese (2022) assesses weak dependence by mitigating the oversensitivity of the classical CD test, especially in large N and T. With CDw = 12.30 and $p < 0.01$, weak dependence is also statistically confirmed in the panel.

The CDw+ test, enhanced by the power increase reported by Fan et al. (2015), is effective for assessing the strength of cross-sectional dependence. In this study, the result of CDw+ = 993.71, $p < 0.01$, indicates very strong cross-sectional dependence and strongly confirms the classic CD finding.

The CD* test, proposed by Pesaran and Xie (2021), tests for dependence by accounting for the common factor structure of the series. Here, CD* = 0.81, p = 0.416, indicating that there is no significant dependence between the residuals after removing several dominant common factors. This result suggests that the panel dependence is primarily due to strong common factors (common shocks).

When cross-sectional dependence is detected in panel data analysis, it is assumed that first-generation methods (IPS, LLC, etc.) will yield inadequate and erroneous results in unit root tests (Pesaran, 2006; 2015). In this context, Pesaran (2007) preferred the CIPS (Cross-sectionally Augmented IPS) method, a second-generation unit root test, for panel data analysis.

Unit root test

Panel CIPS

The Panel CIPS test is based on the IPS (Im, Pesaran, Shin) test. Still, it eliminates cross-sectional dependence by adding cross-sectional averages to the model for each panel unit. Table 5 presents the Panel CIPS test results for the variables included in the model.

Table 5: LGDP Variable Panel CIPS Unit Root Test Results

Level	Model	Test	Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Level	Fixed	CIPS	-1.0897	-2.3260	-2.1653	-2.0817
		T-CIPS	-1.3265	-2.3260	-2.1653	-2.0817
Level	Fixed + Trend	CIPS	-2.2946	-2.8336	-2.6790	-2.5950
		T-CIPS	-2.2946	-2.8336	-2.6790	-2.5950
1st Difference	Fixed	CIPS	-3.4724***	-2.3280	-2.1656	-2.0814
		T-CIPS	-3.4724***	-2.3280	-2.1656	-2.0814
1st Difference	Fixed + Trend	CIPS	-3.6101***	-2.8362	-2.6800	-2.5950
		T-CIPS	-3.6101***	-2.8362	-2.6800	-2.5950

Note: ***, ** and * indicate the significance level of the variables at 1%, 5% and 10% levels.

When Table 5 is examined, both the CIPS and Truncated CIPS statistics in the fixed model and the fixed + trend model fail to reject the null hypothesis even at the 10% significance level. Therefore, the LGDP variable is determined to be non-stationary at the level. When the first difference of the variable is taken, it is observed that the statistics in the fixed and fixed + trend models are below the critical values and become stationary.

Table 6: Panel CIPS Unit Root Test Results for the PHC Variable

Level	Model	Test	Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Level	Fixed	CIPS	-1.7620	-2.3260	-2.1653	-2.0817
		T-CIPS	-1.5768	-2.3260	-2.1653	-2.0817
Level	Fixed + Trend	CIPS	-2.3703	-2.8336	-2.6790	-2.5950
		T-CIPS	-2.1763	-2.8336	-2.6790	-2.5950
1st Difference	Fixed	CIPS	-4.5420***	-2.3280	-2.1656	-2.0814
		T-CIPS	-4.3950***	-2.3280	-2.1656	-2.0814
1st Difference	Fixed + Trend	CIPS	-4.9095***	-2.8362	-2.6800	-2.5950
		T-CIPS	-4.5859***	-2.8362	-2.6800	-2.5950

Note: ***, ** and * indicate the significance level of the variables at 1%, 5% and 10% levels.

When Table 6 is examined, both the CIPS and Truncated CIPS statistics in the fixed model and the fixed + trend model fail to reject the null hypothesis even at the 10% significance level. Therefore, the PHC variable is found to be non-stationary at the level. When the first difference of the variable is taken, it is seen that the statistics in the fixed and fixed + trend models are below the critical values and become stationary.

Table 7: Panel CIPS Unit Root Test Results for the FDI Variable

Level	Model	Test	Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Level	Fixed	CIPS	-4.0516***	-2.3260	-2.1653	-2.0817
		T-CIPS	-2.2280**	-2.3260	-2.1653	-2.0817
Level	Fixed + Trend	CIPS	-3.5263***	-2.8336	-2.6790	-2.5950
		T-CIPS	-3.5263***	-2.8336	-2.6790	-2.5950
1st Difference	Fixed	CIPS	-6.6271***	-2.3280	-2.1656	-2.0814
		T-CIPS	-5.8318***	-2.3280	-2.1656	-2.0814
1st Difference	Fixed + Trend	CIPS	-6.7327***	-2.8362	-2.6800	-2.5950
		T-CIPS	-6.0395***	-2.8362	-2.6800	-2.5950

Note: ***, ** and * indicate the significance level of the variables at 1%, 5% and 10% levels.

An examination of Table 7 reveals that the FDI variable is significant at the 5% level in the T-CIPS test for the fixed-at-level model. Other test results indicate that the FDI variable is significant at the 1% level, as indicated by both the CIPS and the Truncated CIPS statistics in the model. Therefore, the FDI variable is determined to be stationary at the level. When the first difference of the variable is taken, the statistics in the fixed and fixed + trend models are well below the critical values.

Table 8: Panel CIPS Unit Root Test Results for the IND Variable

Level	Model	Test	Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Level	Fixed	CIPS	-1.7248	-2.3260	-2.1653	-2.0817
		T-CIPS	-1.4970	-2.3260	-2.1653	-2.0817
Level	Fixed + Trend	CIPS	-2.1339	-2.8336	-2.6790	-2.5950
		T-CIPS	-1.7711	-2.8336	-2.6790	-2.5950
1st Difference	Fixed	CIPS	-4.6455***	-2.3280	-2.1656	-2.0814
		T-CIPS	-4.5081***	-2.3280	-2.1656	-2.0814
1st Difference	Fixed + Trend	CIPS	-4.3532***	-2.8362	-2.6800	-2.5950
		T-CIPS	-4.3156***	-2.8362	-2.6800	-2.5950

Note: ***, ** and * indicate the significance level of the variables at 1%, 5% and 10% levels.

When Table 8 is examined, both the CIPS and Truncated CIPS statistics in the fixed-at-level and fixed-plus-trend models fail to reject the null hypothesis even at the 10% significance level. Therefore, the IND variable is determined to non-stationary at the level. When the first difference of the variable is taken, it is observed that the statistics in the fixed-at-level and fixed-plus-trend models are below the critical values and become stationary.

Table 9: Panel CIPS Unit Root Test Results for the LLAB Variable

Level	Model	Test	Statistics	1% Critical Value	5% Critical Value	10% Critical Value
Level	Fixed	CIPS	−1.609	−2.3000	−2.1500	−2.0700
		T-CIPS	−1.609	−2.3000	−2.1500	−2.0700
Level	Fixed + Trend	CIPS	−2.056	−2.8100	−2.6600	−2.5800
		T-CIPS	−2.056	−2.8100	−2.6600	−2.5800
1st Difference	Fixed	CIPS	−3.054***	−2.3000	−2.1500	−2.0700
		T-CIPS	−3.054***	−2.3000	−2.1500	−2.0700
1st Difference	Fixed + Trend	CIPS	−3.380***	−2.8100	−2.6600	−2.5800
		T-CIPS	−3.380***	−2.8100	−2.6600	−2.5800

Note: ***, ** and * indicate the significance level of the variables at 1%, 5% and 10% levels.

An examination of Table 9 reveals that both the CIPS and Truncated CIPS statistics fail to reject the null hypothesis at the 10% significance level in the fixed-at-level and fixed-plus-trend models. Therefore, the LLAB variable is determined to be non-stationary at the level. When the first difference of the variable is taken, it is observed that the statistics in the fixed-at-level and fixed-plus-trend models are below the critical values and become stationary.

Homogeneity test

In panel data analysis, it is used to determine whether the long-term coefficients of the units constituting the panel are homogeneous. The Delta homogeneity test, developed by Pesaran and Yamagata (2008), is used to determine whether the panel's coefficients are homogeneous or heterogeneous. The results of this test determine whether methods such as PMG (Pooled Mean Group) or MG (Mean Group) are preferred.

Table 10: Homogeneity Test Results

Test	Test Statistic	Probability Value
Δ	34.688	0.000
Δadj	38.047	0.000

Examining Table 10, the homogeneity of the long-term coefficients of the series was tested using the Delta and Adjusted Delta homogeneity tests developed by Pesaran and Yamagata (2008). Both test results were statistically significant. Therefore, the long-term coefficients were assumed to be heterogeneous among the panel units.

In this study, the stationarity structures of the series were examined by considering cross-sectional dependence and unit root tests. According to Pesaran (2007), the CIPS test results indicated that the FDI variable was stationary at the level, while the other variables were first-differenced. In panel data analysis, when variables differ in stationarity (I(0) and I(1)), traditional panel cointegration tests (Pedroni, Kao, etc.) that assume all variables are stationary at the same level are insufficient. In this context, it was concluded that using the Panel ARDL method, which allows for modelling different levels of stationarity in panel data analysis and can estimate both the long-term cointegration relationship and short-term dynamics, would be appropriate (Pesaran, Shin, and Smith, 1999).

Panel ARDL

The Panel ARDL (Autoregressive Distributed Lag) model is a method for estimating short- and long-run relationships in panel data analysis. Panel ARDL allows both dependent and independent variables to have different stationarity levels (I(0) and I(1)) (Pesaran et al., 1999). The Panel ARDL model uses the PMG (Pooled Mean Group) and MG (Mean Group) estimators. The PMG model assumes homogeneous coefficients in the long run. The MG model, on the other hand, assumes complete heterogeneity in both the short- and long-run. In this context, the Hausman (1978) test was used to determine whether the long-run coefficients are homogeneous.

Table 11: Hausman Test Results

Estimator	Test Statistic	P-Value
MG, PMG	29.00553	0.0000

An examination of Table 11 reveals that the resulting p-value is statistically significant. Therefore, hypothesis H_0 is rejected. This indicates a statistically significant difference between the PMG and MG estimators. Consequently, it seems more appropriate to assume that the long-term coefficients are homogeneous in the panel data set and to choose the MG (Mean Group) estimator.

The homogeneity test indicates that the slope coefficients are similar in the long run. However, the Hausman test revealed a significant difference between the PMG and MG models, and that the PMG model should not be preferred. This indicates a high sensitivity to differences between models. In the subsequent stages of the study, the Hausman test was prioritised.

The next prerequisite for establishing the panel ARDL model was determining the appropriate lag length. For this purpose, the Akaike Information Criterion (AIC) was used to select the lag length, and the comparative results for 20 alternative models are presented in Figure 1.

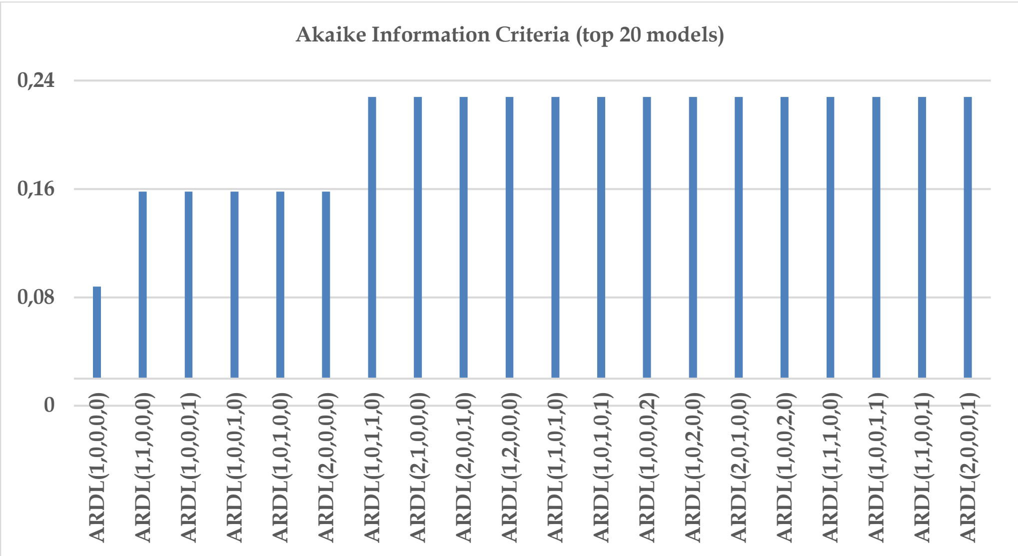

Figure 1: Panel ARDL Delay Length (Top 20 Models)

Based on the findings, the ARDL(1,0,0,0,0) model, which produces a lower AIC than other alternatives, was chosen as the most suitable structure for Panel ARDL. After determining the Panel ARDL lag length, both the long- and short-term dynamics were analysed.

Table 12: Panel ARDL(MG) Long-Term Results

Variable	Coefficient	Standard Error	t-Statistic
IND	−0.0219	0.0382	−0.574
PHC	−0.0052	0.0237	−0.218
FDI	0.0186	0.0146	1.276
LLAB	−1.1349	1.7066	−0.665
C	27.0280	26.5715	1.017

Note: ***, ** and * indicate the significance level of the variables at 1%, 5% and 10% levels.

When Table 12 is examined, according to the Panel ARDL (Mean Group) long-term estimation results, the variables IND (Industry Value Added), PHC (Physical Capital), FDI (Foreign Direct Investment), and LLAB (Total Labour Force) do not have a statistically significant effect on LGDP (Economic Growth) in the long run.

Table 13: Panel ARDL (MG) Short-Term Results

Variable	Coefficient	Standard Error	t-Statistic
COINTEQ	−0.2151***	0.0420	−5.126
D(IND)	0.00489**	0.00244	2.006
D(PHC)	0.00824***	0.0014	5.892
D(FDI)	−0.00032	0.00065	−0.497
D(LLAB)	0.4525**	0.1444	3.134

Note: ***, ** and * indicate the significance level of the variables at 1%, 5% and 10% levels.

An examination of Table 13 reveals that the error-correction term (COINTEQ) is negative and significant at the 1% level. This indicates that the model has a long-term equilibrium relationship, and approximately 21.5% of potential deviations are corrected and returned to the system in each period. While PHC ($\Delta PHC = 0.00824$; $p<0.001$), IND ($\Delta IND = 0.00489$; $p=0.045$), and LLAB ($\Delta LLAB = 0.453$; $p=0.0018$) produce positive and significant effects in the short term, the short-term impact of FDI is not substantial. In the long run, the coefficients for PHC, IND, FDI, and LLAB are not statistically significant, and the constant term is not substantial either.

In this study, although the Panel ARDL (PMG/MG) results indicate significant short-term error correction dynamics ($ECT \approx -0.215$, $p<0.01$), the panel data's statistical properties indicate strong cross-sectional dependence (CSD) due to a common factor. Indeed, the CD, CDw, and CDw+ statistics are significant in the xtcd2 tests. Furthermore, the slope-heterogeneity test (Pesaran and Yamagata, 2008) indicated that the long-run coefficients differ significantly across units. The main problem here is that unobserved common factors are not directly incorporated into the Panel ARDL model.

Because the classical Panel ARDL (PMG/MG/DFE) framework does not directly model common shocks or correlated errors, it can lead to biased coefficients and standard errors, especially under strong CSD. This shortcoming is addressed by the Cross-Section Augmented ARDL (CS-ARDL) approach developed by Chudik and Pesaran (2015). CS-ARDL explicitly captures unobserved common factors by including cross-sectional means (and lags) in each equation. Thus, it provides consistency under conditions of strong/weak cross-sectional dependence and estimates long- and short-run dynamics in a manner consistent with mixed integration structures I(0)–I(1). Furthermore, because it allows for a heterogeneous coefficient structure (Mean Group), it preserves the country-based differences indicated by the homogeneity test. Therefore, the CS-ARDL method was preferred in the final analysis.

Period dummies were included in the analyses to explicitly model the structural breaks caused by the 2008–2009 Global Financial Crisis and the 2020–2022 COVID-19 periods. This choice is based on two reasons. First, shocks are known to be widespread and simultaneous during these periods. If these breaks are ignored, the long-run relationship is assumed to be constant, leading to misleading estimates and omitted-variable bias. Second, these shocks can affect not only levels but also short-run adjustment dynamics depending on timing; therefore, the dummies were controlled for in both the long-run equation and the short-run difference equation.

CS-ARDL

Table 14: CS-ARDL Long-Term Results

Variable	Coefficient	Standard Error	z-Statistic
PHC	0.0041**	0.0017	2.40
IND	0.0100**	0.0043	2.30
LLAB	−0.4863	0.4848	−1.00
GFC	0.0020	0.0076	0.27
COVID	0.0003	0.012	0.03

Note: ***, ** and * indicate the significance level of the variables at 1%, 5% and 10% levels.

When the long-term coefficients from the CS-ARDL model are examined in Table 14, it is seen that the IND and PHC variables have a positive and statistically significant effect on economic growth (LGDP) at the 5% level. This indicates that a 1% increase in the IND variable corresponds to an approximately 0.01% increase in LGDP. Similarly, a 1% increase in the PHC variable leads to an approximately 0.0041% increase in LGDP. On the other hand, the LLAB (Total Labour Force), GFC (Global Financial Crisis dummy), and COVID (Pandemic dummy) variables have no statistically significant impact on LGDP in the long run.

Table 15: CS-ARDL Short-Term Results

Variable	Coefficient	Standard Error	z-Statistic
D.PHC	0.0011	0.0013	0.84
D.FDI	-0.00007	0.0006	-0.11
D.IND	-0.0041*	0.0022	-1.87
D.LLAB	0.3410	0.2211	1.54
GFC	0.0085	0.0106	0.80
COVID	-0.0068	0.0135	−0.50
ECM(LR_FDI)	-0.9978***	0.0014	- 615.85

Note: ***, ** and * indicate the significance level of the variables at 1%, 5% and 10% levels. The CD statistic applied to the residuals was determined as 0.41, and the P-value as 0.6790

When the short-term coefficients in Table 15 are examined, it is seen that the D.IND variable has a negative, statistically significant coefficient. D.PHC, D.FDI, D.LLAB, and the crisis dummies have no statistically significant effect on LGDP in the short term. The error correction coefficient (ECM) represents the speed of return to the long term and is statistically significant at the 1% level. A negative coefficient very close to -1 indicates that the system returns to equilibrium exceptionally quickly. In other words, approximately 99.78% of the imbalance following a short-term shock is corrected in the next period. Furthermore, a Pesaran-type CSD test applied to the residuals yielded a CD of 0.41 (p=0.679). Accordingly, no significant cross-sectional dependence was detected in the residuals, confirming that the CS-ARDL specification effectively addresses common factors.

Conclusions and policy discussions

This study examines the relationships between economic growth and physical capital, industry value added, FDI, and the labour force in a panel of EU countries covering the period 1995–2024 using panel data analysis. In this context, three primary research questions were posed, and empirical findings were used to answer them. The empirical analyses revealed no significant multicollinearity among the variables. Given cross-sectional dependence, the CIPS test developed by Pesaran (2007) was used in second-generation unit root analyses, and the Panel ARDL approach was deemed appropriate because the variables had different degrees of stationarity. According to the findings, physical capital, industry value added, and labour force variables have positive, statistically significant effects on short-term economic growth. In contrast, the short-term impact of FDI was not statistically significant. In the long-term analysis, the coefficients for physical capital, industry value added, FDI, and labour force variables were not statistically significant, and the constant term was not important.

Classical Panel ARDL approaches (PMG, MG, DFE) cannot directly model common shocks and inter-unit correlated errors, leading to deviations in coefficient estimates and standard errors, especially in panels with strong cross-sectional dependence. Therefore, to obtain more reliable and consistent results in this study, the CS-ARDL method, developed by Chudik and Pesaran (2015), which allows for heterogeneous coefficient structures across units, was chosen as the final analysis method. The findings indicate that, in the short term, the industry value-added variable has a negative, statistically significant effect on economic growth. In contrast, the short-term effects of other variables are insignificant.

The long-term analysis results indicate that industry value added and physical capital variables have a positive and statistically significant impact on economic growth. This positive impact of industry value added on growth is consistent with the findings of Mehmood et al. (2022). This result suggests that technological progress, productivity growth, and export-oriented structural transformation in industrial production contribute to economic growth. However, this finding contradicts the negative relationship reported by Jelilov et al. (2016). This difference may be due to differences in the countries' industrial structures, the share of the industrial sector in total value added, and the analysis period. Jelilov et al.'s study examined economies in the early stages of industrialisation and found that environmental costs, low productivity, and structural vulnerabilities limited industry's contribution to growth. In contrast, in the EU sample, the impact on growth was positive, as industrial production was supported by digital transformation and green economy policies.

The results regarding the physical capital variable are also generally consistent with the literature. The findings are parallel to the positive results obtained by Li, Wang, Westlund, and Liu (2015); Pomi et al. (2021); Bhattacharjee et al. (2022); Bunyamin (2022); Asad et al. (2023); Ishfaq et al. (2024); Agbolosoo, Septya, and Hutagoal (2025); and Hacıimamoğlu and Sungur (2024). These studies emphasise that physical capital increases productivity by increasing production capacity and accelerates growth, particularly in capital-intensive sectors. In the EU sample, the integrated progress of capital accumulation through investments in digital infrastructure, green energy, and innovation is the main driver of this positive relationship. This is consistent with the fundamental assumption of the Neoclassical Growth Model, which holds that capital accumulation is a determinant of long-term growth.

In contrast, FDI and labour force variables are found to have no statistically significant impact on long-run economic growth. This result is consistent with Alvarado et al. (2017), who found that FDI's effect on growth was insignificant. However, the findings are inconsistent with studies that have seen the impact of FDI on economic growth to be positive and significant, such as Iamsiraroj (2016), Noori (2019), Nguyen (2020), Okwu et al. (2020), Banday et al. (2021), Elrasheed and Muhammad Abdullahi (2022), Darwin et al. (2022), Kusairi et al. (2023), Raihan (2024), and Raihan et al. (2025). Similarly, it differs from Mawutor et al. (2023) and Mamun and Kabir (2023), who stated that FDI has a negative and significant effect on economic growth. The main reasons for these discrepancies include the development levels of the analysed country groups, the sectoral distribution of investment, and the nature of FDI. While FDI in developing countries generally increases production capacity, in developed EU economies, capital accumulation is already saturated, so the contribution of new investments to growth may be limited. Furthermore, the concentration of FDI in EU countries in low-productivity sectors such as financial services and real estate weakens channels for technology transfer and productivity growth. This explains the lack of statistical significance of the impact of FDI on growth.

The insignificant labour force variable suggests that growth in developed economies is driven primarily by productivity growth and technological advancements. In EU countries, ageing populations, the automation of digitalised production processes, and skill mismatches limit the direct contribution of employment growth to overall growth. Therefore, the key to sustained growth lies in the quality of the workforce and human capital, rather than the volume of employment.

Furthermore, the lack of a significant effect of crisis dummies (Global Financial Crisis and COVID-19) and labour force variables on economic growth in both the short and long runs suggests that macroeconomic fluctuations and employment dynamics play a limited role in long-term development. These results reveal that the main determinants of economic growth in EU countries are value-added creation and capital accumulation in production. In contrast, the impact of external shocks on growth is limited to the short term.

In a cointegrated model, the ECM indicates the speed with which short-term deviations are carried back to the long-term equilibrium relationship. In light of the study's findings, a high ECM value of -0.9978 indicates that deviations are almost eliminated in the subsequent period. This finding meets theoretical expectations in the presence of mechanisms such as high market and financial integration, price/wage elasticities, and strong policy coordination, rather than the slow capital accumulation lags of traditional neoclassical growth models. Therefore, under these conditions, arbitrage and policy channel shocks are likely to disappear quickly.

In this study, the inclusion of cross-sectional averages in the CS-ARDL equation endogenously controlled for unobserved common factors. The statistical disappearance of CSD in the residuals (CD=0.41, p=0.679) confirms the methodological soundness of the model and the reliability of the estimated coefficients. Furthermore, the long-run positive effects of physical capital deepening (PHC) and industrial production (IND) support the real basis of equilibrium in the extended Solow/MRW and endogenous growth frameworks.

The results are generally consistent with the Neoclassical Growth Model (Solow, 1956). According to the neoclassical model, the primary determinants of economic growth are physical capital accumulation, labour force growth, and technological progress. This study confirms this approach by demonstrating that capital accumulation supports long-run growth. However, the lack of significance in the labour force variable suggests that productivity growth, rather than employment growth, is the driving force of growth in developed EU countries. In the extended model developed by Solow's successors, Mankiw, Romer and Weil (1992), human capital and technology stand out as key drivers of growth. In this framework, the positive impact of industry value added demonstrates that technological progress and productivity growth are among the key factors ensuring the sustainability of growth in EU countries.

The findings indicate that long-term economic growth in EU countries is primarily driven by increases in physical capital and industry value added. However, the lack of statistically significant impact of FDI and labour force variables on growth suggests that growth in EU economies is sustainable not only through capital inflows but also through productivity growth, innovation, and technological transformation. These results indicate that growth and sustainable development must be supported by structural transformation, consistent with EU policy frameworks such as the European Green Deal, the EU Industrial Strategy, and the Digital Europe Programme.

In this context, the finding that physical capital supports long-term growth highlights the need to allocate capital to productive sectors at the EU level. Strengthening support for infrastructure, renewable energy, digital transformation, and innovative production investments, particularly within the framework of InvestEU, the Cohesion Policy Funds, and Horizon Europe, can enhance total factor productivity, ensuring the longevity of the positive impact on growth. Such investments will contribute to the sustainability of capital accumulation not only quantitatively but also qualitatively.

The long-term positive impact of industry value added on economic growth supports the EU's New Industrial Strategy's goals of transitioning to digital, green, and resilient production structures. Findings indicate that promoting high-tech, innovation-focused sectors in the production process will strengthen sustainable growth. In this context, implementing policies for carbon-neutral production, a circular economy, and energy efficiency within the scope of the Green Deal Industrial Plan could enhance long-term growth potential.

The limited impact of FDI on growth suggests that current investment flows are largely concentrated in low-technology or service sectors. Therefore, within the framework of the EU's Investment Plan (e.g., the "Global Gateway" initiative), foreign investment should be integrated with technology transfer, R&D activities, and sustainable production capacities. Such policies will strengthen the impact of foreign capital flows on real productivity and innovation.

The lack of a significant effect of the labour force variable demonstrates that growth no longer relies solely on employment volume but rather on a skilled workforce and a skills match. This directly aligns with the EU's European Pillar of Social Rights and Skills Agenda objectives. Developing skills compatible with digitalisation, green transformation, and technological innovation will strengthen the productivity-driven nature of growth.

In conclusion, the study's findings indicate that the EU's current policy frameworks (Green Deal, Digital Europe Program, Horizon Europe, and Industrial Strategy) point in the right direction for economic growth, but these strategies need to be implemented more holistically, with a focus on productivity, innovation, and human capital. Priorities for policymakers should be to qualitatively strengthen physical capital investments, increase value-added production, and align the labour market with new technological transformations.

Future research that builds on the findings of this study, examines growth dynamics from a broader perspective, and tests the validity of the results through different methodological approaches will make significant contributions to the literature and policymaking processes.

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