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Digital Literacy as an Indicator of Socio-Economic Development. The Case of EU Countries

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Abstract: This study sets out to demonstrate the hypothesis that the degree of digital literacy can serve as an effective indicator of the socio-economic development of a country or region. The study is based on the EU approach for measuring digital literacy. The Granger test for panel data provides evidence that supports the hypothesis of a mutual influence between digital literacy and GDP per capita. Conversely, the insufficient proportion of the population possessing advanced digital competencies may be indicative of the sluggish progression of digital transformation in EU countries. Despite the existence of a positive correlation between digital literacy levels and the proportion of income received by low-income groups, no causal relationship between these variables has been identified.

1 INTRODUCTION

The extant literature on digital literacy, skills and competencies is rich in definitions and classifications (Tinmaz et al., 2022). By digital literacy we understand a system of knowledge, skills and attitudes that allow to effectively solve personal and professional tasks in the digital environment. Digital skills have become increasingly crucial in modern society, shaping how individuals interact, work, and access information. As technology permeates various aspects of daily life, proficiency in digital tools and platforms has evolved from a specialized skill to a fundamental requirement for participation in many social, economic, and educational spheres. The degree to which a society is digitally literate can be a useful measure of its overall socio-economic development.

In 2015, the European Union initiated the Digital Single Market Strategy with the objective of promoting economic growth, generating employment opportunities, enhancing competition, encouraging investment and fostering innovation. In March 2021, the European Commission unveiled a proposal for a strategic framework to be known as the Digital Decade. Since 2014, the European Commission has been engaged in the monitoring of the digital progress of its Member States via the Digital Economy and Society Index (DESI) reports. In accordance with the Digital Decade Policy Programme 2030, DESI has been incorporated into the State of the Digital Decade report as of 2023. This integration facilitates the monitoring of progress towards the digital targets.

The objective of the present study is to demonstrate that the degree of digital literacy can serve as an effective indicator of the socio-economic development of a country or region, based on EU approach for measuring the digital literacy. Specifically, we focus on whether digital literacy can be considered a cause of decreasing income inequality. To the best of our knowledge, this has not been reported in the literature before.

2 MATIREALS AND METHODS

The DigComp approach (The Digital Competence Framework for Citizens) has been developed by the

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European Commission as part of the implementation of a digital skills training programme for citizens (Vouricari, Kluzer, Punie, 2022).

Within this framework, digital competences are analysed according to five main areas (DigComp 2.0): information literacy, communication literacy, digital content creation, digital safety, problem-solving skills in the digital environment (Fig.1).

Figure 1: Digital competence areas.

Information literacy is defined as the ability to locate relevant information regarding goods and services, as well as to read news and periodicals, and to verify facts.

Communication literacy is the ability to utilise various modes of digital communication, including email, social media, and internet calls, in addition to engaging in social and political activities online.

Digital content creation means the ability to create various digital content (text, images, audio and video, interactive media) while understanding how copyright and licences are to be applied.

Key aspects of safety in the DigComp framework include device protection, personal data protection, environment protection, risk assessment, safe online behaviour, cybersecurity awareness and critical thinking.

The final area to be addressed is that of problem solving. This is defined as the ability to identify needs and problems, and to resolve conceptual problems and problem situations in a digital environment.

In each of these areas, proficiency is assessed on a three-point scale: ‘above basic’ - presence of more than one skill / presence of an advanced level skill; “basic” - presence of only one skill / presence of an entry level skill; ‘no skills’ - absence of any skills from this group.

The present study employs DESI indices as a tool for the purpose of characterising digital literacy. The DESI_HC is an overall index, calculated as the weighted average of its indicators. The DESI_HC_ABDS accounts for individuals with 'above basic' digital skills in each of the following five dimensions: information and data literacy, communication and collaboration, problem solving, digital content creation and safety (percentage of adult internet users).

We considered data for EU countries (excluding Luxembourg and Ireland) for the period 2017–2022. In 2023, the European Commission changed the methodology and stopped publishing overall scores. The main socio-economic indicators, used in this study are GDP per capita (PPP, constant 2017 international $) from the World Bank DataBank, Median equivalised net income from Eurostat, converted into constant 2017 international $. The distribution of income among different population groups and the Gini index are used to test the hypothesis that there is an association between digital literacy and inequality.

We use scatter diagrams and pairwise correlations to assess the strength of the relationship between digital literacy and key economic indicators.

To address the question of whether digital literacy can be considered a leading indicator of economic development, we use the Granger causality test for panel data.

Granger causality is a statistical concept used to analyze the relationship between time series data as well as for panel data, which involves time series data for multiple series (EU countries in our case). It was introduced by economist Clive Granger in 1969 (Granger, 1969) and has since become a widely used tool in econometrics and other fields. The fundamental idea behind Granger causality is that if one variable can be used to predict future values of another variable more accurately than using only the past values of that variable itself, then the first variable is said to "Granger-cause" the second. This concept does not imply true causality in the philosophical sense but rather a temporal precedence and predictive power (Shojaie & Fox, 2021).

3 RESULTS AND DISCUSSION

3.1 The Overall Performance of Digital Competence in EU

The Digital Economy and Society Index (DESI) identifies countries with strong digital performance. In the EU, the top performers are typically Denmark, Finland, Sweden, and the Netherlands, often leading

in various DESI dimensions. These countries also lead the way in terms of digital competence (see the box-plot diagram of DESI HC in Fig. 2). Finland's average score is 67, which is much higher than the EU average of 44 (the red line in Fig. 2). Even its lowest value is much higher than the EU average. The same applies to Sweden, Denmark and the Netherlands. Estonia is close to these countries in terms of developing digital competence.

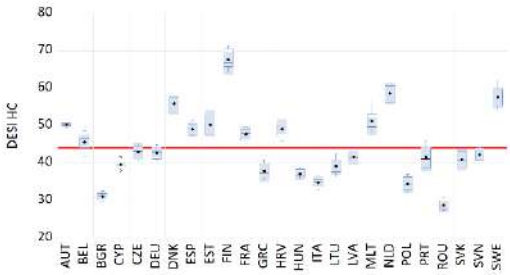

Figure 2: The box-plot diagram of DESI HC.

These countries are leaders among EU countries in terms of digital economy development. The three Scandinavian countries (Norway, Sweden, Finland), Denmark, and the Netherlands display high levels of digitization, economic performance, and sustainability (Bocean, Varzaru, 2023).

The increasing share of individuals with advanced digital competences (Fig.3) also indicates the increasing role of the digital economy in the EC economies. Individuals with basic or above basic overall digital skills (all five component indicators are at basic or above basic level) reached in 2023 55.56 percentage of all individuals in EU. However, researchers argue that the EU is lagging behind the global leaders in digital transformation , with the gap between the two widening (Młynarzewska-Borowiec, 2022).

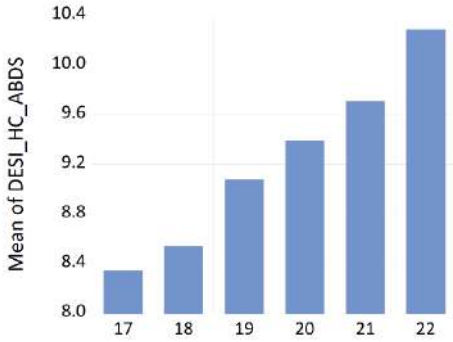

Figure 3: The mean of DESI HC ABDS across 25 EU countries.

It should be noted that according to Rosstat data, in 2022 the share of the population with digital skills above the basic level in Russia was 13.3%, which is above the European average. It emphasises the importance of education and training initiatives in the EU, which aim to improve the digital competence of specific target groups. while improving citizens' digital competence.

3.2 Association between Digital Literacy and Key Socio-economic Indicators

The scatter diagram between DESI_HC and per capita income shows that there is a positive association between these indicators (Fig.4). The correlation between GDP per capita and digital literacy is 0.69. Richer countries are expected to have more resources available to them to ensure the development of digital infrastructure. This, in turn, contributes to the growth of digital literacy among the population. This finding is consistent with the results of Antonijević et al. (2023), who examined data from 135 countries based on the World Economic Forum's measurement of digital skills.

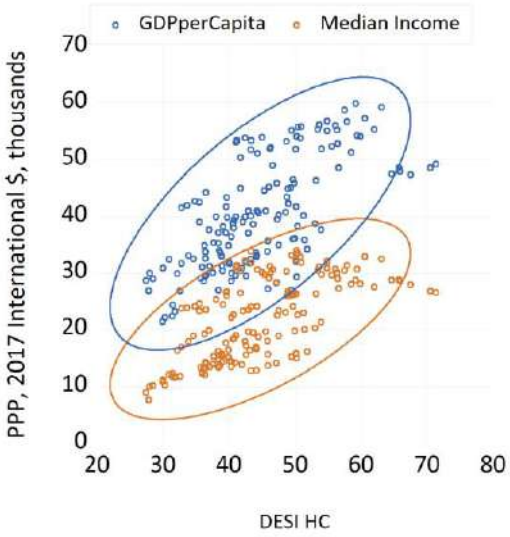

Figure 4: The association between income and digital literacy.

Although the correlation between median income and digital literacy is slightly lower (0.65), it still

confirms the hypothesis of a positive relationship between income and digital competence.

Digitalisation and digital transformation can play a significant role in reducing inequality by improving access to resources, opportunities and services (Abbas, Zaman, 2024). It can also contribute in decreasing inequality by enhancing access to education, expanding job opportunities and economic participation. Improving digital skills reduces the digital divide and social and gender inequalities. It also makes it possible to find work far from where you live. However, we do not expect a very close relationship between the level of inequality and digital competences, as the possession of digital skills does not automatically lead to a levelling of all opportunities and a reduction in inequality of opportunity.

We found, that the correlation between DESI-HC and the Gini coefficient, which generally characterises income distribution inequality, is -0.42 (moderate and statistically significant).

We analysed the relationship between the share of income of different income groups in the population and digital literacy. We found that the growth of digital literacy is associated with a decrease in the share of income of the richest. It is also associated with an increase in the share of income of the 10% and 20% of the lowest-income groups in the population (Fig.5).

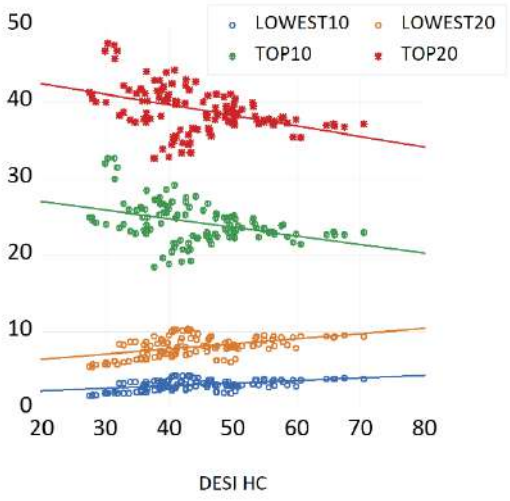

Figure 5: The association between income distribution and digital literacy.

It should also be noted that growth in human capital (of which digital literacy is a part) does not necessarily lead to increased income, as is particularly evident in times of crisis (Balashova, Gabrielyan, 2024).

3.3 Granger causality

Granger causality tests typically involve running regression models and comparing the predictive accuracy of models with and without the potential causal variable. While useful, it is important to note that Granger causality has limitations, such as its sensitivity to the choice of lag length and its inability to detect instantaneous or nonlinear causal relationships.

Due to the short time span, we only use two lags in the regression equations. Results of Pairwise Granger Causality Tests are reported in Table 1.

The Granger test for panel data confirms the hypothesis of a mutual influence between digital literacy and GDP per capita. The corresponding F-statistics are significant. The null hypothesis that GDP per Capita does not Granger Cause DESI HC is rejected at the 5% significance level. The contraversion hypothesis is rejected at the 1% significance level. However, the Granger test does not confirm the hypothesis of an influence of digital literacy on median income (there is no Granger causality).

The Granger test for panel data supports the hypothesis of the impact of digital literacy on the level of inequality as measured by the Gini index. At the same time, the Gini index is not a Granger cause for digital literacy.

No causal relationship was found between digital literacy and the share of income of low-income groups of the population

Table 1: Results of Pairwise Granger Causality Tests.

Null Hypothesis	F-Statistics
GDP per Capita does not Granger Cause DESI HC	3.52 **
DESI HC does not Granger Cause GDP per Capita	5.56***
Median Income does not Granger Cause DESI HC	0.99
DESI HC does not Granger Cause Median Income	1.44
GINI does not Granger Cause DESI HC	0.35
DESI HC does not Granger Cause GINI	3.41**

Note. *** - p-value<0.01, ** - p-value<0.05

4 CONCLUSIONS

Digital literacy is one of the key indicators of socioeconomic development. It is closely correlated with the population's level of well-being and economic activity. In the short term, it stimulates development. This is especially true of the digital economy. Digital skills are essential for most modern jobs, from basic computer use to advanced data analysis. Workers with digital literacy have access to better-paying jobs.

However, the hypothesis that digital skills increase median income or the income of the low-income group in the population was not supported by the findings.

On the one hand, it may be caused by the limitations of the Granger causality approach and the short time series examined. However, it may also signal to policymakers the necessity of more intensive integration of digital skills in schools and vocational training in order to achieve better results and avoid the risk of a digital divide and job displacement.

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