MUHANDISLIK & IQTISODIYOT

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ijtimoiy-iqtisodiy, innovatsion texnik, fan va ta'limga oid ilmiy-amaliy jurnal

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05.00.00 - Texnika fanlari
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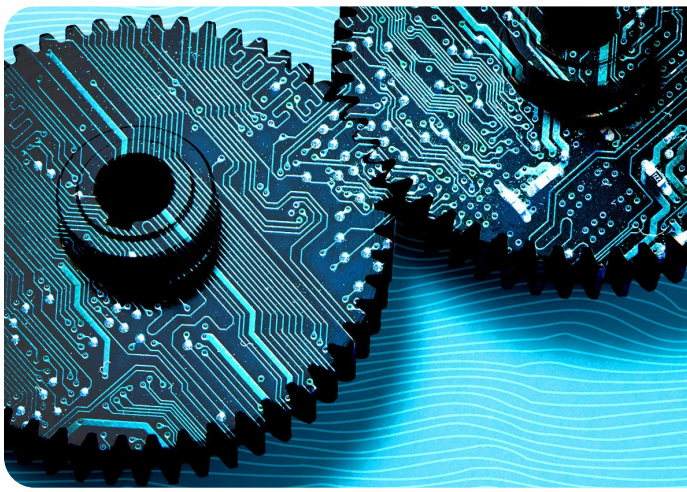

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05.01.00 – Axborot texnologiyalari, boshqaruv va kompyuter grafikasi
05.01.01 – Muhandislik geometriyasi va kompyuter grafikasi. Audio va video texnologiyalari
05.01.02 – Tizimli tahlil, boshqaruv va axborotni qayta ishlash
05.01.03 – Informatikaning nazariy asoslari
05.01.04 – Hisoblash mashinalari, majmualari va kompyuter tarmoqlarining matematik va dasturiy ta'minoti
05.01.05 – Axborotlarni himoyalash usullari va tizimlari. Axborot xavfsizligi
05.01.06 – Hisoblash texnikasi va boshqaruv tizimlarining elementlari va qurilmalari
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05.02.00 – Mashinasozlik va mashinashunoslik
05.02.08 – Yer usti majmualari va uchish apparatlari
05.03.02 – Metrologiya va metrologiya ta'minoti
05.04.01 – Telekommunikasiya va kompyuter tizimlari, telekommunikasiya tarmoqlari va qurilmalari. Axborotlarni taqsimlash
05.05.03 – Yorug'lik texnikasi. Maxsus yoritish texnologiyasi
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05.08.03 – Temir yo'l transportini ishlatish
05.08.06 – "G'ildirakli va gusenisali mashinalar va ularni ishlatish" (texnika fanlari)
05.09.01 – Qurilish konstruksiyalari, bino va inshootlar
05.09.04 – Suv ta'minoti. Kanalizatsiya. Suv havzalarini muhofazalovchi qurilish tizimlari
10.00.06 – Qiyosiy adabiyotshunoslik, chog'ishtirma tilshunoslik va tarjimashunoslik
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08.00.16 – Raqamli iqtisodiyot va xalqaro raqamli integratsiya
08.00.17 – Turizm va mehmonxona faoliyati

Ma'lumot uchun, OAK Rayosatining 2024-yil 28-avgustdagi 360/5-son qarori bilan "Dissertatsiyalar asosiy ilmiy natijalarini chop etishga tavsiya etilgan milliy ilmiy nashrlar ro'yxati"ga texnika va iqtisodiyot fanlari bo'yicha "Muhandislik va iqtisodiyot" jurnali ro'yxatga kiritilgan.

Muassis: "Tadbirkor va ishbilarmon" MChJ

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A CROSS-SECTIONAL ANALYSIS OF GLOBALIZATION, EDUCATION, AND TECHNOLOGY'S IMPACT ON IQ LEVELS ACROSS 63 COUNTRIES WORLDWIDE

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Abstract. This study examines the impact of globalization, education, and technological development on IQ levels across 63 countries using cross-sectional data. The analysis includes key indicators such as GDP per capita, foreign direct investment, trade openness, PISA scores, Human Capital Index, research and development expenditure, internet speed, and the Global AI Index. A robust regression model is applied to estimate the relationships. The results reveal that GDP per capita and PISA scores are the most significant determinants of cognitive performance at the 1% level. FDI and HCI show significant but negative effects, while R&D has a weak positive impact. Technological variables are not statistically significant. The findings suggest that cognitive development is mainly driven by economic and educational factors rather than technological advancement alone.

Keywords: globalization, IQ, human capital, education, economic development, technology.

Annotatsiya. Ushbu tadqiqotda 63 ta mamlakat kesimida globalizatsiya, ta'lim va texnologik rivojlanishning IQ darajalariga ta'siri o'rganildi. Tahlilda aholi jon boshiga YaIM, to'g'ridan-to'g'ri xorijiy investitsiyalar (FDI), savdo ochiqligi, PISA natijalari, Inson kapitali indeksi (HCI), ilmiy-tadqiqot va rivojlantirish xarajatlari (R&D), internet tezligi hamda Global sun'iy intellekt indeksi (GAII) kabi ko'rsatkichlar qo'llanildi. Baholash uchun robust regressiya usuli ishlatildi. Natijalar shuni ko'rsatdiki, aholi jon boshiga YaIM va PISA natijalari IQning eng muhim omillari hisoblanadi (1% darajada). FDI va HCI manfiy, ammo statistik jihatdan ahamiyatli ta'sir ko'rsatadi, R&D esa ijobiy, lekin kuchsiz ta'sirga ega. Texnologik ko'rsatkichlar esa statistik ahamiyatga ega emas. Natijalar kognitiv rivojlanish asosan iqtisodiy va ta'lim omillari bilan belgilanishini ko'rsatadi.

Kalit so'zlar: globalizatsiya, IQ, inson kapitali, ta'lim, iqtisodiy rivojlanish, texnologiya.

Аннотация. В данном исследовании анализируется влияние глобализации, образования и технологического развития на уровень IQ в 63 странах на основе перекрестных данных. В анализ включены такие показатели, как ВВП на душу населения, прямые иностранные инвестиции (FDI), открытость торговли, результаты PISA, индекс человеческого капитала (HCI), расходы на исследования и разработки (R&D), скорость интернета и глобальный индекс искусственного интеллекта (GAII). Для оценки взаимосвязей используется робастная регрессия. Результаты показывают, что ВВП на душу населения и результаты PISA являются наиболее значимыми факторами когнитивного развития (на уровне 1%). FDI и HCI имеют значимое, но отрицательное влияние, в то время как R&D оказывает слабое положительное воздействие. Технологические показатели статистически незначимы. Полученные результаты свидетельствуют о том, что когнитивное развитие в большей степени определяется экономическими и образовательными факторами.

Ключевые слова: глобализация, IQ, человеческий капитал, образование, экономическое развитие, технологии.

INTRODUCTION

Globalization has been characterized by the growing interdependence of world economies through the increasing integration of trade, finance and technology. The objective of globalization is to optimize the movement of capital, human and innovative knowledge across countries so that productivity can grow and develop via its man-power [1]. Cognitive performance is significantly contingent on economic development. Countries with higher levels of income, often measured by GDP per capita, are able to invest more in education, healthcare and infrastructure. These investments lead directly to human capital and cognitive development improvements [2]. Wealthier nations often have greater access to quality education, better living conditions and learning environments that affect the intelligence quotient.

Education is another major predictor of cognitive ability. International comparisons show that there are huge differences in countries when it comes to schools - as seen in the Programme for International Student Assessment (PISA) Countries with better PISA scores show better analytical skills, problem-solving and cognitive performance overall [3]. The differences underscore the role of educational systems in producing intellectual outcomes and productivity spillovers over the long term.

The technological field has also become an important aspect of globalization. The internet, digital platforms, and artificial intelligence will transform knowledge production and dissemination. Digital resources could give way to new educational and skill lessons for one person, which can impact cognitive performance [4]. But how technology actually functions is predicated on strong institutions and quality of education systems.

However, globalization has not served all countries equally. This benefit is greater in developed economies that generally have an advanced infrastructure and institutional capacity, while developing countries tend to have deficiencies such as the poor education system and access to technology [5]. This causes unequal cognitive development among countries. Hence, the primary purpose of this study is to examine how globalization, education and technological features affect IQ levels in 63 countries. Empirically, this research is novel in its integrative consideration of numerous facets of globalization within the same empirical model.

LITERATURE REVIEW

Academics have been increasingly interested in the links between globalization, economic development, education and cognitive performance in recent years. The process of globalization is indeed well acknowledged as multi-dimensional, covering aspects of economic integration, technological diffusion and the expansion of knowledge networks that have contributed to human capital formation, cognitive skills development [1,7]. There exists a substantial body of literature attributing cognitive outcomes to the effect of economic growth. Low GDP per capita and his/her higher level are associated with access to education, health care, nutrition are important determined factors for cognitive ability [2,6]. Investments in education improve cognitive skills, and cognitive skills then support the long-run economic growth [2]. Similarly, Rohde et al. found that cognitive ability is generally stronger across countries with higher income levels as those countries are characterized by better living conditions and therefore more educational attainment.

Indicators of globalization, such as foreign direct investment (FDI) and trade openness are also significant in cognitive development. Foreign Direct Investment [FDI] is the financial independent stability of a company through which it is free to coordinate its management systems and provides technology and financial support to know-how in order to transfer advanced technologies, managerial knowledge as well as innovation leads improvement in productivity affecting human capital upgrade[7]. According to UNCTAD, knowledge transfer due to FDI inflows leads the receiver country to improve its industrial development and educational indicators [7]. And trade openness expands the exposure of domestic firms to foreign markets and ideas, facilitating knowledge spillovers and multinational involvement [17].

Education is widely acknowledged as the most significant predictor of cognitive performance. On the one hand, state tests administered internally do not offer valuable insights especially compared to international assessments such as Programme for International Student Assessment (PISA) which take place every three years. Countries with higher PISA scores exhibit greater analytical skills, improved problem-solving abilities, and overall cognitive performance according to OECD studies [3]. In addition, Barro and Lee [8] highlight that development in human capital to represent years of schooling and education equalization is closely related to intelligence growth and productivity.

In 2018, the World Bank released an important yardstick for every nation's leaders—the Human Capital Index (HCI), which combines indicators of education and health to generate a measure of how productive future generations will be. Several studies have found a positive relationship between HCI levels and cognitive abilities, as well as economic outcomes [11]. Add to Cart Becker's human capital theory provides additional evidence for this relationship by emphasizing the value of education and skills as a means of increasing individual productivity and intellectual potential [15].

Technical development in recent years has also proven to be a significant component affecting cognitive performance. The increasing availability of internet access and digital technologies are changing how people learn and develop skills. Zhang et al. [4] show that better internet access leads to more learning through increased availability of information. Likewise, Acemoglu and Restrepo[9] suggest that advances in technology especially artificial intelligence may disrupt labor markets and education systems, thereby shaping cognitive skill development. However, evidence from empirical studies on the technology effect is still mixed. Some studies highlight the positive role of digital technologies, while others state that technology alone will not improve cognitive outcomes without strong institutional frameworks and education systems [5]. Rodrik [5] argues that globalization and technological advancement shape inequality in the absence of sufficient institutional capacity of countries for those transitions.

A related body of literature has explored the link between globalization and inequality in cognitive development. Thus, rich countries benefit more from globalisation given that they possess superior infrastructure and properly developed institutions, while poorer states are constrained by structure, with limited access to education and technology [16]. And so, we see massive differences in terms of cognitive performance between countries. In-depth literature has been produced so far, yet there are still research gaps. First, most studies address individual components like education or income, rather than simultaneously take into account the joint impacts of economic, educational and technological factors. Second, few studies incorporate several dimensions of globalization simultaneously into one empirical model. Third, cross-country comparative analyses based on a wider set of indicators are still comparatively few and far between. Integrating economic, educational and technological variables into one model provides a more nuanced understanding of the drivers of cognitive development.

RESEARCH METHODOLOGY

The research will analyse the impact of trade variables including trade and foreign direct investments across countries on cognitive performance for different countries, as measured in IQ scores. It also aims to explore the role of cognitive scores assessed by educational and technological metrics like PISA scores, Human Capital Index (HCI), Global AI Index (GAII), R&D expenditure, and global internet speed on IQ level. Mathematically, the regression model takes the following general form:

$$IQ = \alpha + \beta^0 + \beta^1 \cdot Trade + \beta^2 \cdot FDI + \beta^3 \cdot GDP\ per\ capita + \beta^4 \cdot PISA + \beta^5 \cdot HCI + \beta^6 \cdot GAII + \beta^7 \cdot R\&D\ expenditure + \beta^8 \cdot Internet\ Speed + \epsilon \quad (1)$$

Where, in equation 1, the variable IQ is dependent variable, while the independent variables consist on trade, FDI, GDP per capita, PISA score, HCI, GAII, R&D expenditure, and internet speed, α is the intercept, $\beta_1, \beta_2, \beta_3 .., \beta^8$ are the estimated coefficients for each independent variable, ϵ is the error term. The model is estimated using robust regression to correct for heteroskedasticity and ensure reliable results [8].

Table 1: Data Sources and Measurement

Variables	Description of Variables	Sources
Intelligence Quotient (iq)	It measures the cognitive ability (Lynn/Becker dataset)	World Population Review
Trade (trade)	Measured by the sum of a country's exports and imports as a percentage of GDP	World Bank
Foreign Direct Investment (fdi)	Measured by the net inflows of foreign direct investment	World Bank
Gross Domestic Product Per capita (gdp_per_ capita)	Reflects the total economic output per person within a country, measured in dollars.	World Bank
Programme for International Student Assessment (pisa)	Assesses the quality of public education systems across countries	OECD
Human Capital Index (hci)	Measured by factors such as education, health, and skills.	World Bank
Global Artificial Intelligence Index (gaii)	Measures a country's performance and readiness in artificial intelligence (AI).	Tortoise Media
Research and Development Expenditure (RandD_expenditure)	Measures the total spending on research and development activities within a country.	World Bank
Internet Speed (internet_ speed)	Measures the average internet connection speeds across countries.	World Population Review

ANALYSIS AND RESULTS

This study aimed at quantifying the effects of globalization, education and technology on IQ level of different countries. This section is intended to report the results of such econometric process as descriptive statistics, Breusch-Pagan/Cook-Weisberg test for heteroskedasticity, Spearman correlation and Robust regression.

Table 2. Descriptive Statistics of the variables

Variable	Obs	Mean	Std. Dev.	Min	Max
IQ	63	4.529	.075	4.366	4.668
FDI	63	15.854	1.312	13.103	19.67
GDP per capita	63	10.086	.93	7.586	11.762
PISA	63	7.19	.124	6.913	7.381
HCI	63	-.367	.099	-.528	-.223
Trade	63	33480.272	139565.49	66.742	1013367.9
GAII	63	62.36	11.874	37.2	88.16
Internet speed	63	126.558	62.787	14.81	297.62
RandD expenditure	63	1.492	1.25	.08	5.56

Descriptive statistics for the variables utilized in this analysis are presented in Table 2. GDP per capita and trade show the most variation across countries, which reflects the high variance in levels of economic development. This is reinforced as we look at the relatively lower variation (and therefore more stable distributions across sample) in the two outcoming measures IQ and PISA scores. On the contrary, indicators of technology, like the speed of internet connectivity and R&D expenditure follow a median distribution which means some countries are more technologically well-endowed.

Table 3. Spearman correlation analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) iq	1.000								
(2) fdi	0.243	1.000							
(3) gdp_per_ca~a	0.589	0.423	1.000						
(4) pisa	0.844	0.484	0.638	1.000					
(5) hci	0.822	0.307	0.774	0.845	1.000				
(6) trade	0.297	0.732	0.322	0.432	0.241	1.000			
(7) gaii	0.668	0.604	0.843	0.793	0.755	0.540	1.000		
(8) internet_speed	0.298	0.443	0.465	0.414	0.364	0.391	0.564	1.000	
(9) RandD_expendit~e	0.740	0.391	0.753	0.777	0.763	0.501	0.858	0.479	1.000

Spearman rho = 0.479

The results of Spearman correlation are shown in Table 3. The results show a strong positive correlation (0.844) between IQ and PISA scores, as well as between IQ and Human Capital Index (0.822), indicating the importance of education for cognitive development. The average IQ also has a notable positive correlation with GDP per capita (0.589), indicating the role of economic development. On the other hand, both FDI and trade are relatively weakly correlated with IQ, suggesting lack of a direct impact on cognitive performance. Very high correlations between independent variables (such as GAII with R&D) can diagnose potential multicollinearity, which is corrected through robust estimation of the regression. Some independent variables (e.g., GAII and R&D) have a high correlation, suggesting potential multicollinearity; however, this is handled by means of robust regression estimation.

Breusch Pagan/Cook Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of iq
H0: Constant variance
chi2(1) = 2.70
Prob > chi2 = 0.1006

According to the Breusch–Pagan test heteroskedasticity is not present ($p > 0.05$), which indicates that the assumption of constant variance is satisfied. However, robust regression is used to reflect reliability within the estimates.

Table 4. Robust regression analysis

ln_IQ	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
ln_FDI	-.008	.004	-2.13	.04	-.016	0	**
ln_gdp_per_capita	.03	.008	3.89	0	.014	.045	***
ln_PISA	.495	.057	8.70	0	.379	.611	***
ln_HCI	-.167	.079	-2.10	.044	-.328	-.005	**
ln_trade	.001	0	0.95	.347	0	0	
ln_GAII	.001	.001	0.14	.89	-.001	.002	
ln_internet_speed	0	0	0.06	.953	0	0	
ln_RandD_expenditure	.008	.005	1.86	.072	-.001	.018	*
base Africa	.	.	.	.	.	.	
Asia	-.046	.024	-1.92	.064	-.096	.003	*
Europe	-.068	.024	-2.82	.008	-.117	-.019	***
Latin America	-.099	.028	-3.47	.001	-.156	-.041	***
Middle East	-.128	.027	-4.65	0	-.184	-.072	***
North America	-.051	.029	-1.74	.091	-.111	.009	*
Oceanica	-.059	.029	-2.04	.049	-.118	0	**
Constant	.784	.424	1.85	.074	-.079	1.646	*

Mean dependent var	4.520	SD dependent var	0.076
R-squared	0.951	Number of obs	48
F-test	45.643	Prob > F	0.000

*** p<.01, ** p<.05, * p<.1

Robust regression results are shown in Table 4. The model is statistically significant (Prob > F = 0.000) and exhibits high explanatory power ($R^2 = 0.951$).” Both GDP per capita and PISA scores have strong positive effects on IQ ($p < 0.01$), suggesting that economic development and education are the main determinants of IQ levels. Both factors of FDI and HCI present significant but inversely oriented correlations ($p < 0.05$), indicating indirect or structural influences. R&D expenditure has a weak positive impact (at 10% level). Neither trade, internet speed nor Global AI Index are statistically significant. These regional variables show variation in cognitive outcomes between regions.

It shows that economic development and education prove the be the major drivers of cognitive performance between countries. The significant positive influence of GDP per capita means that as the level of income grows, it promotes better education and healthcare access, in addition to elevated living conditions which help in cognitive development [6].

The results also underscore the importance of education in determining intellectual skills. The powerful association with PISA scores indicates that educational quality is one of the most significant predictors of cognitive performance: better education systems yield higher levels of cognitive skills [3]. The signs of the coefficients imply that FDI and HCI may not affect IQ positively but indeed indirectly or through some structural channels unique to each country. While FDI is widely viewed as a contributor to economic growth, the extent of its benefits on cognitive development is contingent upon the economy’s absorptive capacity and institution quality [7].

Above chart results indicate that access to technology does not convert and enhance cognition. This aligns well with the need for technology to be properly integrated into education systems if meaningful processes of learning are to result [4]. The findings imply that the impact of globalization on cognitive development is indirect, working through economic and educational pathways rather than via direct technological mechanisms.

CONCLUSION AND POLICY RECOMMENDATIONS

This analysis here based on 63 countries shows that globalization, education and technological factors are relevant for IQ levels. The findings highlight the importance of economic development and educational quality among determinants of cognitive ability. Income level (measured in terms of GDP per capita) and overall level of educational attainment as measured by PISA both show strong positive effects illustrating how much income and general education matter in producing intelligent citizens. FDI and HCI have a less pronounced or indirect relationship, whereas technology indicators do not display a statistically significant impact.

The implication of these results is that globalization also promotes human cognition, but only indirectly through higher economic growth and better education system, not as a result of technological progress.

The findings of the study lead to several policy recommendations. First, governments need to invest in their education systems as improving the quality of education is critical for cognitive development and human capital. Second, policies to boost economic growth and income levels should be stronger because GDP per capita has a direct positive effect on cognitive performance. Third, foreign direct investment must flow into sectors that foster transfer of technology and skills to the local economy, so that its benefits spread beyond enhancing growth to building capacity. Lastly, the technology progress must be well implanted into education systems. Of course, access to digital technologies is not enough, they must be used properly to help people learn how to think.

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