DIGITALIZATION AND INCLUSIVE ECONOMIC GROWTH: A CROSS-COUNTRY ANALYSIS

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Abstract. *This study investigates how digitalization affects inclusive economic growth in various countries. The research examines the relationship between digital transformation and inclusive development, using composite indicators and cluster analysis. The empirical analysis includes data from 20 countries between 2010 and 2022, enabling examination of both temporal changes and differences in development patterns. The research creates indices for digitalization and inclusive development, and then uses comparison, correlation, cluster analysis, and regression modelling to analyse the data. The results suggest that digitization and inclusive growth are clearly linked in a good way. The strength of this link is different in different countries and is primarily based on how well the economy is doing and how well the institutions are. The cluster analysis shows that there are many groups of countries with different levels of digitization and inclusion. The findings underscore the diverse trajectories of development. Specifically, the data indicate that the benefits of digitization are contingent upon a confluence of factors: a well-educated workforce, robust institutional frameworks, and equitable opportunities for broad-based economic participation. These findings offer valuable insights for creating economic policies. Such policies should try to ensure that the benefits of digital transformation translate to long-term and inclusive economic growth.*

Keywords: *Digitalization, Digital divide, Digital transformation, Inclusive economic growth, Inequality, Composite indices, Cluster analysis, Cross-country analysis, Economic development, Sustainable development, Institutional environment, Poverty.*

1. Introduction

The growing digitalization of the global economy poses a major challenge to inclusive economic growth. Digitalization and inclusive growth are interconnected, with digital technology both promoting and hindering equal development. Digitization may affect growth

and inclusivity, but further research is needed. Digital technologies like ICT, platform solutions, and AI drive productivity and economic growth. Erik Brynjolfsson and Andrew McAfee say digital technologies provide a new economic model based on data, automation, and network effects [1].

Research suggests digitalization may improve market and service access, but its effects are uneven across countries and social groups. Carl Benedikt Frey and Michael Osborne argue that automation and the displacement of low-skilled jobs can worsen labor market inequality.

Scientific research suggests that digitization boosts economic possibilities but may increase digital and socio-economic inequalities. Jonathan Haskel and Stian Westlake show that the digitization of the economy of intangible assets increases concentration and inequality between businesses and nations [3]. According to Philipp Aghion and colleagues, technology advancement can be inclusive or exclusive depending on institutional architecture and regulations [4]. A detailed analysis of the relationship between digitization and inclusive growth indicators is needed.

Despite substantial research on the digital economy and inclusive development, several questions remain. Most research focuses on single variables, such as internet accessibility or inequality indicators, while ignoring digitalization and inclusive growth. Second, composite metrics that capture the complexity of these processes are underdeveloped. Third, despite its ability to reveal structural differences, cluster analysis is rarely used to classify countries. Fourth, the lack of long-term, multinational studies makes it harder to spot trends.

This study uses composite indices and cluster analysis to examine the relationship between digitalization and inclusive economic growth across countries. The study uses a 2012–2022 sample of 20 nations to examine dynamic changes and structural differences in development models.

The study's scientific novelty is as follows. An integrated methodology for assessing digitalization and inclusive growth through composite indices is offered. Secondly, a clustering of nations is conducted, enabling the identification of several models of the relationship between digital advancement and inclusivity. Third, it is established that a high degree of digitization does not necessarily correlate with a high level of inclusive growth, thus validating the

premise of institutional and structural restrictions. The findings establish a foundation for formulating tailored economic policies to promote equitable digital advancement.

2. Literature Review. Evolution of Conceptual Approaches to Inclusive Growth

Inclusive growth is a developing notion in economic theory and development practice that has experienced multiple phases of conceptualization. The notion of inclusive growth arose in response to the shortcomings of conventional economic development strategies, which predominantly emphasized GDP growth while neglecting the distribution of growth benefits, access to economic opportunities, and social mobility. The critique of the Washington Consensus agenda, which failed to guarantee sustainable development in Latin America and other regions, served as a significant impetus for exploring alternative development strategies.

The concept's foundations were initially established by the Commission on Growth and Development, led by Nobel laureate M. Spence, in the study titled The Growth Study: Strategies for Sustained Growth and Inclusive Development [7]. Initial strategies for inclusive growth were closely linked to the notion of pro-poor growth, in which the primary criterion was the alleviation of poverty and improvements in the conditions of the most disadvantaged groups. Nevertheless, experts and international organizations later determined that this was inadequate: while economic expansion may alleviate poverty, it concurrently fosters increasing inequality, labor market segmentation, and restricted access to opportunities for a substantial part of the population. This elucidates the transition from a limited "anti-poverty" perspective to a more expansive notion of inclusive growth.

The World Bank's early definition posited that inclusive growth must enable individuals to contribute to and simultaneously benefit from economic progress. The Ianchovichina and Lundstrom research underscored that lasting poverty alleviation requires not only rapid growth but also extensive sectoral engagement, involving a substantial share of the labor force [8]. This analysis focuses not only on the ultimate outcomes of income distribution but also on productive employment, structural transformation, and public engagement in the growth process. This viewpoint is significant as it perceives inclusion primarily as an attribute of the growth mechanism itself, rather than merely its social ramifications.

The subsequent phase of progression entails enhancing the measurement framework. In IMF studies, inclusive growth is classified as a category that amalgamates growth rates with their distributional impacts. Anand, Mishra, and Peiris advocate assessing this phenomenon using a single macroeconomic framework that simultaneously accounts for income trends and income distribution across population segments. The authors clearly state that the analysis of growth and inequality must not be conducted in isolation, and that inclusive growth should be understood as a synthesis of efficiency and equity. This signified a significant methodological transition: from qualitative and political-normative descriptions to the development of standardized quantitative indices of inclusive growth for cross-country comparisons [9].

Thereafter, the concept was considerably broadened within the context of OECD methodologies. Initial talks focused on income, poverty, and employment; however, the OECD defines inclusive growth as growth that creates opportunities for all demographic groups and equitably allocates the benefits of prosperity in both monetary and non-monetary forms [10]. In this framework, inclusivity transcends mere distributional metrics and encompasses a broader array of well-being dimensions: employment, health, education, institutional quality, service accessibility, and subjective well-being. Consequently, the term shifts from a narrow economic interpretation to a broader view of societal advancement.

Consequently, at least three primary conceptual frameworks can be discerned in the current literature on inclusive growth. The initial approach is the results-oriented method, which prioritizes alleviating poverty and inequality. The second is the process approach, which emphasizes job creation, broadening economic participation, and guaranteeing equitable access to opportunities through functional institutions [11]. The third dimension is multidimensional, in which inclusive growth is associated with broader indicators of quality of life and well-being, encompassing the social, economic, and environmental facets of development [12].

Table 1. Conceptual approaches to defining inclusive growth by international organizations

Organization	Publication	Definition
United Nations Sustainable Development Knowledge Platform)	Framework of Inclusive Growth Indicators[1] https://sdgs.un.org	Inclusive growth is a process that simultaneously achieves economic growth, employment, social equity, and sustainable development, in which effective public institutions and equal access to opportunities for all groups play a key role.
OECD	Promoting Inclusive Growth Challenges and Policies[2] https://www.oecd.org/inclusive-growth/	Inclusive growth is defined as economic growth that is sustained and broad-based, creates opportunities for all social groups, and is accompanied by an equitable distribution of the benefits of growth, including both income and non-monetary components of well-being.
World Bank	Ending poverty and sharing prosperity[3] https://www.worldbank.org/en/topic/poverty	Inclusive growth is defined as growth that is rapid, sustainable, and broad-based, engaging a significant portion of the working population and ensuring participation in economic activity with the goal of reducing poverty and increasing well-being.
Asian Development Bank (ADB)	ADB's Support for Inclusive Growth[4] http://www.adb.org/documents/adbs-support-inclusive-growth	Inclusive growth is growth that not only creates new economic opportunities but also ensures equal access to these opportunities for all segments of society, especially the poor and vulnerable, through the development of infrastructure, human capital, and institutions.
International Policy Centre for Inclusive Growth (IPC - IG)	Exploring and Strengthening the Intersections between Social Protection, Employment and Inclusive Growth[5] http://www.ipc-undp.org/publication/26527	Inclusive growth is viewed as both a process and an outcome: on the one hand, it involves all groups in the population in creating economic growth, including decision-making; on the other, it ensures a fair distribution of income and social benefits.
European Commission (EC)	The Europe 2020 Strategy A strategy for smart, sustainable and inclusive growth. – Brussels, EC, 2010[6]. http://ec.europa.eu/europe2020/index_en.htm	Inclusive growth is defined as growth aimed at increasing employment, investing in education, reducing poverty, and modernizing labor markets and social protection, ensuring territorial and social cohesion and equal participation of the population in the economy.
International Monetary Fund	*Inclusive Growth: Measurement and Determinants*[7] https://www.imf.org/external/pubs/ft/wp/2013/wp13135.pdf	Inclusive growth is defined as the combination of economic growth rates and its distributional characteristics, in which income growth is accompanied by a more equal distribution among different groups of the population.

Contemporary definitions of inclusive growth by various international organizations have shifted from a narrow focus on poverty alleviation to a broader perspective encompassing equitable access to opportunities, economic engagement, and the multifaceted dimensions of well-being (Table 1). This has led to the development of diverse methodologies for assessing inclusive growth. Certain studies employ specific metrics, such as the Gini coefficient, poverty rate, employment statistics, and median income. Others endeavor to create composite indices that amalgamate economic and social

attributes. The evolution of inclusive growth signifies a transition in economic thought, shifting from a narrow emphasis on economic expansion to a comprehensive understanding of development that incorporates social equity, environmental sustainability, and institutional quality, thereby necessitating a multidimensional approach to assessing inclusive growth.

Digitalization as a Driver for Economic Advancement: From "Digital Dividends" to the Risks of Digital Inequality

The relationship between inclusive growth and digitalization is a multifaceted, reciprocal process, in which digital technology can both promote and impede inclusive development. An examination of contemporary scholarly literature reveals several crucial characteristics of this connection. Initial research on the correlation between digitization and economic development focused primarily on its impact on productivity, reduced transaction costs, enhanced information accessibility, and the creation of new markets. In this framework, digital technologies were perceived as a universal catalyst for growth, capable of expediting modernization and enhancing the efficiency of both enterprises and governmental organizations. By the mid-2010s, it became evident in the global literature that "digital dividends" were allocated in highly uneven ways. The World Bank's World Development Report 2016: Digital Dividends asserts that digital technologies alone do not ensure enhanced productivity or diminished inequality; their impact is contingent upon the quality of institutions, human capital, and the business environment [13].

Consequently, a more balanced perspective has arisen in the literature, positing that digitalization exerts a dual effect. It enhances access to markets, knowledge, financial services, educational resources, and labor platforms, thus establishing the prerequisites for more inclusive growth. Conversely, in the absence of supportive institutional and social conditions, digitalization may intensify technological segmentation, employment polarization, and disparities in access to opportunities. International experts currently emphasize the need to foster inclusive digitalization that prioritizes infrastructure availability, skill development, territorial coverage, and the equitable distribution of the benefits of digital transformation [14].

Thus, whereas earlier literature (2000-2015) predominantly regarded digitization as a catalyst for progress, more recent studies (post-2016) have increasingly recognized technology as a

determinant that can both diminish and reinforce social disparities. According to World Bank analysts, this is especially crucial for emerging and transitional economies, since the effects of digital transformation are predominantly influenced by infrastructure quality, financial inclusion levels, educational foundations, and the institutional framework.

Research on the Impact of Digitalization on Inclusive Economic Growth. Empirical research on the impact of digitalization on inclusive growth has grown dramatically in recent years, but the findings remain inconclusive. Much evidence demonstrates that developing ICT, digital infrastructure, and digital skills leads to more equitable growth, particularly when linked to financial development, access to loans, and institutional quality. For example, using data from sub-Saharan Africa, Ofori et al. show that ICT dissemination, financial access, and financial development all contribute to inclusive growth, with the interaction between ICT and the financial system enhancing these beneficial effects [15]. Furthermore, digital skills, access to, and the application of ICT are critical conduits for promoting inclusiveness.

Another group of studies highlights that the impact of digitalization on inclusive growth is contingent on the surrounding institutions. Adeleye and Eboagu's analysis, which covered 193 nations between 2010 and 2019, investigated the influence of ICT and institutional quality on inclusive growth and concluded that the benefits of digitalization are not self-sustaining and are amplified by higher institutional quality [16]. In other words, digitalization does not function in a vacuum: its transformational potential is more fully realized when effective norms, accessible institutions, and mechanisms for integrating the populace into the digital economy are in place.

At the same time, a critical line exists in the literature. According to numerous studies and international reports, digitalization can lead to greater income, skill, and opportunity differentiation, particularly if it outpaces adaptation in the labor market and education system. Digital technologies are transforming the labor market, but without "analog complements" such as effective governance, skills, and competition, they do not reduce inequality on their own. Contemporary worldwide studies reach a similar conclusion: digital change must be accompanied by digital inclusion policies, otherwise the advantages will be concentrated among better-prepared groups, regions, and enterprises.

Thus, three major ways to evaluate the relationship between digitalization and inclusive growth are identified in empirical research. The first assumes that digitalization has a direct positive effect by increasing access to information, markets, financing, and jobs. The second emphasizes the conditional nature of the effect, which is determined by institutions, human capital, financial depth, and infrastructure. The final section discusses the dangers of digital inequality and how digitalization without compensating policies might deepen social and geographical polarization. Taken together, these methods lead to the conclusion that the question is no longer whether digitization affects inclusive growth, but rather under what conditions and in what country configurations this influence is actually inclusive.

Research Gap and Subject of This Study. Despite major advances in the literature, numerous significant gaps persist. First, some studies examine inclusive growth or digitalization using individual variables, rather than offering a holistic picture of their multifaceted relationship. Second, much empirical research concentrates on specific regions, primarily African countries or individual national situations, limiting cross-country comparability of outcomes. Third, digitalization and inclusive growth are rarely evaluated simultaneously in composite indices, with nation clustering used to find sustainable development patterns. However, this approach not only allows us to assess the strength of the relationship between indicators, but it also demonstrates that countries can exhibit a variety of patterns of combining digitalization and inclusiveness, ranging from consistently high values to situations in which digital progress does not translate into broad socioeconomic impacts.

Our study examines the relationship between digitalization and inclusive growth over time using an index and cluster analysis across a range of nations. This architecture enables us to progress from a broad statement about the "potentially positive role of digitalization" to a more rigorous comparison of country models and identification of structural variations in growth paths.

Our primary study premise is that the advancement of digital technology helps to expand economic opportunities, enhance access to education, the labor market, and information, and reduce social inequality. As a result, more digitization may improve inclusive development metrics. To test this hypothesis, we conducted an econometric study using panel data, enabling us to assess the impact of digitalization on inclusive development.

The primary research hypothesis is that the advancement of digital technology helps to provide economic possibilities, improve access to education, the labor market, and information, and reduce socioeconomic inequality. As a result, enhanced digitization may positively affect inclusive development metrics.

The purpose of this study is to examine the relationship between economic digitalization and measures of inclusive economic development in various countries.

3. Research Methodology

The empirical research is based on a balanced cross-country dataset comprising 20 nations from 2010 to 2022. The sample comprises nations at various stages of socioeconomic and technological development, enabling comparison of the consequences of digitalization across diverse institutional and structural contexts. The sample comprises nations at various stages of development, ranging from high-income countries (e.g., Norway, Switzerland, and the Republic of Korea) to middle- and low-income developing countries, as well as Central Asian countries (e.g., Kazakhstan, Kyrgyzstan, and Uzbekistan). This variability enables us to detect structural disparities in the relationship between digitization and inclusive growth across different countries. This heterogeneity enables us to identify structural disparities in the relationship between digitization and equitable growth across countries. This research methodology enables us not only to examine the evolution of indicators over time but also to detect persistent disparities across countries in the nature of the relationship between digital transformation and inclusive growth. The study uses two types of indicators. The first group describes the economy's level of digitization and comprises measures of digital infrastructure and technical activities. The second category reflects the parameters of inclusive development, including income, poverty, education, and employment. This distinction is consistent with the study's rationale, which sees digitalization as a potential driver of inclusive economic growth.

3.1. Data and Study Sample

The study used two groupings of indicators. The first group describes the economy's level of digitization and includes metrics such as digital infrastructure penetration and technical activity. The second category represents inclusive development criteria and includes indices of income, poverty, education, and employment (Table 2).

Table 2. Groups of Indicators of the Digitalization Index and the Inclusion Index

Digitalization variables	sign	Inclusive development variables	sign
Internet users (% of population)	NET	GDP per capita	GDPpc
High-technology exports (% of manufactured exports)	HTX	Poverty rate	POV
Fixed broadband subscriptions	BROAD	Tertiary education enrollment	TERT
Fixed telephone subscriptions	TEL	Unemployment rate	UNEMP
Mobile cellular subscriptions	MOBILE		

This decision represents the conceptual framework in which digitalization is viewed as a structural driver of economic opportunity, whereas inclusive development considers both economic outcomes and access to those opportunities. This distinction is consistent with the study's rationale, which sees digitalization as a potential driver of qualitative and overall economic growth.

3.2. Construction of Composite Indices

Normalization Procedure. Given the heterogeneity of measurement units, all variables are normalized using the min–max transformation:

$$X_{i,t}^{norm} = \frac{X_{i,t} - X^{min}}{X^{max} - X^{min}}$$

where X_(i,t)denotes the value of indicator X for country I in year t.

For variables negatively associated with inclusive development (poverty and unemployment), an inverse transformation is applied:

$$X_{i,t}^{inv} = 1 - X_{i,t}^{norm}$$

This ensures that higher values of all normalized indicators correspond to more favorable socio-economic conditions. Higher values for all normalized measures indicate better socioeconomic conditions.

Digitalization Index

The digitalization index was created as an aggregate indicator of five normalized digital variables describing the population's and the economy's access to digital infrastructure, with greater weight assigned to high-tech exports. The ubiquity of digital services, as

well as their relationship to the economy's technological modernization, is of particular analytical relevance in this context.

The Digitalization Index (DI) is constructed as a weighted composite indicator:

$$DI_{i,t} = \frac{NET_{i,t} + 4HTX_{i,t} + BROAD_{i,t} + TEL_{i,t} + MOBILE_{i,t}}{8}$$

The higher weight assigned to HTX reflects its role as a proxy for technological sophistication and structural transformation, beyond mere access to digital infrastructure.

Inclusive Development Index

The Inclusive Development Index (IDI) is calculated as a simple arithmetic mean of normalized indicators:

$$\mathrm{IDI}_{i,t} = \frac{\mathrm{GDPpc}_{i,t} + \mathrm{POV}_{i,t}^{inv} + \mathrm{TERT}_{i,t} + \mathrm{UNEMP}_{i,t}^{inv}}{4}$$

This formulation captures the multidimensional nature of inclusive growth, integrating income, poverty, education, and labor market outcomes into a single comparable measure.

The use of composite indices overcomes the constraints of single-indicator techniques and represents the intrinsic multidimensionality of both digitalization and inclusive growth. Compared to other methods (such as PCA), the chosen approach ensures transparency, interpretability, and comparability across nations and time. Together, the two indices enable us to transition from analysing different variables to a comparable cross-country measurement of digitalization and inclusive growth.

This method enabled us to collect comparable cross-country assessments of digitization and inclusivity over time.

3.3. Indicator Interrelationship Analysis

A comparative investigation of digital and socioeconomic characteristics followed index construction. The intermediate goal of this stage was to determine how digitalization affects economic development and human capital. Digitalization is linked to economic growth and human capital development in all countries, but poverty is negatively correlated with digital indices. In low-income countries,

these correlations are stronger, while in affluent economies, a saturation effect is evident.

Even at this level, the investigation demonstrated that the influence of digitalization is not ubiquitous across countries. Instead, it depends on economic structure, revenue, institutional maturity, and human capital. The next step in the investigation was clustering countries.

4. Research Results

4.1. Dynamics of the Inclusive Development Index

Analysis of the Inclusive Development Index's dynamics from 2010 to 2022 demonstrates a general trend toward increased inclusiveness, but significant intercountry differences persist. Developed high-income countries (Norway, Switzerland, Republic of Korea) have consistently high index values (above 0.85), reaching 0.945, 0.883, and 0.879 by 2022. This demonstrates high levels of human capital and the efficacy of social policy institutions.

Second, upper-middle-income countries (China, Kazakhstan, Malaysia, Belarus, and Russia) are gradually becoming more inclusive. China is the most notable example, with the index rising from 0.495 to 0.679, indicating a substantial increase in socioeconomic opportunities.

Third, developing economies (Uzbekistan, India, Kyrgyzstan, and Vietnam) are seeing moderate growth while keeping lower index values. For example, while Uzbekistan's index rating has risen from 0.447 to 0.541, the gap with more developed countries persists. Fourth, a number of African countries (Madagascar and Zimbabwe) are experiencing a lack of positive dynamics or a decline in performance, indicating significant structural socioeconomic challenges, including high poverty rates, weak institutions, and limited access to economic resources.

Thus, the study demonstrates considerable cross-country inequalities in inclusive development. Despite the overall upward trend in the index across most nations, a persistent disparity between established and emerging markets remains. This emphasizes the importance of comprehensive policies to build human capital, expand access to education, alleviate poverty, and ensure a more equitable distribution of economic progress.

Thus, the findings demonstrate that, despite an overall improvement in inclusivity, significant gaps persist between countries, indicating uneven transformation processes and the reliance of inclusive development on economic and institutional maturity.

4.2. Analysing the Digitalization Index Dynamics

The dynamics of the Digitalization Index for 2010-2022 demonstrate continuous growth in the extent of digital transformation across most countries, but significant cross-country variability remains. Developed economies, including the Republic of Korea, Switzerland, and Norway, consistently have high index values (0.84–0.91). For example, the Republic of Korea's score rose from 0.855 to 0.912, indicating a high level of digital infrastructure and technological maturity.

Second, nations with a medium level of digitalization (China, Malaysia, Belarus, Russia, and Kazakhstan) demonstrate consistent growth. For example, in China, the index rose from 0.522 to 0.699, while in Malaysia, it rose from 0.597 to 0.690, demonstrating the growth of digital infrastructure and high-tech enterprises.

Third, countries with a low beginning base show the fastest growth rates due to the catch-up effect. For example, in Vietnam, the score rose from 0.328 to 0.619, and in Azerbaijan, from 0.256 to 0.505, suggesting substantial progress in the development of telecommunications and digital services.

Fourth, in a handful of nations (Madagascar, Zambia, and Zimbabwe), the index remains low (below 0.30), indicating structural impediments to the development of the digital economy.

The trends in the digitalization index across Central Asian countries warrant special attention. Kazakhstan has the highest score in the region (around 0.50 in 2022), while Uzbekistan (0.42) and Kyrgyzstan (0.32) have lower scores but show consistent positive trends (more than 1.4 times), indicating the gradual development of digital infrastructure and increased public access to digital technologies.

Thus, the study demonstrates considerable cross-country disparities in digital progress. Despite overall development in the digitalization index, a large digital divide persists between technical leaders and developing economies. This emphasizes the importance of further

developing digital infrastructure, fostering innovation, and increasing countries' engagement in the global digital economy.

4.3 Comparative Analysis of the Digitalization and Inclusive Development Indexes

A comparison of the dynamics of the digitalization and inclusive development indices demonstrates a positive correlation between the level of digital transformation and socioeconomic inclusion (Figure 1).

However, the extent of this association varies greatly across countries' levels of development.

Leading countries (the Republic of Korea, Switzerland, and Norway) have high values in both indices. For example, the Republic of Korea's digitalization score is 0.912, with an inclusive development level of 0.879; Switzerland's is 0.839 and 0.883; and Norway's is 0.597 and 0.945. This demonstrates that a developed digital infrastructure, when combined with high-quality human capital and strong social policies, helps achieve high levels of inclusiveness. Medium-development countries (China, Malaysia, Belarus, Russia, and Kazakhstan) show balanced growth across both indexes. China's ratings of 0.699 (digitalization) and 0.679 (inclusiveness) indicate a successful integration of digital transformation with socioeconomic development.

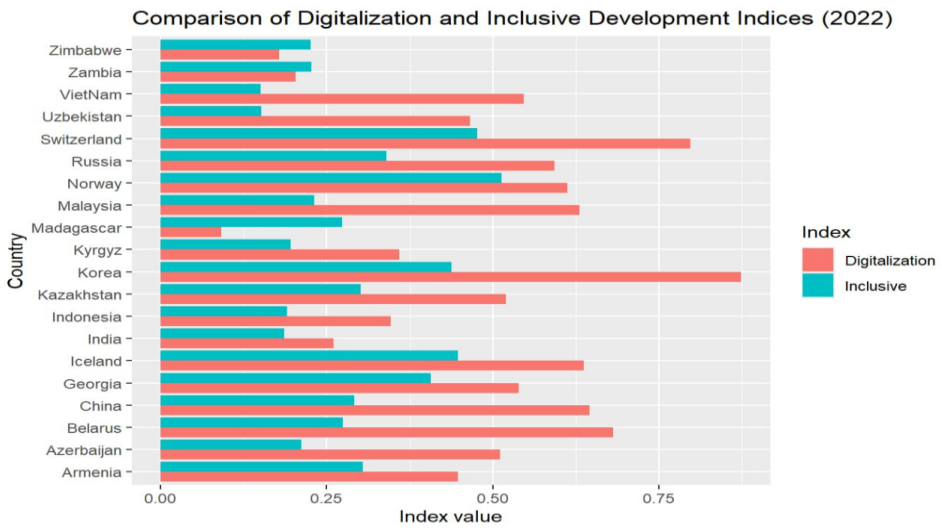

Figure 1. Comparative analysis of the Digitalization and Inclusive Development Indeces. Calculated by the authors.

At the same time, asymmetries in index development are noticed. In a number of nations (e.g., Iceland, Kyrgyzstan, Indonesia), inclusivity outperforms digitization, showing that social institutions are more established despite poor digital infrastructure. In contrast, in Belarus, Azerbaijan, and parts of Vietnam, digitalization outpaces inclusive growth, suggesting a disconnect between technological advancement and social outcomes. Madagascar, Zambia, and Zimbabwe are among the least developed countries, with low values on both indices (e.g., 0.060 and 0.240), indicating ongoing structural constraints.

Central Asian countries deserve special mention: Kazakhstan has significantly better ratings, while Uzbekistan and Kyrgyzstan, despite their lower levels, show positive dynamics on both indices.

An analysis of Uzbekistan's digitalization and inclusive development indices from 2010 to 2022 shows consistent positive growth in both metrics (Figure 2). The inclusive development index has remained higher than the digitalization index throughout the review period, gradually increasing from 0.447 in 2010 to 0.541 in 2022, indicating consistent improvements in socioeconomic conditions and greater opportunities for the population to participate in economic development.

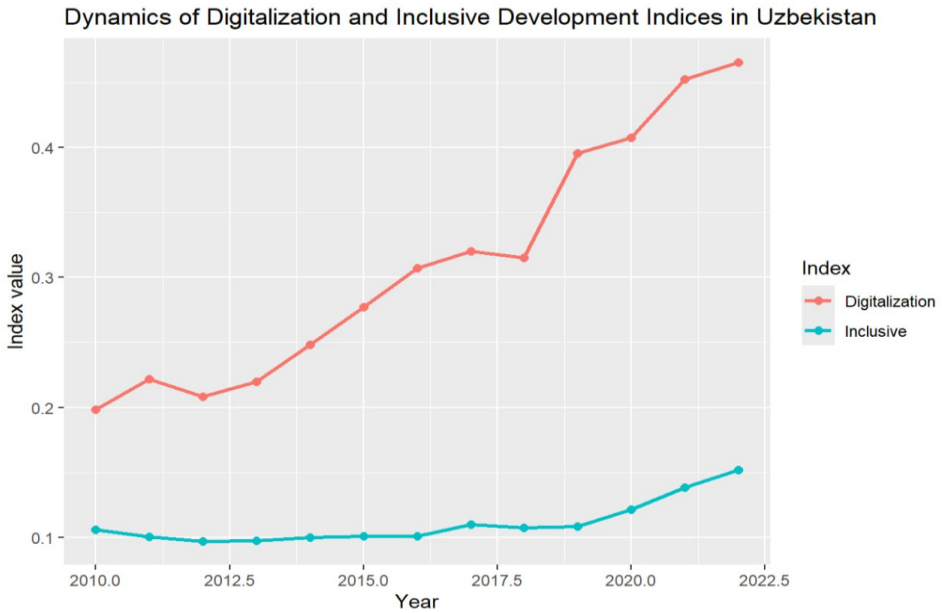

Figure 2. Dynamics of the Digitalization and Inclusive Development Indeces indices. Calculated by the authors.

Meanwhile, the digitalization index has risen fast, from 0.293 to 0.417, suggesting active development of digital infrastructure, increased internet access, and the proliferation of digital technology. Despite transient fluctuations in certain years, the overall trend indicates that the economy's digital transformation has accelerated, particularly after 2018. The analysis demonstrates a progressive convergence of digitalization and inclusive development, demonstrating that digital technologies are playing an increasingly important role in developing Uzbekistan's more inclusive economic growth model.

Overall, the analysis confirms that digitalization is often associated with higher inclusiveness, but this association does not occur automatically. Its strength is dictated by the institutional context, human capital, and the effectiveness of public policy, emphasizing the importance of a multifaceted approach to enabling equitable digital development.

Correlations. A comparative investigation found that digital infrastructure is associated with economic growth, human capital, and poverty reduction, but the strength of these associations varies across countries. Digitalization and poverty reduction are strongly correlated in low-income nations, demonstrating that digital infrastructure is vital for development. Economic development is tightly linked to human capital and digital infrastructure in low- and lower-middle-income nations, according to a correlation study. The positive correlations between GDP per capita (GDPpc), educational attainment (0.61), internet penetration (0.64), high-tech exports (0.72), and mobile communications (0.70) underscore the importance of digital technology and education to these countries' economic success. Meanwhile, the poverty headcount ratio (POV) has strong negative associations with major digitalization and education metrics (ranging from –0.51 to –0.72), demonstrating that digital technology and education reduce poverty.

Digital infrastructure metrics, notably internet and broadband (0.80), are strongly correlated, demonstrating the complementary nature of growth in telecommunications technology. The results show that digital infrastructure and human capital boost economic growth and inclusion in low-income countries. Digital infrastructure and education boost economic growth and inclusion in upper-middle-income countries. The growth of telecommunications infrastructure, notably broadband internet (0.60) and mobile communications (0.46), is positively associated with the tertiary education indicator

(TERT), underscoring the role of human capital in the digital transformation of the economy.

Economic development, human capital, and digital infrastructure metrics are more complicated and diversified in developed countries, according to a correlation study. The moderate positive association between GDP per capita (GDPpc) and broadband internet (0.52) shows the importance of digital infrastructure for economic activity even at high development levels.

4.4. Cluster Analysis of Countries: Identifying Patterns of Digitalization and Inclusive Development

Cluster analysis is used to identify heterogeneity in countries' development trajectories based on the digitalization (DI) and inclusive development (IDI) indices. Unlike regression analysis, which captures general relationships, this approach reveals distinct groups of countries with different combinations of digitalization and inclusiveness. This demonstrates that the impact of digital transformation on inclusive growth is not uniform and depends on institutional and economic conditions.

The cluster analysis identifies three distinct groups of countries differing in their levels of digitalization and inclusive development. The Elbow method was used to estimate the optimal number of clusters, guaranteeing that the classification is relevant and understandable. Figure 3 presents the distribution of countries in the space defined by the digitalization and inclusive development indices. The visualization reveals a clear segmentation into three groups, indicating distinct developmental patterns.

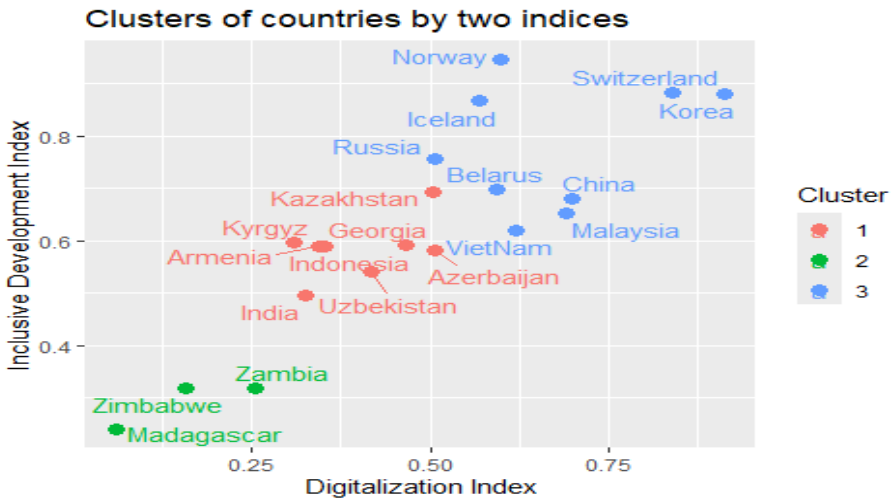

Figure 3. Distribution of countries by digitalization and inclusive development indices (cluster analysis results)

The first cluster includes countries with moderate levels of digitalization and inclusiveness (DI ≈ 0.40; IDI ≈ 0.58), including Armenia, Azerbaijan, Georgia, India, Indonesia, Kyrgyzstan, Uzbekistan, and Kazakhstan (Table 3). These countries are characterized by emerging digital infrastructure and gradual institutional development, reflecting their transitional nature.

The second cluster includes countries with low levels of both indices (DI ≈ 0.16; IDI ≈ 0.29), such as Madagascar, Zambia, and Zimbabwe. As shown in Figure 3, these countries are concentrated at the lower end of the distribution, indicating significant structural constraints, including limited digital infrastructure and low inclusiveness.

The third cluster comprises countries with high levels of digitalization and inclusive development (DI ≈ 0.67; IDI ≈ 0.78), including Norway, Switzerland, the Republic of Korea, Iceland, China, Malaysia, Belarus, Russia, and Vietnam. These countries occupy the upper part of the distribution, demonstrating a stable combination of technological advancement and socio-economic inclusiveness.

Table 3. Distribution of countries across clusters by levels of digitalization and inclusive development

Cluster	Average Digitalization Index	Average Inclusive Development Index	Characteristics	Countries
1	0.40	0.58	Medium level of digitalization and inclusive development; countries with emerging digital economies and gradual progress in socio-economic inclusiveness	Armenia, Azerbaijan, Georgia, India, Indonesia, Kyrgyzstan, Uzbekistan, Kazakhstan
2	0.16	0.29	Low level of digitalization and inclusive development; countries with limited digital infrastructure and persistent socio-economic challenges	Madagascar, Zambia, Zimbabwe
3	0.67	0.78	High level of digitalization and inclusive development; technologically advanced economies with well-developed digital infrastructure and high levels of human capital	Norway, Switzerland, Republic of Korea, Iceland, China, Malaysia, Belarus, Russia, Vietnam

Further analysis of cluster profiles (Figure 4) shows that differences between clusters are systemic. Countries in the third cluster exhibit high levels of GDP per capita, education, and digital infrastructure, as well as low poverty rates. In contrast, countries in the second cluster exhibit low values on most indicators and higher poverty levels. The first cluster occupies an intermediate position, reflecting a transitional stage of development.

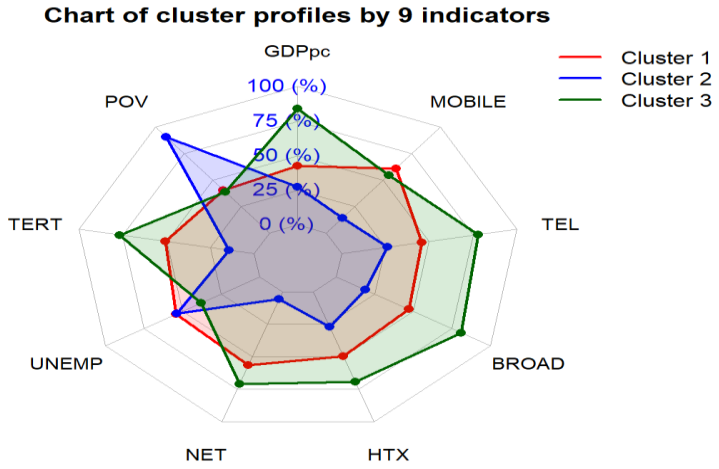

Figure 4. Cluster profiles based on normalized socio-economic and digital indicators

The results confirm a positive relationship between digitalization and inclusive development; however, this relationship manifests through different development patterns. Comparing the clusters with conventional country classifications shows general alignment, while also revealing deeper structural heterogeneity within groups. This suggests that digital transformation is an important but non-uniform driver of global socio-economic differentiation.

4.5. Econometric Assessment of the Impact of Digitalization on Inclusive Development

To quantitatively assess the relationship between digitalization and inclusive development, a linear regression model was estimated with the inclusive development index (IDI) as the dependent variable and the digitalization index (DI) as the explanatory variable. Separate models were estimated for 2010 and 2022, enabling analysis of changes in the strength and nature of this relationship over time.

The estimated regression equations are as follows:

for 2010: $IDI=0.282+0.659 \cdot DI$

for 2022: $IDI=0.264+0.746 \cdot DI$

The regression results indicate a statistically significant positive relationship between digitalization and inclusive development in both periods. The coefficient for digitalization is positive and highly significant (p-value < 0.001), confirming the robustness of the relationship. The estimated coefficients show that in 2010, a 0.1 increase in the digitalization index was associated with an average increase of 0.066 in the inclusive development index, whereas in 2022, the same increase was associated with an average increase of approximately 0.075. Thus, the impact of digitalization on inclusive development strengthened over the period 2010–2022 – the coefficient increased by 13%. The increase in the regression coefficient (from 0.659 to 0.746) indicates a strengthening impact of digitalization on inclusive development over time. The relatively high values of the coefficient of determination ($R^2 \approx 0.70$ in 2010 and $R^2 \approx 0.71$ in 2022) suggest that a substantial share of cross-country variation in inclusive development is explained by differences in levels of digitalization. The overall statistical significance of the models is confirmed by high F-statistics.

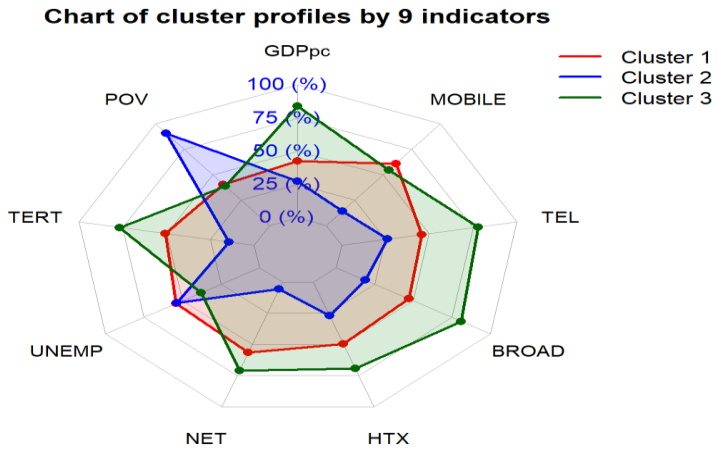

Figure 5. Comparison of the linear relationship between digitalization and inclusive development in 2010 and 2022

Visual inspection of the regression results (Figure 5) further supports these findings: in both years, a clear positive relationship is observed, while in 2022, countries are more closely clustered around the regression line, indicating a more systematic relationship. These findings are consistent with the results of the cluster analysis. Countries in the high-digitalization cluster exhibit the highest levels of inclusive development, whereas those with low digitalization remain at the lower end of the distribution. This confirms that digitalization acts as a key driver of cross-country differentiation.

5. Conclusions

This research allows for several important conclusions. Initially, the establishment of composite measures for digitalization and inclusive development enabled a quantitative comparison of both processes across multiple countries. Despite a prevailing upward trajectory, the findings revealed significant disparities in both digital transformation and inclusive development outcomes.

Following this, both comparative and correlational analyses confirmed a consistent positive relationship between digitalization and key socioeconomic development indicators, including income, education, and poverty levels. Moreover, the intensity of this impact is not uniform; in low- and middle-income nations, digital infrastructure significantly contributes to economic expansion and

poverty alleviation, while a saturation effect is evident in more developed economies. Cluster analysis further delineated specific country groupings that integrate digitalization and inclusiveness, encompassing both high-performing and those exhibiting a "double deficit." This underscores the distinct economic development trajectories shaped by digital transformation and inclusive development.

Finally, the regression analysis indicated a statistically significant positive correlation between digitalization and the degree of inclusive development, with this effect intensifying from 2010 to 2022. Simultaneously, the research found that digitalization's contribution to inclusive growth is contingent on a conducive institutional framework, a well-developed human capital base, and mechanisms that facilitate widespread public engagement.

Consequently, the study's conclusions position digitalization as a crucial, albeit conditional, determinant of inclusive growth, whose effectiveness is contingent upon prevailing institutional and socioeconomic circumstances. Moreover, the results suggest that enhancing digital infrastructure and expanding access to digital technologies can serve as effective instruments in pursuing the Sustainable Development Goals, particularly SDGs 8, 9, and 10.

Based on a review of the existing research, the following economic policy recommendations are suggested:

Improving digital infrastructure requires prioritizing investments in telecommunications networks, especially in rural and remote areas, to reduce the digital divide.

Developing digital skills involves creating educational systems and professional development programs for vulnerable groups, such as people with disabilities, the elderly, women, and youth in remote areas.

Creating an inclusive digital environment requires developing platforms and services that promote equal access to economic opportunities and consider the diverse needs of users.

Strengthening the institutional environment is facilitated by enhancements in public administration, the development of regulatory frameworks, and the promotion of digital inclusion within economic policy.

Encouraging digital entrepreneurship requires cultivating innovation and integrating marginalized groups into the digital economy

through targeted initiatives and financial instruments. As a result, the relationship between digitalization and inclusive growth is complex and multifaceted, in which digital technologies can both expand economic opportunities and exacerbate existing inequalities. The research results corroborate the view that digitalization has significant potential to advance inclusive growth by enhancing access to information, financial services, and labor markets.

References

Brynjolfsson, E., & McAfee, A. (2014). The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. W. W. Norton & Company, 86 p.

Carl Benedikt Frey, Michael A. Osborne (2017). The future of employment: How susceptible are jobs to computerisation? Technological Forecasting and Social Change, Volume 114, pp. 254-280.

Mihaljek, D. (2020). Capitalism without capital: the rise of the intangible economy. Public Sector Economics, 2020/03, volume 44, pp.147–152.

Philippe Aghion, Ufuk Akcigit, Antonin Bergeaud, Richard Blundell, David Hemous, Innovation and Top Income Inequality, The Review of Economic Studies, Volume 86, Issue 1, January 2019, Pages 1–45, https://doi.org/10.1093/restud/rdy027\

Biswas, A. (2016). Insight on the evolution and distinction of inclusive growth. Development in Practice, 26(4), 503–516. https://doi.org/10.1080/09614524.2016.1167169

George G., McGahan A. M., Prabhu J. Innovation for Inclusive Growth: Towards a Theoretical Framework and a Research Agenda // Journal of Management Studies. 2012. Т. 49. № 4. С. 661-683.

The Growth Report Strategies for Sustained Growth and Inclusive Development.Commission on Growth and Development. World Bank. 2008. p.142.

Inclusive Growth Analytics Framework and Application (2009) Elena Ianchovichina Susanna Lundstrom. World Bank, p.42. https://documents1.worldbank.org/curated/en/771771468180864543/pdf/WPS4851.pdf

Anand, Saurabh Mishra, and Shanaka J. Peiris. Inclusive Growth: Measurement and Determinants.IMF, 2018, p.27

Inclusive Growth: the OECD Measurement Framework. Romina Boarini, Fabrice Murtin, and Paul Schreyer. 2015. p.39

Grömling M., Klös H.-P. Inclusive Growth – Institutions Matter! // Intereconomics. 2019. Т. 54. № 3. С. 184-192.

Hay C., Hunt T., McGregor J. A. Inclusive growth: the challenges of multidimensionality and multilateralism // Cambridge Review of International Affairs. 2020. Т. 35. № 6. С. 888-914.

World Development Report 2016: Digital Dividends.2016. p.359

OECD (2019), Going Digital: Shaping Policies, Improving Lives, OECD Publishing, Paris, https://doi.org/10.1787/9789264312012-en.p.171.

Isaac K. Ofori, Dennis B. Osei, Imhotep P. Alagidede. Inclusive growth in Sub-Saharan Africa: Exploring the interaction between ICT diffusion, and financial development.Telecommunications Policy, Volume 46, Issue 7, 2022,102315, https://doi.org/10.1016/j.telpol.2022.102315.

Adeleye, B.N.; Arogundade, S.; Mduduzi, B. Empirical Analysis of Inclusive Growth, Information and Communication Technology Adoption, and Institutional Quality. Economies 2023, 11, 124. https://doi.org/10.3390/economies11040124