TECHNOLOGY AND INNOVATION AS DRIVERS OF DEVELOPMENT

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Abstract: This comprehensive study delves into the intricate relationship between techno-logical advancement, innovations, and their impact on the development of financial markets (FD index), Human Development Index (HDI), and Gross Domestic Product (GDP) per capita. The fundamental inquiry driving this research is: "How does the level of technology and innova-tions influence the market development index, the Human Development Index, and GDP per capita?" This study aims to examine how technology and strategies affect important economic indicators. It asks if following the same digital and innovation strategies as specific countries could help improve the financial market, make people happy, and increase GDP per capita.

This study employed regression analysis, with help from research and theory, to come up with conclusions. This is an inductive approach, so conclusions are not necessarily absolute. The findings underscore a pressing need for financial intermediaries in developing nations to reimagine their business models and swiftly adapt to the dynamic landscape of technological evolution. The research illuminates a critical nexus between advancements in digitization and tangible outcomes in the realms of economy and finance. It serves as a clarion call, emphasizing the paramount importance of agile responses to rapid technological shifts for ensuring enduring and sustainable development.

The study's implications reverberate across diverse sectors of society. By elucidating the intricate dynamics between technological progress and economic metrics, this research equips policymakers, financial institutions, and businesses with invaluable insights. These insights are indispensable for crafting strategic initiatives, fostering innovative ecosystems, and steering nations toward robust financial health, enhanced human development, and heightened GDP per capita.

This research shows how technology can help improve financial and societal progress in developing nations. By embracing a culture of adaptability and harnessing the transformative power of innovation, countries can navigate the complexities of the modern era with resilience and agility. The findings serve as a catalyst for future research endeavors, encouraging scholars and practitioners to delve deeper into the multifaceted interplay between technology, finance, and human development. As societies stand at the crossroads of unprecedented technological proliferation, this study offers a roadmap, illuminating the path toward a future where technology catalyzes holistic and sustainable advancement, fostering a world marked by equitable prosperity and enduring progress.

Keywords: *technological advancement, innovations, financial market, human development index , gross domestic product, digitalization.*

INTRODUCTION

In the past three centuries, civilization went through three industrial revolutions, while according to the opinion of the world's leading economists, the fourth industrial revolution is ongoing, the one popularly called the Industry 4.0. Each of these industrial revolutions was characterised by technological innovations that had a key impact on the development of the entire mankind. What is characteristic of the Industry 4.0 is that it already in different ways affects all business activities, while simultaneously developing digital and other technology, but also affecting the entire lifestyle in the world. After the process of globalization and intertwining of the world into one global market, which resulted in an unobstructed expansion of business, a new era began, which may be called the age of digital transformation. The basic characteristic of the new, digital age is that it takes on new dimensions and new forms, from one day to another. Accelerated technological development, the expansion of smart devices, mass production of mobile devices, as some of the elements of the fourth industrial revolution, have challenged financial institutions, which have responded with digitalisation, the creation of new communicative channels towards clients, as well as with a variety of other innovative services (Šehović, 2017, 136). For example, mobile money technology has a positive and significant effect on financial inclusion, measured by access to credit, savings, insurance, and payments (Alshahrani and Alsadiq, 2020). Besides, innovation system variables, such as R&D intensity, patenting, education, and institutional quality, have a positive and significant impact on economic development, measured by GDP per capita (Fagerberg and Srholec, 2008).

Although banks are less likely to accept changes by their structure, line of business and other characteristic, they have largely adjusted their business to changes in the business environment and, consequently, adopted and applied certain processes imposed by the digitalisation process. The continuous process of creating new banking products and services which are directly linked to the digitalisation process, is a clear sign that the banking sector has seriously acknowledged the upcoming changes, which certainly result in the creation of a competitive advantage and a better position in the market. According to experts, technological innovations and clients will "set new rules of the game" in the banking sector (Ćukić, 2013), which will significantly affect banks, especially the ones in which traditional banking is prominent (Tornjanski, V., Petrović, D., & Milanović, M. (2016). In order for banks to retain their competitiveness, growth and development, and to continually create valuable products for the users of banking services, as well as shareholders, the bank management should without any delays acknowledge these trends and redefine existing business strategies (Fasnacht, 2009; Huo & Hong, 2013; Tornjanski et.al., 2014) and develop new models for the expansion of knowledge. Research so far indicates that financial institutions and the population largely benefit from the process of digitalisation and innovations (Laursen & Salter, 2006; Fasnacht, 2009). On the other hand, despite the digitalisation representing an important step in the application of innovations in the existing body of scientific research (Grujić, 2022), there is not enough research on these processes, i.e. on how digitalisation, innovations and information and communication technologies contribute to the performances of open innovations in banking (Tornjanski et al., 2016). Bearing that in mind, this papers aims at depeening and expanding the body of research on the effects of digitalisation and innovations in the financial market and the population, along with indicating the significance of these processes.

The main objective of this paper is to examine how technological advancement and innovations affect the development of financial markets, human development, and GDP per capita in selected countries, using regression analysis and data from various sources. The paper contributes to the literature by providing empirical evidence on the relationship between technology, innovation, and development, and by discussing the implications for policy and practice.

1. LITERATURE REVIEW

This section reviews the relevant literature on technology, innovation, and development, focusing on three aspects: the impact of information and communication technology on economic growth and human development; the role of innovation in financial inclusion and inclusive growth; and the challenges and opportunities of digitalization for sustainable development. The section also identifies some research gaps and questions that motivate this study.

The advent of Industry 4.0, or the fourth industrial revolution, marked by the digitalization of industries, has become a focal point in enhancing global market competitiveness.

This revolution involves the integration of smart devices, tools, robots, and human resources, aiming to create adaptable and efficient smart factories. The impetus for this transformation was driven by economic crises and the need for leading European Union countries to bolster their economies and global standing. According to the European Banking Federation (EBF, 2018), the establishment of a unified digital market fosters business development, benefits clients, and fuels economic growth and employment. Consequently, this revolution has given rise to a novel economic paradigm - digital economics (Lazarević & Đuričković, 2018, 27).

There are studies that show the positive impact of information and communication technology on economic growth and human development (Gao et al., 2022; Alshahrani & Alsadiq, 2014) or the role of innovation in financial inclusion and inclusive growth (Naudé & Nagler, 2017; Abor, Amidu and Issahaku, 2018) or some sources that show the challenges and opportunities of digitalization for sustainable development (Naudé, 2020).

Digital economics comprises three main components (Lazarević & Đuričković, 2018, 27): e-business infrastructure, which includes hardware, software, telecommunications, networks, and human capital; e-business, focusing on the execution of business activities through computer networks; and e-trade, involving online goods and services transactions.

From the OECD standpoint, digital economics encompasses markets centered around digital technology, facilitating trade in information goods and services through electronic channels. This framework operates through a layered foundation with distinct segments for data transport and applications.

In general, the development of information and communication technology has a positive and significant impact on economy (Gao et al., 2022). Recent studies highlight the need for open-ended innovations in the banking sector, emphasizing the incorporation of external knowledge through appropriate technologies (Tornjanski, Petrović, & Milanović, 2016). Banks are not only urged to be innovative partners investing in financial technologies but also to contribute to overall economic growth and development in the financial market (Grujić, 2019).

A plethora of studies have delved into the impact of financial development on economic growth, inequality, and stability. Financial sectors worldwide have evolved, incorporating various institutions like banks, investment firms, insurance companies, and pension funds, enabling diversification of savings and capital collection through diverse financial instruments. Financial systems' accessibility and efficiency are pivotal, with a need for diverse indicators to measure their development. For instance, Alshahrani and Alsadiq (2014). proved that technological innovation has a positive and significant impact on both GDP per capita and the HDI. The study suggests that country should diversify its economy and invest more in human capital and innovation to achieve sustainable development.

In evaluating financial development, researchers have examined its functions such as pooling savings, allocating capital, tracking investments, diversifying risk, and facilitating the exchange of goods and services. These functions impact savings, investments, asset allocation efficiency, and overall economic growth. Naudé an Nagler (2017) showed that

technological innovation has a positive and significant effect on inclusive growth, measured by income inequality, poverty reduction, social mobility, and social cohesion. They also finds that this effect is mediated by various factors, such as education level, skill intensity, firm size, industry sector, and regional location. The study concludes that technological innovation can foster inclusive growth in Germany if it is accompanied by appropriate policies that enhance human capital formation, skill upgrading, entrepreneurship promotion, and regional development.. Financial development's multidimensional nature necessitates comprehensive indices, like the financial development index, combining depth, accessibility, and efficiency aspects.

These indices provide a nuanced understanding of specific financial system features and overall development. The methodology involves integrating various indicators, addressing missing data, and considering functional forms and weights for aggregation. Comparative analysis between new indices and traditional measures offers insights into global financial development patterns. Additionally, examining the influence of pension fund structures on these indices helps gauge their impact on financial market evolution.

The study focuses on developing markets characterized by institutional challenges, weak corporate management, and limited economic development compared to developed countries. Every country has its own unique priorities when it comes to the organization of functions that enable its optimal development and survival in international relations (Glišović and Zupac, 2023). Countries in transition, particularly those in the Western Balkans, face bureaucratic inefficiencies and corruption due to historical legacies, impacting economic growth and development (Haramija & Njavro, 2016; Bjørnskov, 2007). These challenges underscore the need for targeted strategies to foster sustainable development and overcome systemic limitations.

2. DATA AND METHODOLOGY

Data on the level of technological development and innovations were taken from the publication Readiness for the Future of Production Report 2018, data on the market development were expressed through FD index, and the level of human development index was found in data from the United Nations Development Programme. Besides, in the study we have observed data given by The Natioanl Bureau of Economic Research for GDP per capita (2022), Organisation for Economic Co-operation and Development for FD index (2022), The World Economic Forum for data on digitalisation and innovations (2022) and International Monetary Fund for GDP per capita (2022).

Table 1. Table-matrix of the correlation of all four observed variables
(each with another one, countries of OECD)

Description	Scale according to technology and innovations	FD Index	HD Index	GDP per capita
Scale according to technology and innovations	1	0,366	0,721	0,444
FD Index	0,366	1	0,478	0,49
HD Index	0,721	0,478	1	0,757
GDP per capita	0,444	0,49	0,757	1

Source: Authors' calculation

Table 2. Table-matrix of correlation of all four observed variables
(each with another one, countries which are not in OECD)

Description	Scale according to technology and innovations	FD Index	HD Index	GDP per capita
Scale according to technology and innovations	1,000	0,496	0,688	0,673
FD Index	0,496	1,000	0,592	0,594
HD Index	0,688	0,592	1,000	0,896
GDP per capita	0,673	0,594	0,896	1,000

Source: Authors' calculation

In the study we have observed data given by The Natioanl Bureau of Economic Research (2022), Organisation for Economic Co-operation and Development (2022), The World Economic Forum (2022) and International Monetary Fund for GDP per capita (2022). For each country we considered the level of digitalisation and compared it to FD index, HD index and GDP per capita in 2020.

The relationship between the realised rates of non-payment of liabilities and macro-economic indicators may be checked in several ways. We used linear regression because we supposed that there is a linear relationship between the independent variable (X) and dependent variable (Y).

Hypotheses were constructed in the following manner:

H0 – null-hypothesis 0 = negative

H1 – alternative = affirmative

In relation to that, the research question was formulated so as to ask whether variable X affects the variable Y. Therefore, the hypotheses are:

H01: Technologies and innovations do not affect the FD index.

H02: Technologies and innovations do not affect the HDI.

H03: Technologies and innovations do not affect GDP per capita.

3. RESULTS

By analysing the relation between digitalisation and innovations across countries of OECD and non OECD countries and FD index, we have obtained the following table (Table 3).

Table 3. Regression analysis Source: Authors calculation

Sample	OECD			non OECD		
Regression Statistics	digitalisation and FDI	digitalisation and HDI	digitalisation technological innovations and GDP per capita	digitalisation and FDI	digitalisation and HDI	digitalisation technological innovations and GDP per capita
Multiple R	0.37146	0.71383	0.44179	0.49587	0.68841	0.67281
R Square	0.13798	0.50955	0.19518	0.24589	0.47391	0.45267
Adjusted R Square	0.11263	0.49512	0.17151	0.20998	0.44886	0.42661
Standard Error	1.43110	1.07947	1.38281	1.21393	1.01392	1.03419
Observations	36.00000	36.00000	36.00000	23.00000	23.00000	23.00000
Regression coefficient	4.63838	- 16.38613	5.30653	2.36695	- 9.38182	3.00364
Standard Error	0.82349	3.85106	0.46830	0.65270	3.07048	0.31164
F	5.44227	35.32355	8.24533	6.84728	18.91725	17.36814
Significance F	0.02571	0.00000	0.00699	0.01611	0.00028	0.00044
F crit	0.00000	0.00016	0.00000	0.00158	0.00601	0.00000
Test	we fail to reject the null hypothesis H01	we reject the null hypothesis H02	the null hypothesis H03 is rejected	we reject the null hypothesis	we reject the null hypothesis	the null hypothesis H03 is rejected

In the first relationship between digitalization and innovations (X) and the Financial Development Index (FDI) (Y), the coefficient of determination R^2 is 0.13798, indicating that 13.8% of the variance in FDI can be explained by the level of digitalization and innovations. The multiple correlation coefficient (R) of 0.371 suggests a weak direct relationship between digitalization/innovations and FDI. The multiple regression analysis for OECD countries indicates that the relationship between digitalization and innovations (X) and the Financial Development Index (FDI) (Y) is not statistically significant ($p > 0.01$). Therefore, **we fail to reject the null hypothesis H01**. In this sample, there is insufficient evidence to suggest that technology and innovations significantly affect the FD Index for OECD countries. Therefore, **we cannot conclude that technology and innovations significantly affect the FD index**.

Figure 1: Technology and inovations vs FD index for OECD countries
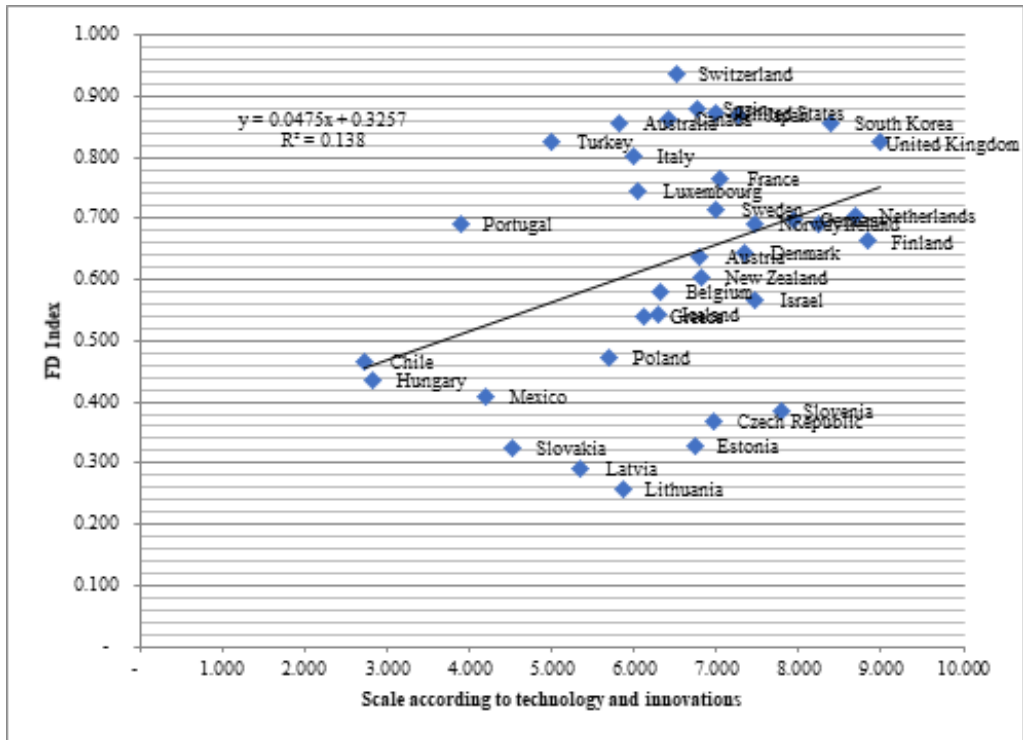
(Source: the author's research)

However, when examining the relationship between digitalization/innovations and the Human Development Index (HDI), R2 increases to 0.50955, meaning that 50.96% of the variance in HDI can be explained by digitalization and innovations. The multiple correlation coefficient (R) of 0.71383 indicates a strong direct relationship between digitalization/innovations and HDI. The low p-value (< 0.01) suggests that this relationship is statistically significant. Consequently, **we reject the null hypothesis H02**. In the context of OECD countries, technology and innovations do have a significant impact on HDI, indicating that technological advancements contribute to human development in these countries

Additionally, the relationship between digitalization/innovations and GDP per capita also shows significance R2= 0.19518, R = 0.44179), explaining 19.52% of the variance in GDP per capita with a moderate positive correlation. The p-value (< 0.01) confirms the statistical significance of this relationship. Hence, the null hypothesis H03 is rejected. Technology and innovations play a significant role in influencing GDP per capita in these countries, implying that economic prosperity is linked to technological advancement.

These results imply that digitalization and innovations play a substantial role in enhancing human development and economic prosperity, as reflected in HDI and GDP

per capita. However, concerning financial market development (FDI), the impact is not statistically significant.

It's crucial to note that correlation does not imply causation. While there's a strong correlation between digitalization/innovations and HDI/GDP per capita, establishing a cause-and-effect relationship requires further in-depth analysis and consideration of other variables.

In the analysis of non-OECD countries, the relationships between digitalization and innovations (X) and various indicators including Foreign Direct Investment (FDI) (Y1), Human Development Index (HDI) (Y2), and GDP per capita (Y3) were examined. The coefficient of determination R^2 for digitalization and FDI (Y1) is 0.24589, indicating that 24.59% of the variance in FDI can be explained by digitalization and innovations in non-OECD countries. The multiple correlation coefficient (R) of 0.49587 suggests a moderate positive relationship between digitalization/innovations and FDI and we reject the null hypothesis. The low p-value (0.01611) indicates that the relationship is statistically significant. Therefore, technology and innovations significantly impact FDI in non-OECD countries, indicating that these factors attract foreign investments in these countries.

The coefficient of determination R^2 for digitalization and HDI (Y2)i s 0.47391, meaning that 47.39% of the variance in HDI can be explained by digitalization and innovations and **we reject the null hypothesis**. The multiple correlation coefficient (R) of 0.68841 suggests a strong positive relationship between digitalization/innovations and HDI. The extremely low p-value (0.00028) confirms the highly significant and positive relationship between digitalization/innovations and HDI in non-OECD countries.

Similar is for digitalization, Technological Innovations and GDP per capita (Y3). The coefficient of determination R^2 is 0.45267, indicating that 45.27% of the variance in GDP per capita can be explained by digitalization and innovations. The multiple correlation coefficient (R) of 0.67281 suggests a strong positive relationship between digitalization/innovations and GDP per capita. The very low p-value (0.00044) confirms the highly significant and positive relationship between digitalization/innovations and GDP per capita in non-OECD countries. . Thus, the null hypothesis H03 is rejected. Technology and innovations significantly impact GDP per capita in these nations, emphasizing their crucial role in driving economic growth.

These results highlight the substantial impact of digitalization and innovations on economic indicators in non-OECD countries. The statistically significant relationships observed in FDI, HDI, and GDP per capita emphasize the importance of technological advancement in driving economic development and human well-being in these nations. However, as always, it's important to approach causation cautiously and consider the influence of other variables in these relationships.

4. DISCUSSION

In our study, we found strong correlations between digitization, innovation, and economic indicators. But it's difficult to say which causes which effects. Future research

could delve deeper into the mechanisms through which digitization and innovation cause changes in economic parameters. Longitudinal studies tracking the evolution of digital technologies within economies over time can provide invaluable insights into the causal links at play. Additionally, exploring intermediary factors that amplify or diminish the impact of digitization on economic development can enhance our understanding. Factors such as governance policies, educational systems, and social infrastructure can act as catalysts or barriers in the causal pathway. Furthermore, conducting comparative analyses across different cultural and regulatory contexts can shed light on nuanced causal relationships specific to different regions. Examining the temporal aspects of technology adoption and its lagged effects on economic indicators can add a temporal dimension to the observed causal relationships. By addressing these avenues, future research can contribute to unraveling the complexity of causal links between digitization, innovation, and economic development, providing valuable guidance for decision-makers and stakeholders navigating the evolving landscape of technology-driven economies.

Our analysis shows that digitization and innovation have a significant impact on human development and economic prosperity, but the link between digitization/innovation and financial market development (FDI) is not statistically significant. It's important to note that correlation does not imply causation. While there is a strong correlation between digitization/innovations and HDI/GDP per capita, establishing a cause-and-effect relationship requires deeper analysis and consideration of other variables. In future research, we could explore specific factors that contribute to or limit the establishment of causal relationships in the context of the financial market. Also, investigating the role of regulatory policies and market conditions in these relationships can enhance our understanding. Furthermore, assessing the impact of cultural differences and historical contexts on the observed relationships can provide insights into the diverse causal pathways specific to different regions. Studying the temporal aspects of technology adoption and its delayed effects on financial market development can add a temporal dimension to the observed causal relationships. Addressing these directions, future research can contribute to uncovering the intricacies of the causal links between technological changes and financial development.

Despite challenges in determining causal relationships, our study provides a foundation for further research and practical interventions. Identifying key indicators and variables that modulate the impact of digitization and innovation on economic development can serve as a starting point for the development of targeted policies. Furthermore, a deeper understanding of these links can support the creation of sustainable strategies for economic growth and inclusive development, especially in developing countries. Integrating such knowledge into policy formulation can have a significant impact on improving economic performance and the quality of life for citizens.

CONCLUSION

Upon scrutinizing the regression analyses for both OECD and non-OECD countries, a nuanced picture emerges regarding the influence of digitalization and innovations on economic parameters. These analyses, meticulously conducted and rooted in robust statistical methods, illuminate the complex interplay between technological advancements and socioeconomic indicators.

In the realm of OECD countries, the data speaks of a moderate correlation between digitalization and key economic variables. Specifically, the analysis reveals a noteworthy relationship between digitalization and Foreign Direct Investment (FDI), Human Development Index (HDI), and GDP per capita. However, the impact, while observable, is not as profound as one might anticipate. The coefficients, although significant, underscore a subtle influence rather than a transformative one. This suggests that while digitalization does play a role in shaping economic metrics within OECD nations, its effect is tempered, indicating the presence of additional influential factors.

Conversely, the non-OECD countries exhibit a more substantial relationship between digitalization, innovations, and economic parameters. The correlation coefficients for FDI, HDI, and GDP per capita are more pronounced in this group. This implies that in economies outside the OECD sphere, digitalization and innovations wield a more significant influence on economic development. The data underscores their pivotal role in shaping FDI, human development, and GDP per capita in these nations, indicating a stronger correlation compared to their OECD counterparts.

The significance of these findings reverberates across the landscape of economic policy and development. For OECD nations, the message is one of careful consideration: while digitalization matters, it is not the sole driver of economic progress. Collaboration with other influential factors is imperative for holistic economic growth.

In non-OECD countries, the results signify a call to action. The substantial impact of digitalization and innovations on economic parameters underscores the potential for transformative change. Policymakers and stakeholders in these nations are presented with an opportunity — a roadmap to leverage technology for comprehensive socioeconomic development. By harnessing the power of digitalization in conjunction with strategic policies, these countries can potentially accelerate their economic growth and enhance the well-being of their citizens.

As we reflect on these findings, it becomes evident that the relationship between technology and economics is intricate, multifaceted, and ever-evolving. This research not only deepens our understanding of these dynamics but also lays the groundwork for future exploration. Further studies could delve into the specific mechanisms through which digitalization influences economic variables, unraveling the intricacies of this relationship and guiding precise policy interventions.

In essence, this analysis serves as a testament to the complexity of the modern economic landscape. While digitalization and innovations are undeniably influential, their

impact varies across different contexts. As we navigate the path forward, armed with these insights, we are better equipped to foster inclusive, sustainable, and technology-driven economic development for nations around the globe.

Financial institutions in developing nations must swiftly adapt their business models to align with market shifts. This adaptation may entail forging alliances with large technological firms or smaller entities offering complementary solutions. Moreover, the financial sector is poised to transition towards open-ended financial services, necessitating continuous adjustments in strategies and services offered by banks and other institutions. Consequently, regulatory frameworks should be revised to foster digitalization and innovation in the financial sector.

Further research is imperative to pinpoint specific innovations that have the most impact on diverse segments of the financial system and society. Additionally, investigating the reasons behind the weaker relationship between innovations and financial development, particularly concerning the FD index, remains a crucial avenue for future exploration.

It is important to consider the statistical significance of regression coefficients and the chosen threshold during result interpretation. The study underscores the need for a critical, balanced view of the significance assigned to R2 values. Overemphasis on R2 values, especially when comparing relationships across different variables, can lead to inaccurate, skewed conclusions.

In this research, we explore the intricate dynamics of digitalization and innovations on various facets of economic development, and how their impact varies based on the level of development. We find that while their impact on financial market development is limited, these factors wield significant influence over human development and GDP per capita. Financial institutions, especially in developing economies, must proactively prepare for a future where digitalization and emerging technologies occupy central roles in shaping the financial landscape. Continued research is vital to unravel the intricate dynamics of these relationships and their implications for the financial sector.

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