



# DO HUMAN CAPITAL AND ECONOMIC DEVELOPMENT DRIVE ADOPTION OF DIGITAL TECHNOLOGIES ACROSS COUNTRIES? SOME CORRELATIONAL EVIDENCE

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## ABSTRACT

The goal of this study is to explore the relationship between human capital, economic development and the adoption of digital technologies across countries. Using data for 175 countries for the year 2015, we find that human capital and GDP per capita are positively correlated with Digital Adoption Index (DAI). One standard deviation increases in HCI (SD = 0.13) is associated with slightly less than a standard deviation increases in DAI. The policy implications are discussed.

## CCS CONCEPTS

• Digital adoption; • human capital; • economic development;

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## 1 INTRODUCTION

Innovations in the area of digital technology such as Internet, cell-phones, laptops, gadgets and platforms aimed at gathering, processing and preserving big data have penetrated into our life rapidly over the past three decades. For example, more than half of global population today has access to Internet. Consequently, this implies that digitalization may have positive implications for quality of life and economy as communication and connectedness leads to the rise of e-commerce, e-governance and more employment prospects. Digitalization can reduce inequality, improve quality of financial services, increase inclusiveness and decrease transaction and coordination costs. For example, MPesa mobile payment system in

Africa significantly improved the efficiency of financial services by improving the transfer of money from people to people, and from people to business. There is also plenty evidence that companies connected to internet are more likely to export [1-2].

In a recent study, [3] using data for SMEs in China for the year 2012 finds that the adoption of ICT and decreased costs has significant positive impact on the exports of Chinese SMEs. Therefore, the study argues that more policies should be instituted in the field of ICT development to decrease exports uncertainty.

While there is plenty evidence that ICT has significant positive effect on economic growth and exports, more studies needed to understand the adoption of digital technologies across countries. The goal of this study is to contribute to this field of research by exploring the relationship between human capital, proxied by cognitive abilities index, and digital adoption. Cognitive abilities have been linked to shadow economy [4], economic growth [5], gender inequality [6], deforestation [7-8], environmental awareness [9] and finance [10]. There are several arguments how cognitive abilities may increase adoption of digital technologies across nations. First, cognitive capital is one of the important determinants of institutional quality [11]. For example, Potrafke [12], using data from more than 100 countries, finds that IQ has significant and positive effect on the quality of anti-corruption policies. Kodila-Tedika [13], using data from African countries, also confirms positive correlation between cognitive abilities and quality of governance. In turn, research also suggests that quality of governance and institutions is important driver of ICT development [14].

Apart from institutions, cognitive abilities may serve as an important proxy for the skills and social approval for the ICT adoption by private sector and population. For example, Andres and Salahodjaev [15] finds that cognitive skills are negatively related to cost of business opening. Moreover, Odilova and Xiaomin [16] while modeling the determinants of software piracy find that the piracy rates are lower in countries with higher levels of cognitive and democratic capital. Therefore, considering correlation of cognitive abilities with wide range of socio-economic outcomes we propose that IQ has significant relationship with adoption of digital technologies across countries.

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**Table 1: Correlation matrix between HCI, GDP per capita and DAI**

| Variable       | Correlation (r) | Significance |
|----------------|-----------------|--------------|
| HCI            | 0.88            | p = 0.00     |
| GDP per capita | 0.79            | p = 0.00     |

**Table 2: Regression results between DAI and HCI**

| Source   | SS                | df         | MS                | Number of obs | = | 175           |
|----------|-------------------|------------|-------------------|---------------|---|---------------|
| Model    | <b>4.99688733</b> | <b>1</b>   | <b>4.99688733</b> | F(1, 173)     | = | <b>608.70</b> |
| Residual | <b>1.42016512</b> | <b>173</b> | <b>.008209047</b> | Prob > F      | = | <b>0.0000</b> |
|          |                   |            |                   | R-squared     | = | <b>0.7787</b> |
|          |                   |            |                   | Adj R-squared | = | <b>0.7774</b> |
| Total    | <b>6.41705246</b> | <b>174</b> | <b>.036879612</b> | Root MSE      | = | <b>.0906</b>  |

| DAI   | Coef.           | Std. Err.       | t            | P> t         | [95% Conf. Interval]     |
|-------|-----------------|-----------------|--------------|--------------|--------------------------|
| HCI   | <b>.1276134</b> | <b>.0051724</b> | <b>24.67</b> | <b>0.000</b> | <b>.1174043 .1378226</b> |
| _cons | <b>.522549</b>  | <b>.0068493</b> | <b>76.29</b> | <b>0.000</b> | <b>.5090299 .536068</b>  |

## 2 DATA AND METHODOLOGY

In order to explore the relationship between human capital and digital technologies adoption, we use data for 175 countries for the year 2016. As a measure of digital technologies adoption, we rely on Digital Adoption Index (DAI) from the World Bank. The DAI is a global indicator that evaluates countries' digital adoption across three facets of the economy: people, government, and business. The index is estimated for more than 170 countries on a 0–1 scale. We construct human capital, using principal components analysis method in Stata 16. The human capital index (HCI) is constructed from two variables: cognitive skills index from Lynn and Vanhanen (2012) and Education index from the UN. The HCI in our study ranges from -3 to +3, where higher values reflect higher levels of human capital. We also take into account the role of GDP per capita, as economic development is correlated both with human capital and ICT development. Figures 1 plots the visual association between DAI, HCI and GDP per capita. As it can be seen there is positive and strong correlation between economic development, human capital and DAI.

## 3 RESULTS

We first report the size of the correlations between our main variables in Table 1. The result suggest that human capital has a higher value of the correlation coefficient ( $r=0.88$ ) compared to GDP per capita ( $r=0.79$ ). This may imply that while economic development is important predictor of ICT development, human capital as derived from skills, literacy and education system has stronger relationship with DAI.

The bivariate regression modeling results with the use of OLS method are presented in Table 2. The number of countries (N) is 175

and the goodness of fit (adjusted R-squared is 0.77). This suggests that in a sample of 175 nations, HCI explains 77% of global variation in DAI. The F-statistics is 608.70 confirming the overall significance of the modeling. Turning to the coefficient for the HCI it is positive and significant at the 1% level. One standard deviation increases in HCI ( $SD = 0.13$ ) is associated with slightly less than a standard deviation increase ( $0.127 \times 0.13$ ) in DAI.

Table 3 further tests whether GDP per capita may influence HCI-DAI relationship. We include GDP per capita for 2016 in our regression model. As expected, both GDP per capita and HCI are positive and significant at the 1% level. Due to missing data for some of the countries the sample size has decreased to 170. The overall quality of the model has improved as it explains 84% of variations in DAI.

Based on the regression modeling, we have also made a forecast of the DAI improvement in Uzbekistan. We have used Romania (a country that is in the top-50 list of the Global Innovation Index) as a benchmark. If Uzbekistan's human capital index and GDP per capita would increase to that of Romania by 2030, DAI would increase by nearly 59%, from 0.40 to 0.64.

## 4 CONCLUSION

The goal of this study is to explore whether human capital is important predictor of adoption of digital technologies and offer implications for Uzbekistan. Our study relies on a sample of 175 countries for which data is available. The role of human capital has been acknowledged in the extant research, however not carefully explored for the adoption of digital technologies in the context of cross-country empirical analysis. This study aims to contribute to this research gap.

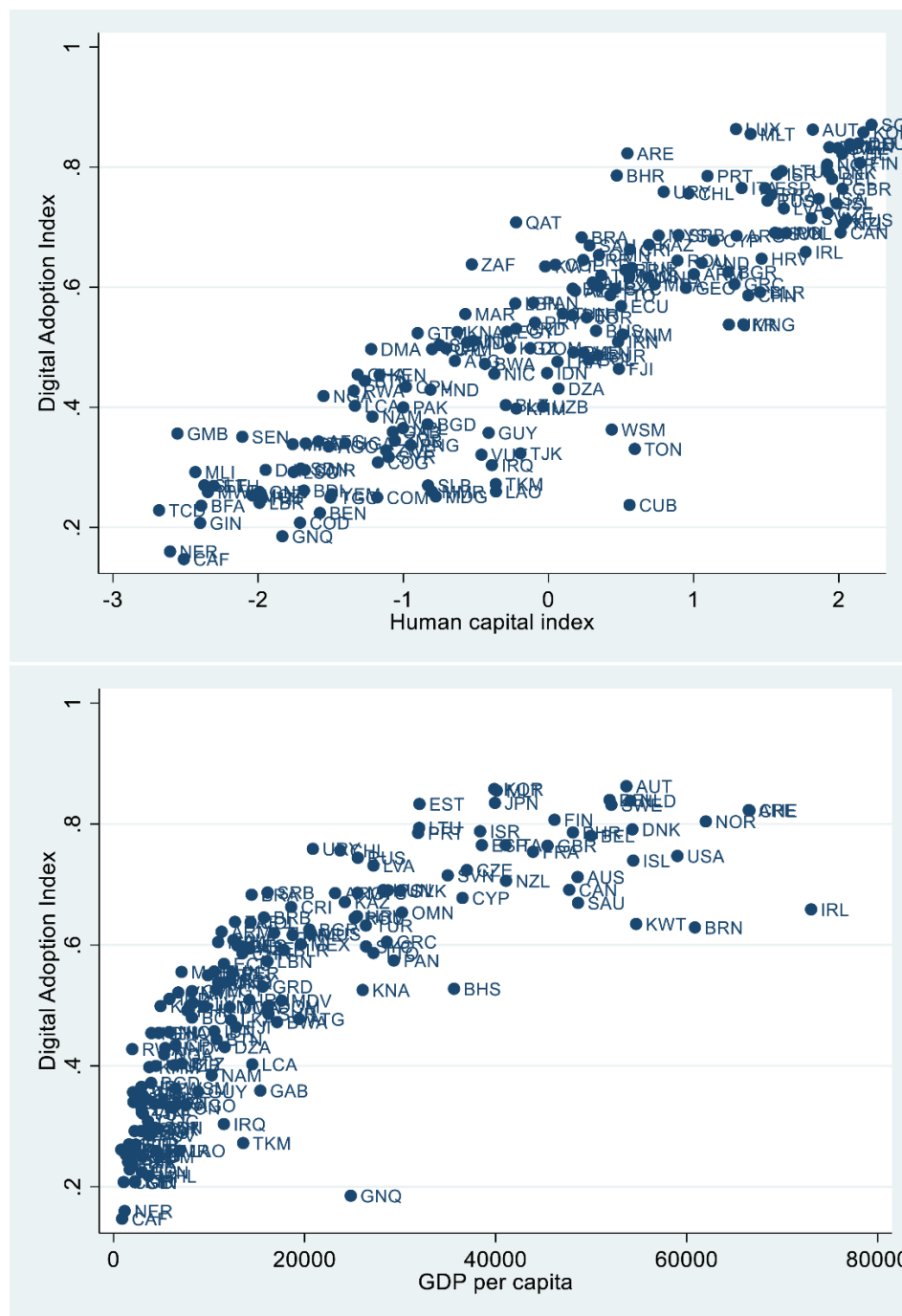


Figure 1: Scatterplots of main variables

This study using correlation and regression analysis finds that human capital is important driver of digitalization and ICT penetration. The regression parameters used for scenario forecasting suggest that Uzbekistan can increase DAI by 59% by the year 2030 if HCI and GDP per capita will reach to the levels of Romania. We suggest a number of policy recommendations. First, it is important to

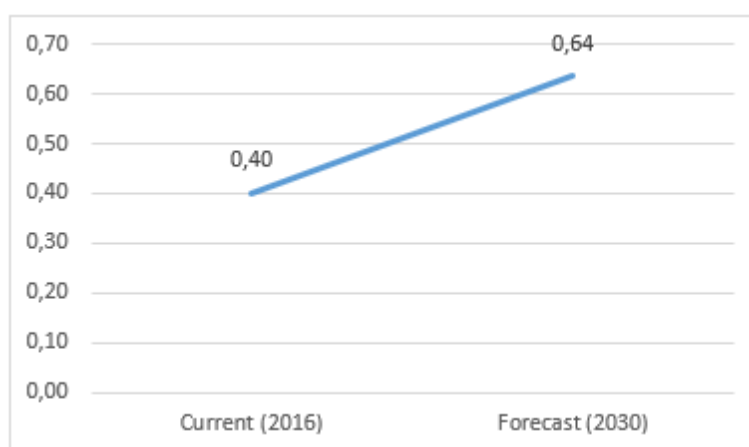
increase the education programs aimed at improving digital literacy of the population. Second, it is essential to increase investment in ICT infrastructure and equip schools and universities with modern IT hardware and high-speed internet. Third, it is vital to increase number of universities that offer blended education which incorporates IT classes in existing curriculum. These measures would

**Table 3: The regression between DAI, HCI and GDP**

| Source   | SS                | df         | MS                | Number of obs | = | 170           |
|----------|-------------------|------------|-------------------|---------------|---|---------------|
| Model    | <b>5.22323011</b> | <b>2</b>   | <b>2.61161505</b> | F(2, 167)     | = | <b>445.47</b> |
| Residual | <b>.979057771</b> | <b>167</b> | <b>.005862621</b> | Prob > F      | = | <b>0.0000</b> |
|          |                   |            |                   | R-squared     | = | <b>0.8421</b> |
|          |                   |            |                   | Adj R-squared | = | <b>0.8403</b> |
| Total    | <b>6.20228788</b> | <b>169</b> | <b>.036699928</b> | Root MSE      | = | <b>.07657</b> |

| DAI   | Coef.           | Std. Err.       | t            | P> t         | [95% Conf. Interval] |                 |
|-------|-----------------|-----------------|--------------|--------------|----------------------|-----------------|
| HCI   | <b>.0964542</b> | <b>.0062192</b> | <b>15.51</b> | <b>0.000</b> | <b>.0841757</b>      | <b>.1087327</b> |
| GDP   | <b>.0028978</b> | <b>.0004066</b> | <b>7.13</b>  | <b>0.000</b> | <b>.0020951</b>      | <b>.0037005</b> |
| _cons | <b>.4674734</b> | <b>.0100895</b> | <b>46.33</b> | <b>0.000</b> | <b>.447554</b>       | <b>.4873928</b> |

**Figure 2: Scenario for DAI improvement for Uzbekistan**

not only improve ICT adoption but also increase quality of human capital.

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