“Regional income inequality in Ukraine: The impact of Internet and mobile access on disposable income”

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REGIONAL INCOME INEQUALITY IN UKRAINE: THE IMPACT OF INTERNET AND MOBILE ACCESS ON DISPOSABLE INCOME

Abstract

The effect of digitalization on inequality continues to spark discussions, with opinions divided on whether it alleviates or exacerbates the issue. This paper explores how digitalization has affected income inequality in Ukraine from 2017 to 2021. A pooled OLS model is used to investigate the relationship between mobile communication access and fixed Internet access and usage and their influence on disposable income levels. The findings reveal that mobile and Internet access significantly impact income distribution, with a notable disparity between high- and low-income regions. Specifically, wealthier regions benefit more from mobile access, while low-income regions lag due to insufficient broadband infrastructure. These results underscore the need for targeted management strategies to reduce regional income inequality via digitalization in Ukraine. The transition from desktop internet to mobile connectivity is clear, as 4G and 4G+ networks have enough speed to substitute fixed Internet and have become the primary means of internet access in Ukraine, reflecting a global trend. This highlights the increasing significance of mobile Internet, especially in lower-income regions, as a practical alternative to fixed broadband. Hence, mobile networks can boost economic participation and reduce regional disposable income inequality. The study suggests that targeted investments in digital infrastructure can significantly contribute to regional economic development.

Keywords inequality, disposable income, digitalization, regional governance, economic development, pooled OLS model

JEL Classification I31, G59, H70, O33, O38

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INTRODUCTION

Digital inequality, which has arisen from the technological advancements of the past century, is recognized as a significant factor contributing to various forms of inequality. However, there is an ongoing debate about whether digitalization serves as a tool for reducing income inequality or as a catalyst for its increase, and both issues are discussed simultaneously. Therefore, it is essential to explore the implications of digital instruments when examining their role in tackling poverty and diminishing income disparity.

As digital technologies become central to economic activities, understanding their role in income distribution is crucial for effective government management. The Ukrainian experience, especially in light of the COVID-19 pandemic and the ongoing war, underscores the need for robust digital infrastructure to sustain economic activity. Cloud data storage has proven to be crucial in averting economic collapse, especially when technology infrastructure is subjected to missile attacks. Governmental initiatives such as the Diia app have been instrumental in digitizing public services, emphasizing the importance of digital tools for state management and regional governance. The announcement of 5G technology testing in three cities across Ukraine (Ministry

of Digital Transformation of Ukraine, 2024) marks a significant step toward improving access to high-speed mobile Internet, which is crucial for small and medium businesses. However, the persistent disparities in Internet access between urban and rural regions highlight the urgent need for effective management strategies to close the digital divide and promote equitable economic opportunities.

1. LITERATURE REVIEW

The impact of technology on economic development has long been a subject of academic inquiry, often focusing on how technological advancements shape income distribution. Theorists turned to identifying issues and inequalities that new types of economy and society could have fueled. In the modern information society, such inequality is the digital one, which, along with related issues, has been actively discussed in the literature over the past 40 years. While some stated the positive impact of ICT and digital technologies on reducing inequality globally, namely between developing countries of the so-called global South and the developed countries of the so-called reach North (Hamelink, 1979), others very quickly began to claim the opposite effect meaning those who would lose because of being excluded from the process of digitalization (Traber, 1986). The challenge of overcoming the digital divide began to be articulated at the highest international level in the early 2000s in Declarations and Plans of Action of two World Summits on the Information Society (2003a, 2003b, 2005a, 2005b). This made the digital divide issue one of the priorities on a global level.

Analyzing the "digital inequality" phenomenon, it is essential to note its inseparability from the term "digital divide." The term "digital divide" refers to the gap between people who have access to the Internet and other digital technologies and those who do not and, as a result, cannot utilize online services (Eurostat, n.d.). This disparity can be categorized based on factors such as gender, age, education, income, social groups, or geographic location, affecting individuals' participation levels in digital opportunities. On the other hand, digital inequality appears when all the actors can access the Internet. However, not all of them have the same quality and speed of the Internet connection, which results in different possibilities and efficiency of use. DiMaggio and Hargittai (2001) proposed the interpretation of digital inequality as a broader concept that encompasses not only differences in access to the Internet but also the disparities among individuals who already have formal access. According to them, it includes variations in equipment, autonomy of use, skill levels, social support, and the purposes for which technology is employed. The shift from the digital divide to digital inequality reflects a recognition that simply having access does not guarantee equitable benefits from technology use, as there are significant differences in how individuals utilize and benefit from their access to the Internet. Due to other concepts, there are a few orders (Riggins & Dewan, 2005) or levels of the digital divide (Ragnedda & Ruiu, 2017). On the first level, the source of inequality lies in access to the Internet and digital technologies, as well as the availability of digital gadgets. On the second level, everyone has gadgets, but not everyone understands how they work, so inequality is rooted in their efficiency.

Myskevych (2019) states that in Ukraine, both levels exist simultaneously, making the inequality issue even more severe. The distinction between the two levels of the digital divide is similar to the one that DiMaggio and Hargittai (2001) revealed. It may explain why some researchers consider digital inequality, digital divide (Myskevych, 2019), and information inequality (Dovzhuk, 2022) as equal terms. Nevertheless, the research focus has undoubtedly "shifted from the access to use" (Vassilakopoulou & Hustad, 2023, p. 966). Such a shift indicates the depth and complexity of digital inequality and digital divide issues, which are complicated by the development of technology concerning economic development.

Different levels or orders of the digital divide reflect the evolution of the actual problem itself. Analyzing digital inequality in the so-called global South, Heeks (2022) introduced the concept of negative digital integration. This concept describes a situation where inclusion in digital systems can lead to exploitation and increased inequality. The study highlighted that digital technologies can

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not only provide access to resources but also create new forms of inequality where more privileged groups can extract a disproportionate share of the resources of less privileged groups.

Modern challenges such as the COVID-19 pandemic have intensified the issue of digital inequality, revealing new threats and trends. Bulatova et al. (2023) described significant changes in access to and use of digital technologies before and after the pandemic. Before the pandemic, the digital divide manifested in various aspects, such as access to basic telecommunications infrastructure, digital skills, and digital technologies. Key dimensions included gaps in access, literacy, use, capacity, participation, and outcomes. The pandemic has exacerbated existing digital divides as many people and businesses have been forced to switch to remote work and learning formats. This led to widening gaps in digital literacy and use, as not everyone had equal access to the Internet and the necessary skills to effectively use digital resources. Therefore, the pandemic has highlighted the importance of digital technologies, revealing, at the same time, exacerbated existing inequalities.

At the enterprise level, the implementation of digital technologies and the digitization of processes have different impacts depending on the firm's size, industry, and region. As shown above, Au's (2024) study shows that small and medium-sized enterprises significantly reduce income inequality in European countries. Zhu (2023) makes similar conclusions regarding China. In particular, it is shown that the development of financial inclusion is associated with an increase in the share of labor income, especially in private companies and in less developed regions, indicating a positive effect on reducing income inequality. Similarly, Shapoval et al. (2022) highlight that digitalization of operations significantly influences financial infrastructure by enhancing access and promoting financial inclusion, which ultimately contributes to the growth of Ukraine's IT sector. On the contrary, another study shows that digitalization tends to increase productivity more in high-paying state-owned companies, which can increase wage inequality between firms. This suggests that although digitalization benefits large companies, it may not always reduce income inequality (Hu et al., 2024). The speed and sustainability of digitalization adoption in firms depending on their size is pointed out by Eller et al. (2020). Their study shows that small and medium-sized enterprises lag behind large firms in digitalization, negatively affecting their efficiency. However, when these enterprises implement digital tools, the impact on productivity and income distribution is significant. Thus, small and medium-sized enterprises demonstrate a more pronounced effect on reducing income inequality through digitalization tools than large companies. This is evident from their significant role in income redistribution and the direct impact of digital integration on reducing inequality.

Eller et al. (2020) pointed out the speed and sustainability of digitalization adoption in firms depending on their size. Their study showed that small and medium-sized enterprises lag behind large firms in digitalization, negatively affecting their efficiency. However, when these enterprises do implement digital tools, the impact on productivity and income distribution is significant. Thus, small and medium-sized enterprises demonstrate a more pronounced effect in reducing income inequality through digitalization tools than large companies. This is evident from their significant role in income redistribution and the direct impact of digital integration on reducing inequality.

This study builds on existing literature that links technology and inequality, using a management lens to analyze the role of digital infrastructure in promoting regional equity. The government's involvement is crucial in addressing regional digital inequality via developing digital infrastructure to ensure everyone has equal access to high-speed Internet and ICT resources. For example, investments in digital infrastructure in Sub-Saharan Africa boost inclusive growth by improving Internet and broadband connectivity (Kouladoum, 2023). Likewise, provincial policies in Canada that leverage public sector procurement to enhance access to essential services have created high-quality broadband networks (Rajabiun & Middleton, 2013). Creating digital literacy programs is vital for improving digital skills and literacy in the community, especially among older adults and those living in rural areas. Choudrie et al. (2006) emphasized that these programs should focus on disadvantaged groups, such as the elder-

ly, disabled individuals, and rural communities, to enhance their digital skills and competencies. Furthermore, fostering the development of digital finance can enable underdeveloped regions to catch up by providing improved access to financial services and promoting green technological innovation (Feng et al., 2022). Thus, to address regional digital inequality, the government may implement several strategies, such as investing in digital infrastructure, especially in remote and underdeveloped regions, developing digital literacy programs, and encouraging the development of digital finance.

At the same time, in recent years, there has been a noticeable shift in the role of SIM cards, with a growing emphasis on facilitating Internet access over traditional telephone communication. Keshav (2005) stated that the image in which people access the Internet exclusively via desktop computer did not fit the reality anymore. He assumed the use of cell phones for that purpose. The only difference is that Keshav (2005) meant CDMA and GPRS type of connection, whereas, in the modern world, people deal with 2G, 4G, and 5G. According to the Pew Research Center, in 2009, 74% of Americans used the Internet, 60% used broadband at home, and 55% used wireless Internet connections, including cell phones (Rainie, 2010). The latest data show that today, 95% use the Internet, demonstrating a dramatic shift compared to 2000, with only 52%, 80% using a broadband connection, and 15% using only cell phones (Gelles-Watnick, 2024). Moreover, Canh et al. (2020), who analyzed a wide range of data from more than eighty countries, evidenced the positive impact of the Internet and mobile connection on income inequality. This means that ICT is seen as an effective tool for eliminating inequality. Another important conclusion was made about the determinants of income inequality, which are not connected exclusively to income itself. Reisdorf et al. (2022) concluded that any Internet connection itself cannot provide full engagement in activities connected to social capital gaining. This conclusion may be discussed, meaning the quality of the analyzed Internet services. Nevertheless, it reinforces the argument about the importance of the Internet and various types of connections and their influence on various social and economic development spheres.

Another critical indicator of social and income inequality is Gross National Disposable Income (GNDI), which reflects disparities in income distribution. GNDI reflects the average level of income that remains at an individual's or household's disposal after paying all taxes and mandatory payments, which can be used to meet needs. Capital income contributes significantly to overall income inequality, forming a large part of disposable income (Fräßdorf et al., 2011). Adjustments in income data to match national accounts reveal that traditional measures may underestimate inequality. Bruil (2023) showed that the Gini coefficient for disposable income increased significantly when all household income was considered in the Netherlands. This indicates that GNDI can provide a more comprehensive view of inequality. Thus, GNDI reveals income disparities as comprehensive income measures show higher inequality, highlighting the importance of considering all income sources.

Thus, while the impact of technology on economic development has been discussed for centuries, its relevance has intensified with the rise of the digital economy, where knowledge, innovation, and information are the key drivers. The digital divide, supplemented with a concept of digital inequality, explains this effect and its modern evolution and describes the emergence of new contradictions being built in society. Along with the promising positive impact of digitalization on the economy, many studies analyze the deepening of economic inequality and the impact on the growing gap between countries depending on their income level. On the regional level, public management has a vital role in developing digital infrastructure and literacy programs to reduce regional digital inequality and promote equitable access to technology and financial services, particularly in underdeveloped areas. Recent studies demonstrated the growing importance of mobile connection in providing Internet access. It raises the issue of the mobile infrastructure's quality and capability to provide high-speed Internet as a factor of income inequality, which remains an insufficiently studied problem. Another problem that needs to be studied due to the lack of relevant research is the role of GNDI as an indicator of disparities in income distribution.

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The growing influence of digitalization in every aspect of society and across various economic sectors is reshaping the nature of work. The shift toward digitalizing business processes has been highly influenced by the widespread use of Internet technologies and remote access solutions powered by mobile connectivity, often referred to as the Internet of Things. Simultaneously, during COVID-19, remote work surged in popularity, thanks to the Internet, even in sectors where it had been rare before. Consequently, production processes, labor resource management, and enterprise capital management have become more heavily reliant on the Internet and remote access systems than ever before. As a result, at the macroeconomic level, the ability to generate income increasingly depends on the population's access to the Internet.

The aim of this study is to explore the potential of digital-based services in reducing regional income inequality in Ukraine.

2. METHODS

This study employs a pooled ordinary least squares (OLS) model to analyze the relationship between digital infrastructure and income inequality across Ukrainian regions from 2017 to 2021.

There are three dependent variables chosen to detect the relationship between income distribution and digital infrastructure:

1) fixed Internet access (per 100 households) helps evaluate the level of coverage of a country's territory with a population representing economic activity;

2) mobile SIM cards can evaluate the number of people who regularly communicate with or use mobile Internet daily;

3) Internet usage helps check how access levels convert to real usage.

The above-mentioned variables influence the income generation process and, therefore, the distribution between regions based on income level and affect disposable income redistribution (Figure 1).

For years in which fixed Internet access data were available per 100 individuals, a recalculation was performed to determine household access, using data on the average household size in a given region for the specified year. The dependent variable is the level of disposable income in a particular region during a specific period. Disposable income was chosen as it directly reflects the funds available for consumption and savings by individual households. The analysis period is 2017–2021, as data on disposable income beyond 202 are currently unavailable due to wartime, and digitalization indicators before 2017 were based on alternative assessment methods. The previously occupied regions of Ukraine are also excluded from the calculations. After preparing the dataset and excluding regions that russia temporarily occupies, 115 observations are in modeling.

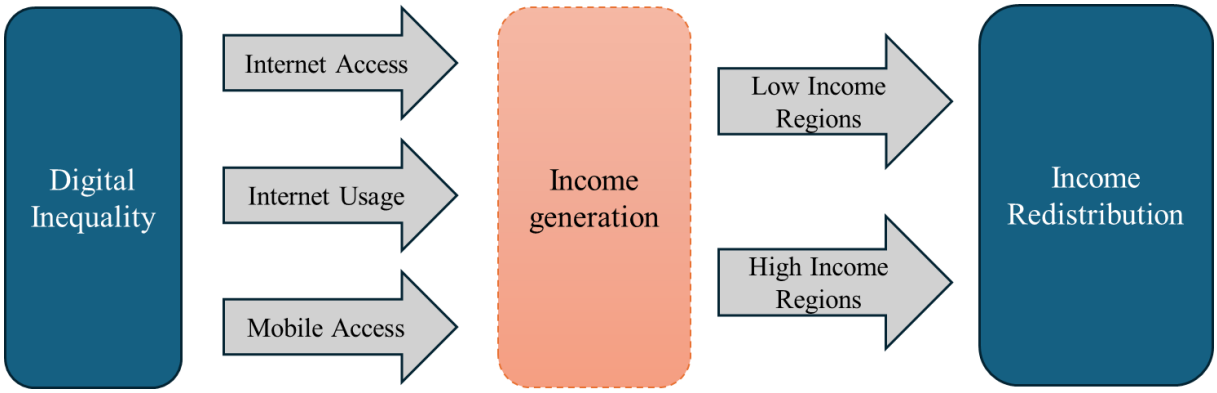

Figure 1. Approach to the measure of the relationship between digital inequality and income distribution

Table 1. Variable characteristics

Characteristics	Symbol	Source
Disposable income (in the region based on year report)	Y	State Statistics Service of Ukraine data
Internet access (number of fixed Internet access per 100 households)	Internet Access	National Commission for the State Regulation of electronic communications, radio frequency spectrum, and the provision of postal services data
Internet usage (percent of the population that uses the Internet)	Internet Usage	State Statistics Service of Ukraine data
Mobile access (number of active SIM cards per 100 people)	Mobile Access	National Commission for the State Regulation of electronic communications, radio frequency spectrum, and the provision of postal services data
Number of people in the household	Additional indicator to align calculation for Internet between years	State Statistics Service of Ukraine data

Since the data are presented in a panel structure, with variable values extending across two dimensions (region and year), the pooled OLS model is chosen as one of the good options for identifying the relationships among them. It is highly interpretable and practical in estimating relationships between variables. Table 1 shows the variables chosen to identify the impact of digitalization on income inequality. Therefore, the linear equation is (1):

$$Y = \beta_0 + \beta_1 \cdot Internet\ Access + \beta_2 \cdot Mobile\ Access + \beta_3 \cdot Internet\ Usage, \quad (1)$$

where Y – disposable income, β_0 – free coeficient, β_1 – Internet access weight coefficient, β_2 – Mobile access weight coefficient, β_3 – Internet usage weight coefficient.

For validation of the model, the *R*-squared and the *F*-statistic are used as critical metrics to evaluate the fit and overall significance of an OLS regression model. *R*-squared helps identify the proportion of the variance in the dependent variable explained by the independent variables in the model. The *F*-statistic tests the overall significance of the model. It assesses whether the relationship between the dependent variable and the independent variables is statistically significant as a whole. Specifically, it tests the null hypothesis that all regression coefficients are equal to zero (i.e., none of the independent variables affect the dependent variable).

3. RESULTS

Evaluation of the entire dataset shows that independent variables can explain up to 67% variation (based on *R*-squared) in independent variables. There is a strong relationship between disposable income, Internet access/usage, and mobile usage. After adjusting for the number of predictors, the model explains 65.8% of the variance. This adjusted value is slightly lower than the *R*-squared, as it accounts for the complexity of the model and is typically more reliable when assessing fit, especially with multiple predictors. The *F*-statistic of 74.03, with a *p*-value close to zero (2.27e-26), indicates that the model as a whole is statistically significant. This means there is strong evidence that at least one of the predictors (Internet or mobile access) is significantly related to the dependent variable (Table 2).

Table 2. General model characteristics

Statistic	Value
R-squared	0.667
Adj. *R*-squared	0.658
F-statistic	74.03
Prob (*F*-statistic)	2.27e-26

The analysis reveals several key trends relevant to regional governance and management strategies. First, the ranking of regions by disposable income remained essentially unchanged throughout the period. Second, there is an increase in mobile usage: the average number of active SIM cards per 100 people grew from 131 in 2017 to 136 in 2021, indicating modest growth in mobile penetration. Third is significant income growth: disposable income nearly doubled, increasing from approximately 47,000 UAH per capita to 90,000 UAH, suggesting substantial economic improvement at the individual level. Fourth is the rise in Internet access: the proportion of households with Internet access saw a notable rise of nearly 70%,

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from 32 per 100 households in 2017 to 54 in 2021, indicating substantial progress in digital accessibility. Overall, the data show a positive trend in average values over the period, especially regarding Internet accessibility and disposable income growth, reflecting advancements in digitalization and economic conditions.

Following the OLS calculation, such coefficients presented in Table 3 were obtained:

1. Intercept (const): When both Internet and mobile variables are zero, the predicted value of the dependent variable is –43950. For now, it is essential to ensure a basic level of mobile and Internet access to facilitate income generation within the economy. The *t*-statistic is –3.616 with a *p*-value of 0.000, just below the standard significance level of 0.05, indicating that this intercept is statistically significant at the 5% level.

2. Internet access coefficient: 469.32. For each additional unit increase in Internet, the dependent variable is predicted to increase by about 469 UAH. The *t*-statistic is equal to 4.319 with a *p*-value of 0.000, which is highly significant and indicates a strong effect of the Internet on the dependent variable.

3. Mobile coefficient: 419.29. The dependent variable is predicted to increase by about 440 UAH for each additional unit increase in mobile, assuming the Internet measures remain constant. The *t*-statistic = 5.425 with a *p*-value of 0.000 is also highly significant, indicating a strong effect of mobile on the dependent variable.

4. Internet usage: variable shows a coefficient of 527.81, with a *t*-value of 2.99 and a *p*-value of 0.003, indicating statistical significance. For every one-unit increase in Internet usage, the dependent variable increases by approximately 527.81 UAH.

In this case, the subsequent equation is obtained:

$$Y = -43950 + 469.32 \cdot InternetAccess + 419.29 \cdot Mobile + 527.81 \cdot InternetUsage. \quad (2)$$

To continue the analysis of the relationship between income and digital inequality, the dataset has been divided into two distinct subsets:

- first – 50% regions with higher income;
- second – 50% regions with lower income.

The analysis was conducted in the same regions in 2017 and 2021, allowing for a consistent evaluation.

Internet usage and access are positively correlated with disposable income in both low- and high-income regions, with similar strength, reflecting the importance of Internet access across income levels (Table 4). The impact of mobile usage on disposable income is more substantial in high-income regions than in low-income regions, and there is a deep difference between the impact of Internet usage on disposable income across regions with different income levels. This suggests that mobile and Internet usage could be a more significant economic driver in wealthier regions, potentially due to greater access to mobile-related economic activities or resources.

While Internet access consistently influences regions, mobile phones, and Internet usage play a more prominent role in high-income regions, potentially reflecting differing economic behaviors and opportunities associated with mobile access across income levels.

The dynamics of relevant indicators worldwide in 198 countries from 2017 to 2021 were also analyzed (Figure 2). GNDI per capita indicates significant disparities across income groups, with high-income countries significantly outpacing others. Mobile cellular access has seen extensive growth

Table 3. OLS results

Variable	coef	std err	t	P>|t|	[0.025	0.975]
const	–43950	12200.00	–3.616	0.000	–68000.00	–19900.00
InternetAccess	469.319	108.67	4.319	0.000	253.982	684.656
Mobile	419.2882	77.286	5.425	0.000	266.14	572.437
InternetUsage	527.8052	176.548	2.99	0.003	177.964	877.646

Table 4. Comparison between results for low- and high-income regions of Ukraine

Variable	Low Income				High Income			
	coef	std err	T	P>|t|	coef	std err	t	P>|t|
const	705.522	8757.276	0.081	0.936	–13300	17700	–0.752	0.455
Mobile	172.788	62.422	2.768	0.008	312.346	157.598	1.982	0.053
InternetAccess	427.712	96.672	4.424	0	465.353	176.15	2.642	0.011
InternetUsage	272.491	116.893	2.331	0.023	1073.09	359.876	2.982	0.004

across all income groups, with lower–income countries making substantial gains, though they still lag higher-income groups. Fixed broadband adoption remains limited in low-income regions, with much more robust growth observed in middle and high-income countries, reflecting disparities in infrastructure development.

There is a positive relationship between income level and mobile and Internet access (Figure 2). Higher income allows for more significant investment in mobile infrastructure and lowers the affordability barrier, resulting in near-saturation levels in high- and upper-middle-income countries. In contrast, despite growth, low-income countries still face significant accessibility challenges. High-income countries have the resources to develop and maintain fixed broadband infrastructure, making it accessible and affordable for their populations. Lower-income countries, on the other hand, lack widespread broadband access due to high infrastructure costs and limited affordability. This gap highlights digital inequality, where lower-income groups rely more on mobile data due to its relatively lower cost and infrastructure requirements than fixed broadband. These findings support the development of management strategies that prioritize digital infrastructure in underserved areas.

Ukraine has transitioned into a higher-income country category, and when compared to its peers,

Source: Compiled based on the World Bank (n.d.a, n.d.b, n.d.c) data.

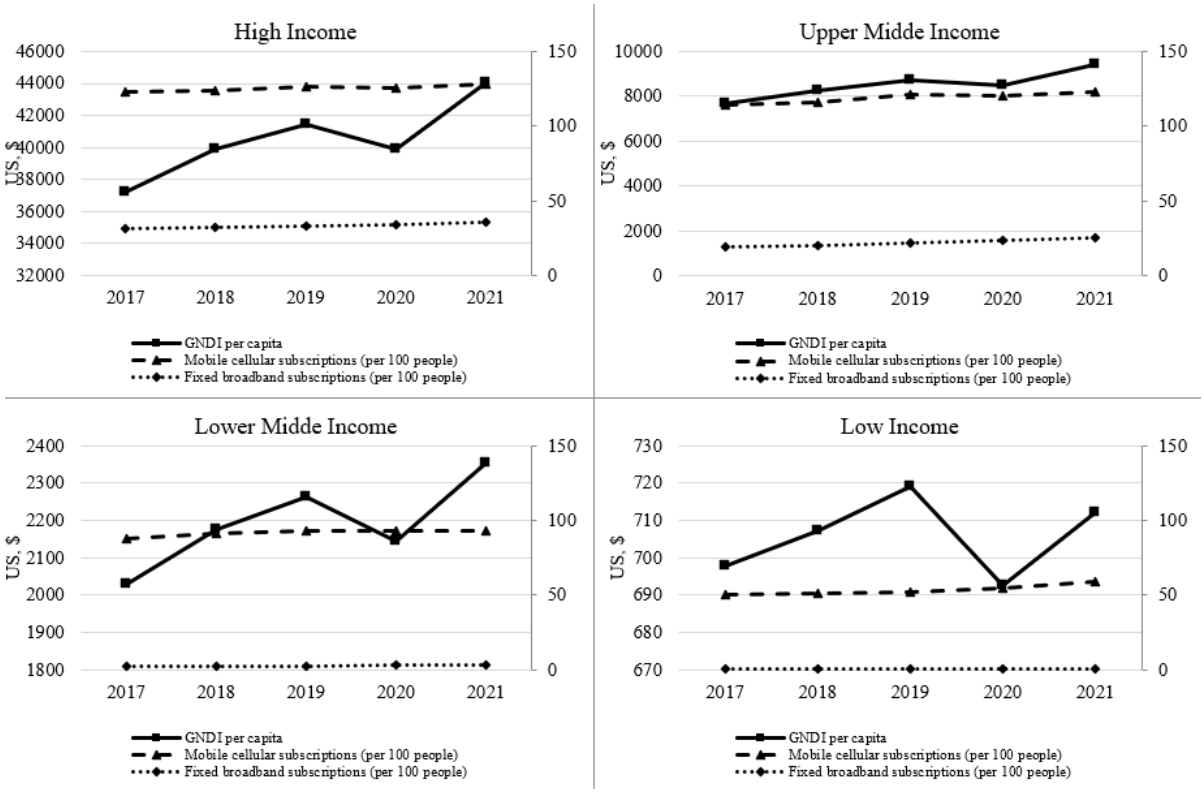

Figure 2. The dynamics of Internet and mobile access, disposable income indicators with breakdown by income groups countries, 2017–2021

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it shows a quicker income growth rate alongside increased fixed Internet penetration. Similarly, mobile access has followed suit with this upward trend. Countries with high and upper-middle incomes tend to have better access, while those classified as low and lower-middle income often struggle, particularly with broadband access. Digital inequality and the digital divide are still significant concerns, underscoring the need for targeted infrastructure investments and policies to improve digital access for lower-income populations.

4. DISCUSSION

This study's findings confirm the hypothesis that technology may affect income inequality. In higher-income regions, mobile access becomes indispensable, likely due to the technology-driven nature of employment and the prevalence of office jobs that demand continuous connectivity. However, in Ukraine, mobile communication access typically includes mobile Internet, enabling individuals to perform various tasks or even fulfill job roles in specific sectors. This underscores connectivity's critical role in facilitating economic participation in these regions.

The findings also align with prior research (Wang & Shen, 2024; Houngbonon & Liang, 2017) that indicates digitalization's impact on income inequality varies across income levels. While low-income countries or regions benefit significantly from digitalization, its effect in upper-middle-income and high-income areas is often less pronounced. Within Ukraine's context, this demonstrates the main role of Internet usage as a key driver for low-income regions that cause the highest impact on income. The results also confirm that Internet access has become a basic factor that stabilizes both groups of Ukrainian regions.

The results presented in this paper contribute to the discussion around contradictions in the digital economy and information society, which were emphasized by information society theorists (Castells, 1996), particularly regarding the emergence of new forms of inequality. While digitalization is often seen as a modern tool for reducing economic inequality, it can also create new forms of inequality and has varying effects based on income levels and development at global, regional, and local levels. Individuals with lower incomes face greater challenges in accessing digital technologies and may have different levels of efficiency in their usage. This aligns with the theoretical justification of the levels of the digital divide by Riggins and Dewan (2005), Ragnedda and Ruiu (2017), and Vassilakopoulou and Hustad (2023). Additionally, the findings on limited access to higher-quality digital tools (high-speed Internet) among lower-income populations underscore the complexity and depth of issues related to digital inequality and the digital divide. As a result, these findings emphasize the vital importance of robust digital infrastructure in mitigating income inequality across various regions.

Policymakers should prioritize investments in mobile and fixed Internet infrastructure, particularly in regions of Ukraine. Effective management of digital resources can enhance economic participation, supporting individual income growth and broader regional economic development. The government needs to incorporate digital considerations into economic policy at the regional level. One of the key strategies for regional institutions should be to enhance digital access in areas with limited digital services. This can be achieved through several steps: a) simplifying the process and fostering the establishment of local or regional Internet providers; b) offering incentives for the installation of Internet cables and the provision of wireless Internet access; c) collaborating with mobile operators to expand the mobile network infrastructure; d) digitizing local services to speed up the digital transition. These recommendations align with global trends, suggesting that investments in digital infrastructure have a more pronounced impact on low-income and underserved regions.

At a regional level, government initiatives to digitize local services and promote mobile network development could enhance economic participation and reduce income disparities. For instance, Kouladoum (2023), analyzing 44 African countries from 2000 to 2020, indicated that the increasing number of Internet users, fixed broadband subscribers, and mobile phone users promoted inclusive growth.

A notable limitation of this study is the lack of comprehensive data on Internet speed and quality across Ukrainian regions. In 2017, mobile Internet primarily relied on 2G technology, although 3G was starting to gain traction. By 2021, however, the landscape had shifted, with 3G, 4G, and 4G+ becoming the norm. These technologies provided speeds that were often comparable to those of fixed Internet access and, in some cases, even served as substitutes for it. Additionally, the measurement methodology does not reflect the demands of current technology quality. According to the World Bank, fixed broadband subscriptions are defined as fixed connections providing high-speed access to the public Internet (via a TCP/IP connection) with downstream speeds of at least 256 kbit/s. However, today's standards consider this speed relatively slow and similar to 2G technology. Hence, the lack of comprehensive data on Internet speed and quality, the shifting technological landscape, and outdated measurement methodology highlight areas where future research could improve by incorporating more granular, up-to-date data and adopting measurement standards aligned with current technological capabilities.

CONCLUSION

This study explores the potential of digital-based services in reducing regional income inequality in Ukraine. The analysis reveals a positive correlation between mobile access, Internet access and usage, and disposable income across Ukraine's regions during 2017–2021. The study highlights that rising disposable incomes align with improved digital connectivity, as reflected in the growth of Internet users and active mobile subscriptions. However, while Internet access enhances disposable income across all income levels, mobile access exerts a more pronounced effect in high-income regions, suggesting that mobile technology is more embedded in higher-value economic activities.

These findings underscore several key conclusions. First, expanding digital infrastructure is pivotal for mitigating regional income disparities, as digital access is a prerequisite for economic participation in a digitalized economy. Second, the disparity in the impact of mobile access across income levels reflects persistent digital divides, necessitating targeted interventions to bridge these gaps. Finally, the study emphasizes that disposable income is a reliable indicator of income inequality. Regression analysis shows that both Internet and mobile access positively influence disposable income, with mobile access playing a particularly strong role in wealthier regions. Therefore, digital resources are increasingly critical for economic engagement, supporting job searches, and enhancing labor market opportunities.

The study calls for an urgent need for regional government management policies addressing the digital divide by prioritizing digital infrastructure investments in underserved areas. While digital access alone may not ensure sufficient income, it is indispensable in supporting work-related activities and fostering entrepreneurship. These findings align with global research, reinforcing digital inclusion as a driver of equitable economic development in Ukraine.

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