ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

Publisher
http://jssidoi.org/esc/home

HUMAN CAPITAL AND ECONOMIC GROWTH UNDER MODERN GLOBALIZATION

Givi Bedianashvili [1*], Murman Tsartsidze [2], Nino Mikeladze [3], Zviad Gabroshvili [4]

[1,2,3,4] Ivane Javakhishvili Tbilisi State University, University Str.2, Tbilisi, 1086, Georgia

E-mails: [1] givi.bedianashvili@tsu.ge (Corresponding author); [2] murman.tsartsidze@tsu.ge; [3] N.Mikeladze2@mof.ge; [4] Zviad.Gabroshvili108@eab.tsu.edu.ge*

Received 20 May 2024; accepted 15 August 2024; published 30 September 2024

Abstract. In the modern globalized world, human capital and economic growth roles have become increasingly vital, demanding a closer examination of their dynamics. It is crucial to grasp the unique nuances of globalization to comprehend how it shapes global socio-economic systems and impacts individual nations. This understanding also highlights the evolving challenges and opportunities for human capital in driving economic progress. Moreover, the distinct circumstances small countries face amidst globalization must be noted. Studies have confirmed that these nations operate under unique mechanisms that influence their socioeconomic development. This study focuses on a macro systemic analysis of the interplay between human capital and economic growth, explicitly offering tailored recommendations for Georgia. Research leveraged econometric methods and harnessed the power of artificial intelligence, specifically employing machine learning models. The analysis shows that the null hypothesis about no cointegration was rejected for the GDP per capita and spending on healthcare with the P-value of 0.0354, while for the GDP per capita (or GDP growth) and spending on environment had the P-value of 0.0074 (0.0052) in Georgia. This reflects the impact of spending on human capital on the economy (in Georgia and Ireland) and vice versa (in Georgia, Latvia and Lithuania). Research findings show that future-oriented skills training for entrepreneurs and specialists is essential in a modern, globally competitive environment, focusing on adaptability and global best practices.

Keywords: Human Capital; Modern Globalization; Economic Growth

JEL Classification: C53, J53, O11, O43

Reference to this paper should be made as follows: Bedianashvili, G., Tsartsidze, M., Mikeladze, N., Gabroshvili, Z. (2024). Human capital and economic growth under modern globalization. *Entrepreneurship and Sustainability Issues*. 12(1), 268-289. http://doi.org/10.9770/jesi.2024.12.1(19)

1. Introduction

In today's interconnected world, a hallmark of globalization, it's vital to grasp the current challenges it faces. The COVID-19 pandemic highlighted this interdependence by disrupting the flow of goods, people, and information. Now, with the war in Ukraine and the economic sanctions on Russia from the West, it is already clear a new aspect of globalization – one marked by deeper political and economic rifts, indicating a more confrontational phase.

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

In the context of a confrontational globalization landscape, a critical macrosystemic challenge arises from heightened uncertainty. This phenomenon transcends the boundaries of individual domains, stemming from a complex interplay of processes across diverse societal spheres. Uncertainty manifests as cascading shock effects that disrupt seemingly unrelated fields, further amplifying the challenge. Additionally, the simultaneous influence of multiple interconnected factors acts as a multiplier, exacerbating the inherent uncertainties and creating a volatile and unpredictable environment.

It is noteworthy that the growing uncertainty caused by both economic and non-economic factors is of a macrosystem nature. This is evidenced, for example, by the global problem of climate change, the most critical problem in the era of globalization, including in the economic and social aspects.

In the face of confronting globalization, human capital remains essential and valuable. It includes knowledge, skills, experience, education and talent and contributes to creating tangible and intangible assets. There is no doubt that individuals with good health, education and motivation can work effectively and, as a result, contribute significantly to economic growth.

The problems of human capital, economic growth and their interaction require identifying the features that accompany the modern stage of globalization and the growth of the uncertainty factor. Taking them into account, the requirements for human capital itself should be formulated based on the positions of more effective promotion of economic growth and sustainability of the state's socio-economic system.

2. Theoretical Background and Hypotheses

Human capital theory evolved from earlier economic thought. As economies modernized and technology advanced, the demand for skilled labour grew, highlighting the increasing importance of human capital in economic progress.

The Solow-Swan model attributes economic growth to labour, capital, and technological progress. Initially excluding human capital, the model was refined to explain productivity and growth disparities (Solow, 1956; Swan, 1956). Mankiw, Romer, and Weil (1992) linked human capital (measured by education) to economic growth, demonstrating its crucial role in boosting labour productivity and overall economic expansion.

Lucas (1988) emphasized human capital accumulation through education and training, leading to a more productive workforce and long-run economic growth.

Romer's 1990 model (endogenous growth theory) highlights epistemic capital (knowledge) and technological innovation as key growth drivers. He argues a skilled workforce (high human capital stock) is crucial for ideating, developing, and spreading new technologies, which fuel sustained economic growth.

Galor and Weil's (2000) theory integrates demographic transitions and human capital accumulation. It posits that as economies develop, investments in human capital lead to lower fertility rates and higher economic growth, facilitating a transition from stagnation to sustained growth.

Barro (1991) examined a substantial number of countries and discovered a positive correlation between higher education levels and economic growth. He highlighted the significance of primary and secondary education in fostering economic development.

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

Acemoglu (2002) examines the impact of technological change on wage inequality. His research suggests that technical advancements have disproportionately benefited skilled workers over the past six decades. This "skill-biased" technological change is identified as a primary driver of the recent rise in income inequality.

Hanushek and Woessmann (2008) used international assessments to show cognitive skills, not just years of schooling, have a stronger link to economic growth. This implies the quality of education, measured by its ability to develop these skills, is crucial for economic prosperity.

For developing countries, studies like those by Psacharopoulos and Patrinos (2004) have shown that returns to investment in education are exceptionally high in these regions, suggesting significant potential for human capital to drive growth.

Case studies of rapidly growing economies such as South Korea and Singapore illustrate how targeted investments in education and skill development can transform economic prospects (Lee, 2001).

Research by Bloom, Canning, and Sevilla (2004) indicates that health improvements contribute significantly to economic growth. Healthier populations are more productive, and reductions in mortality rates can lead to increased investment in education and skills.

Aghion and Howitt (2009) discussed how human capital in the form of research and development (R&D) personnel drives innovation and technological advancements, further promoting economic growth.

Governments should prioritize investments in both the quantity and quality of education. Ensuring access to primary, secondary, and tertiary education, coupled with improvements in educational infrastructure and teaching quality, is essential.

Vocational training and continuous professional development programs align the workforce's skills with the evolving demands of the economy.

Public health policies to improve healthcare access can have substantial economic benefits. Programs targeting maternal and child health, nutrition, and disease prevention are particularly effective. Encouraging innovation through investment in R&D and fostering collaborations between universities, research institutions, and industry can drive technological advancements and economic growth.

The modern theory of human capital originated in the 1960s, following the works of American scientists Schultz (1961) and Becker (1964). According to neoclassical growth theory, as stated by Solow (1956) and Swan (1956), capital, labour, and technological development play a significant role in economic growth.

The importance of education for human capital development, particularly oriented towards the implementation of new technologies, was highlighted by Nelson and Phelps (1966). Romer (1990), in the endogenous economic growth theory, emphasized the priority of human capital and its significance in economic growth through the generation of new ideas.

Endogenous growth models link specialized education to economic growth. These models show how a skilled workforce focused on research and development (R&D) boosts productivity and economic expansion.

The authors have contributed significantly to the literature addressing this research problem, offering theoretical and practical insights. For example, Smith (1938) explores the foundational aspects of human capital in economic theory, while Barro (2001) examines its impact on economic growth. Becker (1964) is renowned for his

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

groundbreaking work on human capital theory, further developed by Blaug (1976) in his analyses of education and economics.

Jones (2014) and Kuznets (1955) delve into historical and empirical aspects of economic growth, focusing on human capital. Mankiw, Romer and Weil (1992) and Lucas (2015) offer influential models that underscore the importance of human capital in macroeconomic contexts. Recent studies, such as those by Bulina Mozgovaya and Pakhnin (2020), Deming (2022) and Bedianashvili (2023), provide contemporary perspectives on the evolving role of human capital in the global economy.

Manuelli and Seshadri (2014) present empirical analyses of the return on investment in human capital, while Mincer (1958) and Schultz (1961) are pioneers in the study of the economic value of education. Solow (1991) and Uzawa (1965) contribute to understanding the relationship between technological change and human capital. Finally, Weil (2007) synthesizes these concepts, providing a comprehensive view of human capital's role in economic development.

Modern views on human capital's role in economic growth are captured by the Human Development Index (HDI) and Human Capital Index (HCI). The HDI (UNDP, 2015) offers a broad view of a nation's human development in terms of health, knowledge, and living standards. The HCI (World Bank, 2018) focuses on health and education, which directly impact future worker productivity.

The literature consistently affirms the pivotal role of human capital in driving economic growth. Theoretical frameworks and empirical studies support the notion that investments in education, health, and innovation are instrumental in enhancing productivity and sustaining long-term economic development. To cultivate robust and inclusive economic growth, policymakers must prioritize the creation of environments conducive to human capital formation.

Based on the review of the existing literature, it is worth noting the weak reflection of the features and challenges of modern globalization in the studies surrounding the problem of human capital and economic growth, the failure to consider the growing economic uncertainty and the simplified representation of human capital as a complex systemic phenomenon. All this points to the urgency of further research in this field.

This paper aims to determine the features of the interaction between human capital and economic growth, considering the specifics of modern globalization, distinguishing the features of Georgia and formulating recommendations. Based on the literature review and the abovementioned, the conceptual model of the study is presented in Figure 1, and the research hypotheses are as follows.

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

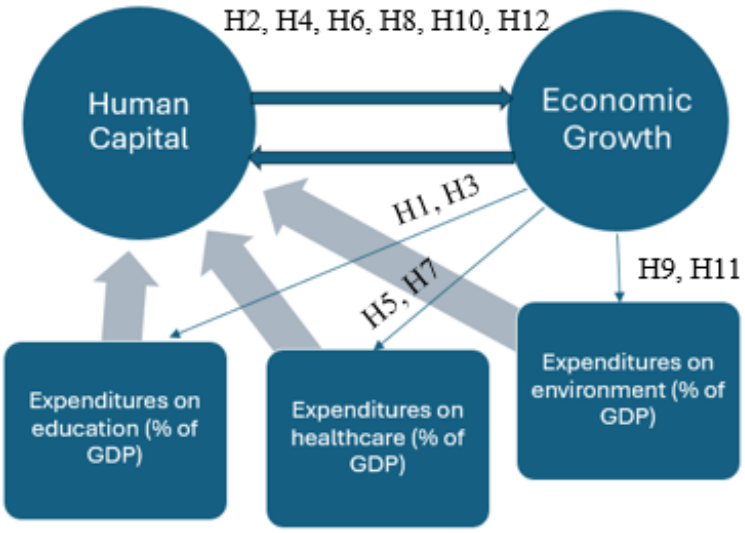


Figure 1. Conceptual Framework

The above conceptual framework refers to Gross Domestic Product (GDP) per capita and GDP growth as indicators of economic growth, but the hypotheses are assumed separately. Education, healthcare, and environmental expenditures reflect human capital development with some conditions. This analysis measures human capital by considering expenses on education, healthcare, and the environment.

H1: GDP per capita has a significant influence on expenditure on education.
H2: Expenditure on education has a significant influence on GDP per capita.
H3: GDP growth has a significant influence on expenditure on education.
H4: Expenditure on education has a significant influence on GDP growth.
H5: GDP per capita has a significant influence on expenditure on healthcare.
H6: Expenditure on healthcare has a significant influence on GDP per capita.
H7: GDP growth has a significant influence on expenditure on healthcare.
H8: Expenditure on healthcare has a significant influence on GDP growth.
H9: GDP per capita has a significant influence on expenditure on environment.
H10: Expenditure on environment has a significant influence on GDP per capita.
H11: GDP growth has a significant influence on expenditure on environment.
H12: Expenditure on the environment has a significant influence on GDP growth.

3. Research Methodology and Methods

A mixed-methods approach was used, combining qualitative and quantitative techniques. Data was collected from literature, Georgian Statistical Office (Geostat) and analyzed statistically. Comparative and benchmarking methods were also applied (Bedianashvili & Kokhreidze, 2024).

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

One of the important methodological frameworks and foundations of the research is confrontational globalization under growing uncertainty as a systemic concept of modern globalization (Bedianashvili, 2021, 2023; Papava, 2022a, 2022b).

The statistical data used in the study were sourced from various organizations, including the International Monetary Fund (IMF), World Bank (WB), United Nations (UN), and Geostat. In addition to these data sources, the research employed econometric methods and advanced artificial intelligence (AI) techniques. Specifically, the study utilized machine learning (ML) models, drawing on the methodologies and findings of notable works such as those by Breiman (2001), which introduced fundamental concepts in ML, and Lundberg and Lee (2017), who developed methods for interpreting ML models. Further contributions from Lundberg et al. (2020) expanded on these interpretative techniques. Pedregosa et al. (2011) provided essential tools for implementing ML algorithms, and Shapley (1951) offered foundational insights into cooperative game theory that are now applied in ML to explain model predictions.

Data from several small countries was used to evaluate how human capital might affect economic growth. Alongside Georgia were selected benchmark countries, considering factors such as population size, country area, and development level. Three European Union (EU) member countries were chosen as benchmark countries: Ireland, Latvia, and Lithuania. The table below presents the primary characteristics of these countries in terms of area and population (Table 1).

Table 1. Area and number of populations in Georgia and benchmark countries, 2023

Country	Number of population (mln)	Area (km2)
Georgia	3.73	69700
Ireland	5.06	70273
Latvia	1.83	64589
Lithuania	2.72	65300

Source: www.imf.org, www.worldometers.info

The data analyzes the relationship between economic growth and human capital for Georgia and benchmark countries. It measures economic growth using GDP per cent change and Purchasing Power Parity (PPP) per capita. Public spending data includes expenditures on education, healthcare, and the environment. Education is measured by the total years spent in primary and secondary school.

The analysis also includes the HDI, using average life expectancy for healthcare and CO2 emissions for environmental indicators. Data from 2000-2021 comes from the IMF, World Bank (WB), and the UNDP for HDI. The World Bank Human Capital Project provides data, with the latest from 2020.

For simplification used the abbreviations of the variables: GDP, GDP_ppp, exp_edu, exp_h, exp_env. Below, the variables used in the analysis and their respective abbreviations are explained (Table 2).

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

Table 2. Abbreviations of used variables

Variable	Abbreviation
Gross Domestic Product	GDP
Economic Growth	Y_gr
GDP per capita by Purchasing Power Parity	Y_capita
expenditures on education (% of GDP)	exp_edu
expenditures on healthcare (% of GDP)	exp_h
expenditures on environment (% of GDP)	exp_env

Considering the causal relationship between economic growth and expenditures on human capital such as education, healthcare and environment, the appropriate quantitative estimation is based on the cointegration analysis. The analysis, cointegration enabled the identification of long-term equilibrium relationships between the variables shown above. First, it should be noted that human capital consists of expenditures on education, healthcare and the environment as well. On the other hand, there is economic growth and GDP per capita data. During the analysis, it formulated the null and alternative hypothesis and tested them. Cointegration testing is crucial to determine if there is a causal relationship between the mentioned variables, and if there is, to identify which variable causes changes in the other. The null hypothesis was that there is no level relationship among the tested time series, while the alternative hypothesis is that there is a level relationship among these series. The casual relationship is tested for the following variables: on the one hand, expenditures on education, healthcare, and the environment as a percentage of GDP, and on the other hand, GDP per capita. The null hypothesis of no cointegration between these variables was rejected in the following cases:

- GDP growth and expenditure on education for Ireland and Latvia;
- GDP per capita and expenditure on healthcare for Georgia and Ireland;
- GDP growth and expenditure on healthcare for Ireland;
- GDP per capita and expenditure on the environment for Georgia and Latvia;
- GDP growth and expenditure on the environment for Georgia, Ireland, and Lithuania.

Considering this, it can express the Granger Causality Test hypothesis as follows (Table 3).

Table 3. Granger Causality Test hypotheses

Null Hypothesis (H0) and Alternative Hypothesis (H1-H12)	Result for Georgia	Result for Ireland	Result for Latvia	Result for Lithuania
H0: Y_capita does not ➔ Exp_edu H1: Y_capita ➔ Exp_edu	H0	H0	H0	H0
H0: Exp_edu does not ➔ Y_capita H2: Exp_edu ➔ Y_capita	H0	H0	H0	H0
H0: Y_gr does not ➔ Exp_edu H3: Y_gr ➔ Exp_edu	H0	H0	H0	H0
H0: Exp_edu does not ➔ Y_gr H4: Exp_edu ➔ Y_gr	H0	H0	H0	H0
H0: Y_capita does not ➔ Exp_h **H5: Y_capita ➔ Exp_h**	H1	H0	H0	H0
H0: Exp_h does not ➔ Y_capita **H6: Exp_h ➔ Y_capita**	H1	H0	H0	H0

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

H0: Y_gr does not ➔ Exp_h H7: Y_gr ➔ Exp_h	H0	H0	H0	H0
H0: Exp_h does not ➔ Y_gr H8: Exp_h ➔ Y_gr	H0	H0	H0	H0
H0: Y_capita does not ➔ Exp_env **H9: Y_capita ➔ Exp_env**	H1	H0	H1	H0
H0: Exp_env does not ➔ Y_capita **H10: Exp_env ➔ Y_capita**	H0	H1	H0	H0
H0: Y_gr does not ➔ Exp_env **H11: Y_gr ➔ Exp_env**	H0	H0	H0	H1
H0: Exp_env does not ➔ Y_gr H12: Exp_env ➔ Y_gr	H0	H0	H0	H0

4. Results

The study explores the causal relationship between education, healthcare, and environment, expressed as a percentage of GDP, on one hand, and economic growth on the other hand. To analyze these interconnections, the first step involves examining stationarity to determine the degree of integration. This is achieved by conducting unit root tests through various methodologies. Subsequently, cointegration is assessed to measure the correlation between the time series. After assessing the degree of cointegration, causality is defined using appropriate tests, providing insights into whether the selected public spending influences economic growth in the chosen countries.

Public spending for education, healthcare, and the environment is represented as a percentage of GDP. As the initial data were non-stationary, they underwent transformation to achieve first-order difference stationarity. This transformation enables the estimation of cointegration in the time series, allowing for the investigation of causality among the variables. In some instances, no cointegration vector was identified, or it was impractical to assess cointegration. For example, the Johansen cointegration test for economic growth and public spending on education did not reject the Null hypothesis, indicating any cointegration in the model for Georgia.

The cointegration test between economic growth and public spending on healthcare yields the same result. Concerning spending on the environment, the Trace Statistic test reveals two vectors, whereas the Maximum Eigenvalue test indicates no cointegration vector among these variables.

Since one of the tests demonstrates correlation, Granger Causality tests are employed to investigate causality. The selected variables are initially nonstationary but attain stationarity through first-order differencing, denoted as I(1). The Vector Error Correction (VECM) method is employed for causality testing. However, the results indicate that none of these variables cause another. If replaced GDP per capita data for economic growth, the findings persist. There is still no discernible relationship for spending on education and healthcare. Both Trace Statistic and Maximum Eigenvalue tests confirm a single cointegration vector for spending on the environment see Table 4).

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

Table 4. Johansen cointegration test for Georgia, between GDP per capita and spending on environment

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.753213	20.73164	15.49471	0.0074
At most 1	0.078362	1.142443	3.841465	0.2851
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.753213	19.58919	14.26460	0.0065
At most 1	0.078362	1.142443	3.841465	0.2851
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

During the causality testing, the results indicate that the GDP per capita causes changes in spending on the environment (see Table 5).

Table 5. Granger Causality test

Null Hypothesis:	Obs	F-Statistic	Prob.
GEORGIA_EXPENDITURE_ON_ENVIRONMENT_PROTECTION does not Granger Cause GEORGIA_GDP_PER_CAPITA	14	0.28353	0.7596
GEORGIA_GDP_PER_CAPITA does not Granger Cause GEORGIA_EXPENDITURE_ON_ENVIRONMENT_PROTECTION		4.94484	0.0356

As it was received the result that there is at most 1 cointegration vector, one can use the Granger Causality test and see whether spending on environment causes GDP per capita or GDP per capita causes spending on environment in Georgia.

The Johansen test reveals one cointegration vector between economic growth and spending on education and economic growth and spending on the environment for Ireland. Additionally, two vectors are identified for economic growth and spending on healthcare. However, causality analysis indicates that none of these variables causes another.

In the case of GDP per capita analysis and causality tests for the same variables, the results show that public spending on the environment causes a change in GDP per capita. This causality is also confirmed for Latvia, where GDP per capita causes a change in spending on the environment. Johansen tests for Latvia indicate one cointegration vector between spending on education and economic growth, a finding was supported by Trace Statistics and Maximum Eigenvalue Statistics. On the other hand, for Lithuania, the causality is observed in the economic growth and expenditure on the environment, where economic growth causes spending on the environment.

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

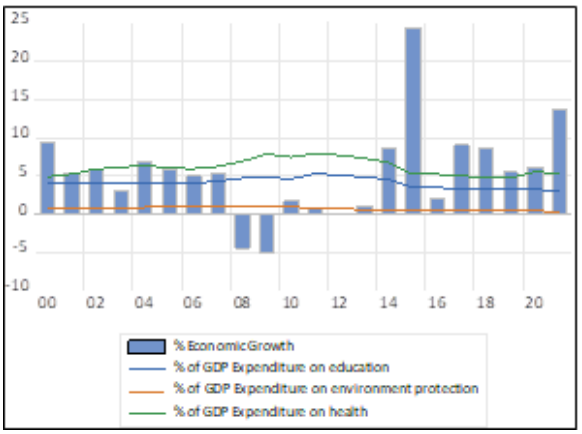
Table 6 below shows the p-values for all four analysed countries, where it tested if there was a cointegration vector. In cases where the results show that no cointegration vector was observed, they had a probability higher than 5 per cent. Otherwise, the p-value was less than 0.05.

Table 6. The p-values for analysed countries

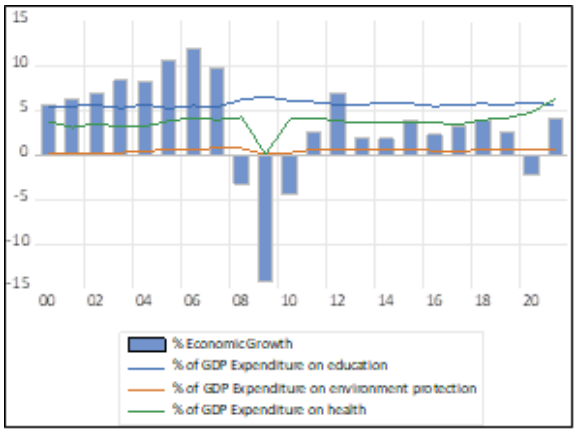
Null Hypothesis (H0) and Alternative Hypothesis (H1)	P-value for Georgia	P-value for Ireland	P-value for Latvia	P-value for Lithuania
H0: No cointegration vector between Y_capita and Exp_edu H1: At least 1 cointegration vector between Y_capita and Exp_edu	0.7995	0.1228	0.0582	0.5117
H0: No cointegration vector between Y_gr and Exp_edu **H1: At least 1 cointegration vector between Y_gr and Exp_edu**	0.0784	0.0197	0.0012	0.0552
H0: No cointegration vector between Y_capita and Exp_h H1: At least 1 cointegration vector between Y_capita and Exp_h	0.0354	0.0294	0.2109	0.3634
H0: No cointegration vector between Y_gr and Exp_h **H1: At least 1 cointegration vector between Y_gr and Exp_h**	0.1091	0.0103	0.1369	0.08
H0: No cointegration vector between Y_capita and Exp_env **H1: At least 1 cointegration vector between Y_capita and Exp_env**	0.0074	0.0954	0.034	0.4744
H0: No cointegration vector between Y_gr and Exp_env **H1: At least 1 cointegration vector between Y_gr and Exp_env**	0.0052	0.0274	0.0649	0.0038

Furthermore, the causality analysis reveals that GDP per capita is a driving factor for changes in spending on the environment in both Georgia and Latvia. Conversely, in Ireland, the spending on the environment serves as the explanatory variable. This discrepancy suggests the potential influence of other variables related to human capital, which were not included in the analysis. The relationship between these omitted variables for Georgia and benchmarking countries is illustrated in Pictures 1-6 below.

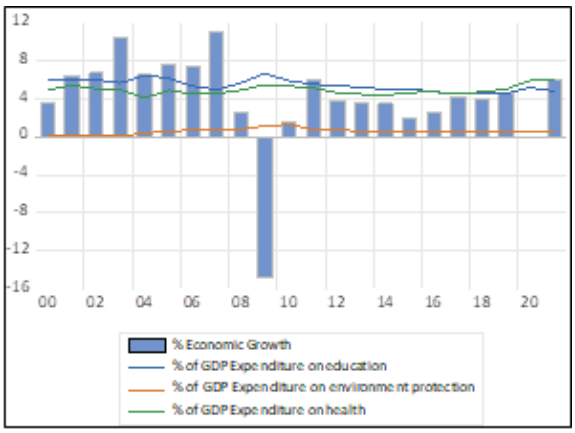
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)



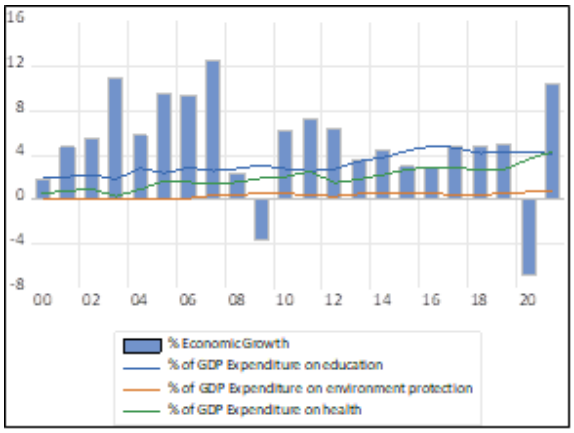
Picture 1. Ireland



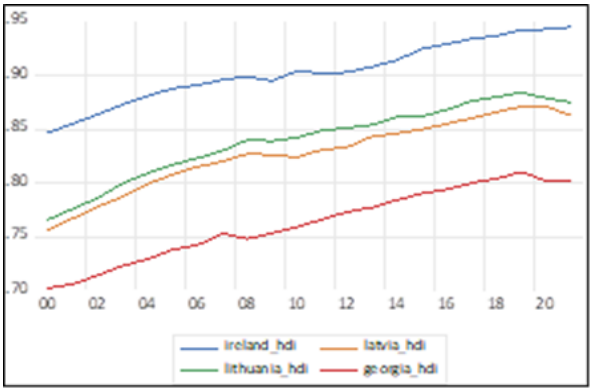
Picture 2. Latvia



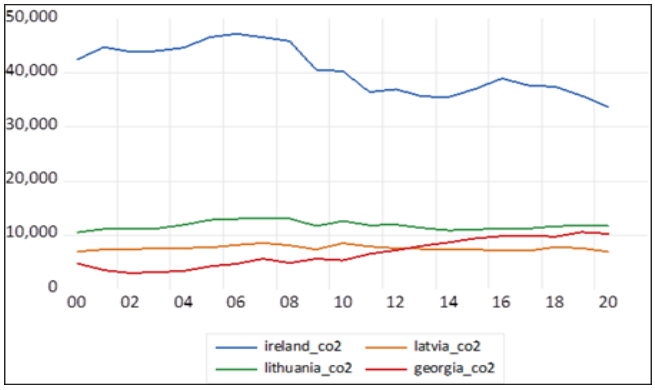
Picture 3. Lithuania



Picture 4. Georgia



Picture 5. HDI



Picture 6. CO_2 emmision (kilotones)

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

Considering one of the main factors affecting income in the human capital analysis, it is crucial to assess the factors influencing income. Similar studies have been conducted in other countries (e.g., Chakrabarty, Biswas, 2018).

Georgian 2019-year labour force survey data analysis using machine learning by Bedianashvili et al. (2023) extracted meaningful insights about relationships between income as the dependent variable and various features like age, education, sex, worked hours, etc. It would be scientifically interesting to analyze 2022-year survey data of Geostat (https://www.geostat.ge/en/modules/categories/130/labour-force-survey-databases) using same methods for two reasons: 1. There was Covid-19 pandemic in the world in 2021; 2. The Russian-Ukrainian war affected the world economy in different ways in 2022. So, these two events might affect relationships between variables described above. There is a difference in methodologies between the 2019 and 2022 surveys. Classifiers are changed, but the general picture is the same.

In 2022-year survey dependent variable in database is B24_B25_Net_earnings, which is the interval of net earnings in the main job for the last worked month in Georgian Laris (GEL). It contains several intervals, but authors removed 'Refuse the answer' and 'Has not received earnings for the last working month', then combined some intervals and created classes. The intervals and created classes are:

- '100 GEL or less': 0,
- '101-150 GEL': 0,
- '151-200 GEL': 0,
- '201-300 GEL': 0,
- '301-400 GEL': 0,
- '401-500 GEL': 0,
- '501-600 GEL': 0,
- '601-800 GEL':1,
- '801-1000 GEL':1,
- '1001-1500 GEL':2,
- '1501-2000 GEL':2,
- 'More than 2000 GEL':3.

So, Class 0 contains 600 GEL or less income, class 1 contains earnings from 601 GEL to 1 000 GEL, class 2 is earnings from 1 001 to 2 000 GEL and class 3 is earning more than 2 000 GEL.

The independent variables from the survey database are sex, age, the second job ('Second_Job' in databases), education (Education attainment level), the status in employment at the main job, occupation (The authors converted the four-digit level ISCO-08 code for the main job occupation to a two-digit level according to the international standard classification of occupations.), atypical work, the number of hours worked in the main job during the last 7 days (denoted as 'M_Actually_worked' in database), the authors converted the NACE Rev.2 four-digit level code for the kind of economic activity (referred to as 'Brunch' in database) to a three-digit level, the permanence of the job, authors mapped null values as 'No' for income sources across variables H2_1_Income_sources through H2_7_Income_sources.

In study was encoded categorical variables. If variable had only two categories, 0 and 1 was used. For example, in variable 'Sex' woman was encoded as 0 and man was encoded as 1. In 'Second Job' variable 'No' was encoded as 0 and 'Yes' was encoded as 1. All other categorical variables were encoded using One-Hot Encoding method using sklearn programming library with drop_first=True parameter. Authors removed rows with missing variables. At last authors got 12 362 rows and 258 columns in 2022-year data.

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

It used Random Forest algorithm for classification (Breiman, 2001). This method is based on decision trees. After that data was split in training and testing datasets using sklearn's train_test_split method, this method used shuffling (for research reproducibility *random_state=365* parameter was used). The size of test dataset was 10% of preprocessed data. Because of class imbalance problem in datasets stratification was used while splitting.

In study used balanced subsample method in Random Forest to deal with imbalanced classification (for research reproducibility *random_state=365* parameter was used). For hyperparameter tuning authors used randomized search cross-validation, where focusing hyperparameters were (some of them were from Bedianashvili et al., 2023):

Number of decision trees: [30, 37, 45, 53, 61, 68, 76, 84, 92, 100];
Maximum tree depth: [10, 14, 18, 22, 26, 30, 34, 38, 42, 46, 50, None];
Minimum samples required to split a node: [2, 5, 10];
Minimum samples required at each leaf node: [1, 2, 3, 4, 5, 6, 7];
Bootstrap sampling: [True, False].

As for randomized search cross-validation, number of iterations was 50 and cv parameter was 10.
After that for this model, the found hyperparameters were:

The number of trees were 92, minimum samples required to split a node was 2, the minimum samples required at each leaf node was 1, the maximum tree depth was 46, bootstrap sampling was True. The score was 0.7137115644411695.

Random Forest used balanced subsample here also.

Using balanced subsample method and these hyperparameters authors trained model and tested it using F1 (weighted) and Jaccard (micro) scores on test dataset. As for model performance, the F1 (weighted) score was 0.726 and Jaccard (micro) was 0.574.

5. Discussion

The analysis aims to comprehend the link between human capital and economic growth. It was included expenditures on education, healthcare, and the environment as components of human capital since investments in these sectors contribute to its development.

Therefore, the table below illustrates the cointegration analysis examining the relationship between economic growth and human capital (Table 7).

Table 7. The table below illustrates the cointegration analysis examining the relationship between economic growth and human capital

Null Hypothesis (H0) and Alternative Hypothesis (H1)	Result for Georgia	Result for Ireland	Result for Latvia	Result for Lithuania
H0: Human capital does not ➔ Y_capita H1: Human capital ➔ Y_capita	H0	H1	H0	H0
H0: Y_capita does not ➔ Human capital H1: Y_capita ➔ Human capital	H1	H0	H1	H0
H0: Human capital does not ➔ Y_gr H1: Human capital ➔ Y_gr	H0	H0	H0	H0
H0: Y_gr does not ➔ Human capital H1: Y_gr ➔ Human capital	H0	H0	H0	H1

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

The table above shows that for Georgia and Latvia, higher GDP per capita leads to higher spending on human capital, while for Ireland, spending on human capital drives higher GDP per capita. This result, combined with the findings above, is logical: countries with rising GDP per capita are investing more in human capital, such as education, healthcare, and the environment, which in turn stimulates economic activity and increases GDP per capita. Additionally, expenditure on education is crucial, especially as environment and climate issues become more prominent, illustrating a bidirectional relationship where economic growth enables more environment spending, which is a form of human capital spending that fosters further economic growth.

In conclusion, it should be noted that spending on human capital does not directly cause economic growth, and this finding can be attributed to various factors. The analysis was constrained by the limited time period, hindering a comprehensive examination of time series with structural variables. The impact of spending on the economy may take years to manifest, underscoring the importance of considering time lags. Moreover, a possible reason could be that a bachelor's degree is sometimes not tailored to real-world practice. Hence, spending on education might not be the right instrument to drive economic growth. Additionally, Georgia is at a developmental stage where prioritizing economic growth is necessary for a shift towards emphasizing capital spending over current spending. The public spending categories analyzed primarily constituted current spending, which typically garners more attention in later stages of development. This trend is observed in other countries that also redirected focus towards education and the environment after reaching a specific stage of development.

From the results of the empirical research, it can be seen that the trace cointegration test confirms that there is 1 cointegration vector (at the 0.05 level) between the GDP per capita and spending on the environment for Georgia. The probability of the null hypothesis about no cointegration vector was set at 0.0074, meaning that the p-value is statistically significant, which implies rejecting the null hypothesis. The alternative hypothesis about at most 1 cointegration vector has the probability at 0.2851, and therefore, it cannot reject this hypothesis, meaning that there is 1 cointegration vector. The same result is from the Maximum Eigenvalue test, with null hypothesis of no cointegration vector and alternative hypothesis of at most 1 cointegration vector. Null hypothesis has the probability at 0.0065, which is statistically significant, and it must reject it, while alternative hypothesis has the p-value at 0.2851, so one cannot to reject this hypothesis and say that there is 1 cointegration vector between the GDP per capita and spending on environment.

Using the Granger Causality test, it turned out that P-value for the null hypothesis that spending on environment causes GDP per capita is 0.7596 with the F-statistic 0.28353, which shows that it is not statistically significant and hence, cannot be reject null hypothesis. This confirms that spending on environment does not cause GDP per capita at this point. On the other hand, another null hypothesis indicates that GDP per capita causes spending on the environment; this has a probability of 0.0356, which is less than 5 per cent and F-statistic is higher, 4.94484. Therefore, one can conclude that can reject the null hypothesis and confirm that GDP per capita causes spending on environment in Georgia.

The possible reason for the abovementioned aspect is that spending on human capital is spending on education, healthcare, and the environment, which creates healthy and educated people who are capable of working better and hence, they are more expected to contribute to the economy. On the other hand, when a country has a higher GDP per capita, it is already in the developing stage and starting to have more concentration on the human capital aspects, such as the education of its population, healthcare and climate-related issues.

It is meaningful to interpret models; sometimes, imbalance of classes and multicollinearity might affect insights, and balanced subsampling can alleviate imbalanced class problems. There are different approaches to get insights from models and data, but authors made interpretation using Shapley values (Shapley, 1951) with Python SHAP library (Lundberg and Lee, 2017). The authors used the TreeExplainer algorithm (Lundberg et al., 2020) on test

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

datasets; this algorithm reduces the effects of multicollinearity. The algorithm gave results. Variables are ranked in descending order by average impact on model output magnitude on Diagram 1.

As for 2022-year model, the most important variables are sex, actually worked hours, age and education level of master's degree or equivalent as displayed on Diagram 1. It is meaningful to consider that SHAP is interpreting here categorical variables as dummy variables after One-Hot Encoding, but the main interest of the study is to interpret individual categories.

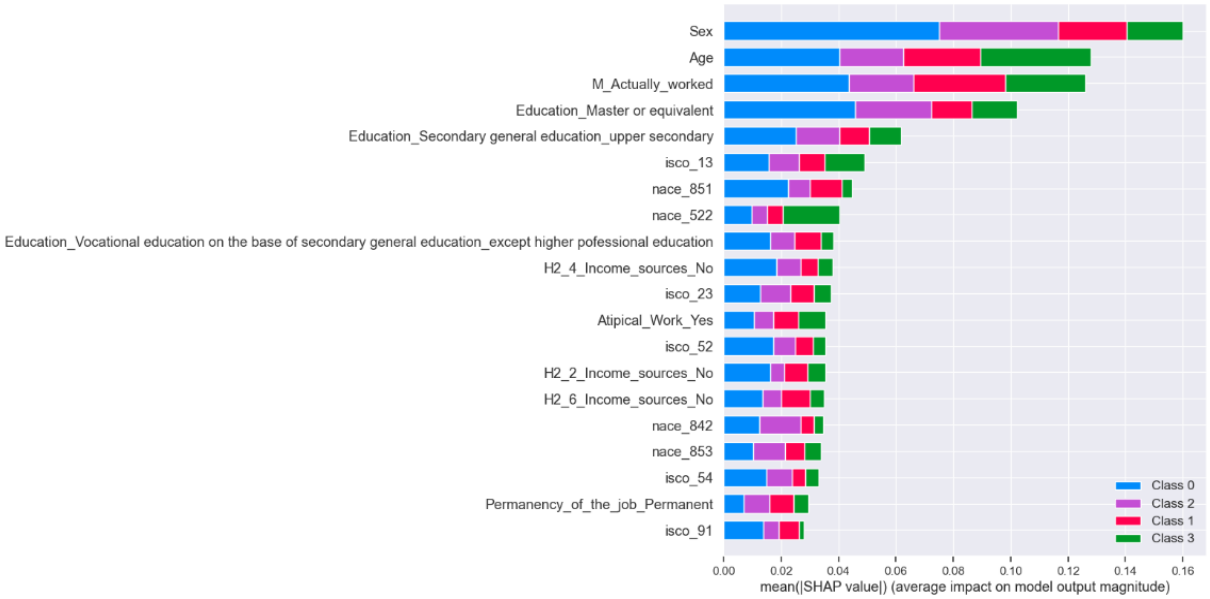


Diagram 1. Average impact on model output magnitude

Next, it's important to interpret features for individual classes. To illustrate the results, it is interesting to consider the year 2022. Diagram 2 shows variable impact for individual classes for 2022-year model.

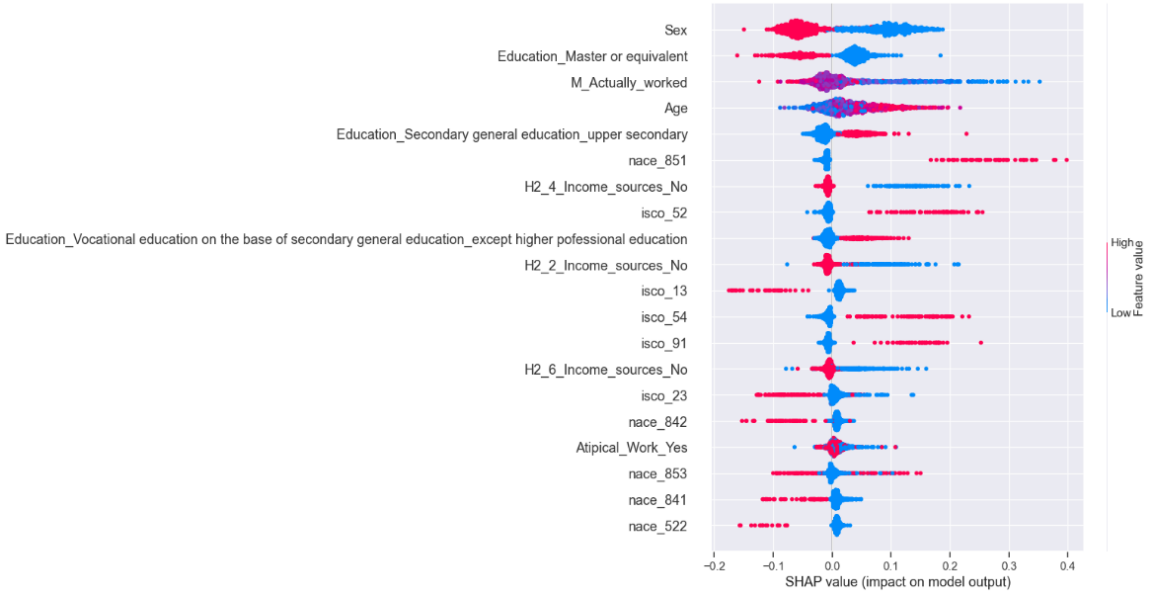
Diagram 2(I) shows the main factors for which the model classifies a particular observation as having a net income of 600 GEL or less. Males are less likely to be included in this class compared to females, increasing actually worked hours per week decreases the probability of inclusion the person in this class, people with master's degree and equivalent are less likely to be included in this class. Older people and people whose highest-level education is secondary general education/upper secondary are more likely to be included in this class. If the person works in economic activity, which NACE Rev.2 code is 85.1 (Pre-primary education), then the model will more likely include the person in this class. Diagram 2(II) shows the main factors for which the model classifies a particular observation as having a net income from 601 GEL to 1 000 GEL. Here actually worked hours per week and age are the most important factors, but these require further analysis. Males are more likely to be included in this class than females. Education shows a nonlinear relationship, but people with master's degrees are more likely to be included in this class. Diagram 2(III) shows the main factors for which the model classifies a particular observation as having a net income from 1 001 GEL to 2 000 GEL. Males, people with master's degree, teaching professionals (ISCO-08 sub-major group 23) or equivalent are more likely to be included in this class.

In contrast, people whose highest education level is secondary general education/upper secondary are less likely to be included here. Diagram 2(IV) shows the main factors for which the model classifies a particular observation

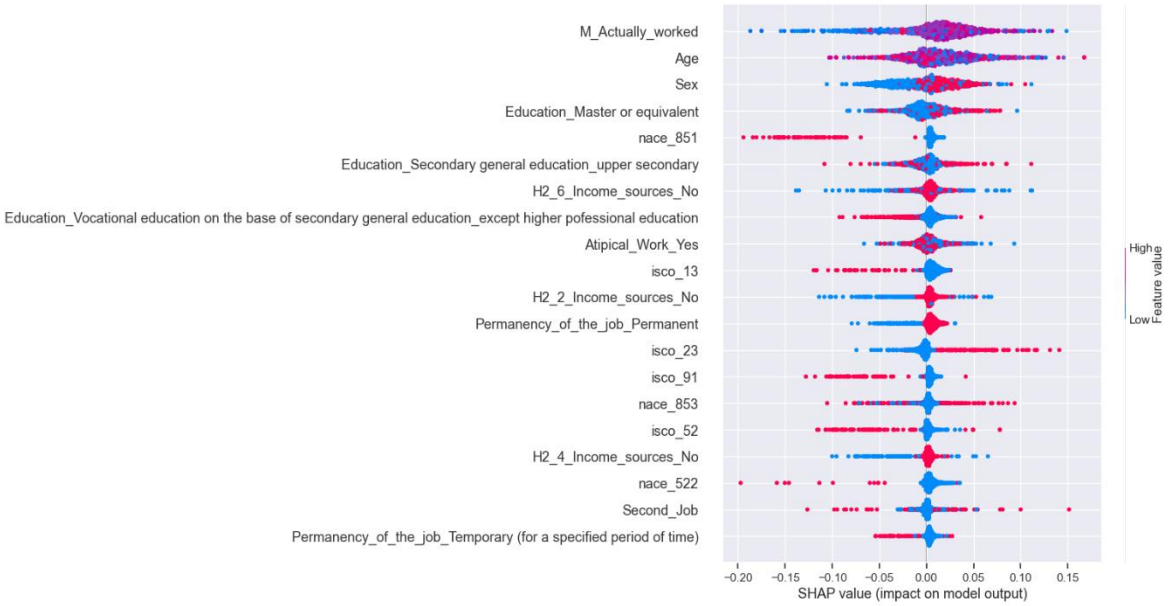
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

as having a net income from 2 001 GEL or more. Older people are less likely to be included here. Still, males, people with master's degrees or equivalent, production and specialized services managers (ISCO-08 sub-major group 13), and people who work in economic activity NACE Rev. 2 52.2 (Support activities for transportation) are more likely to be included here.

I

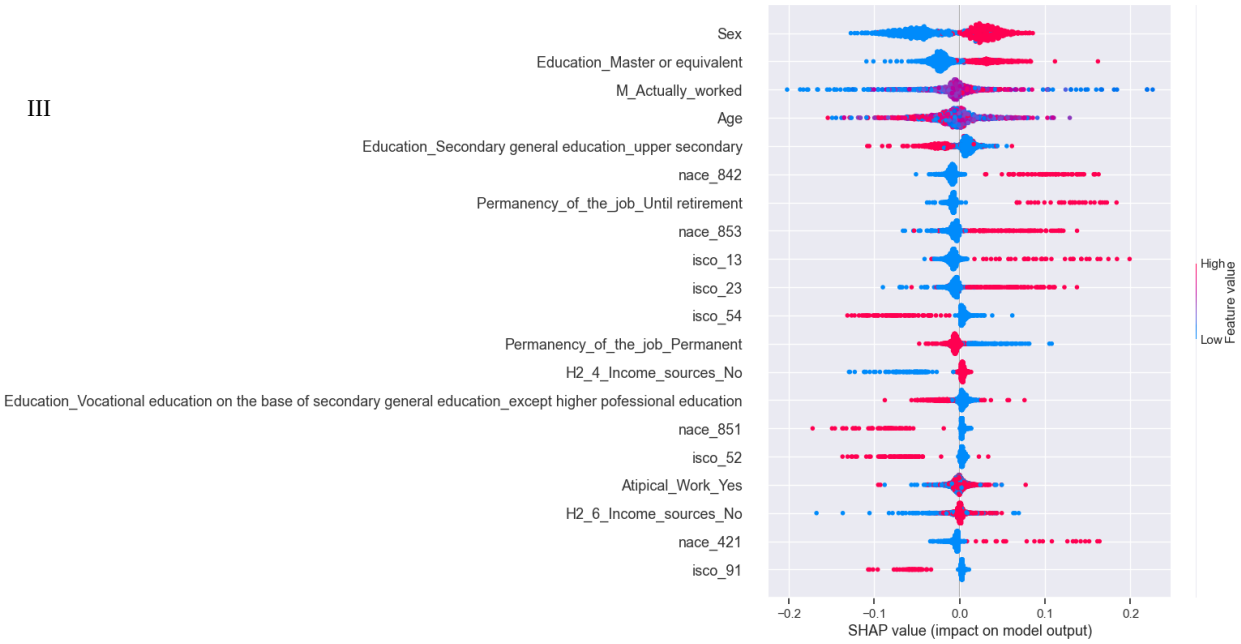


II



ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

III



IV

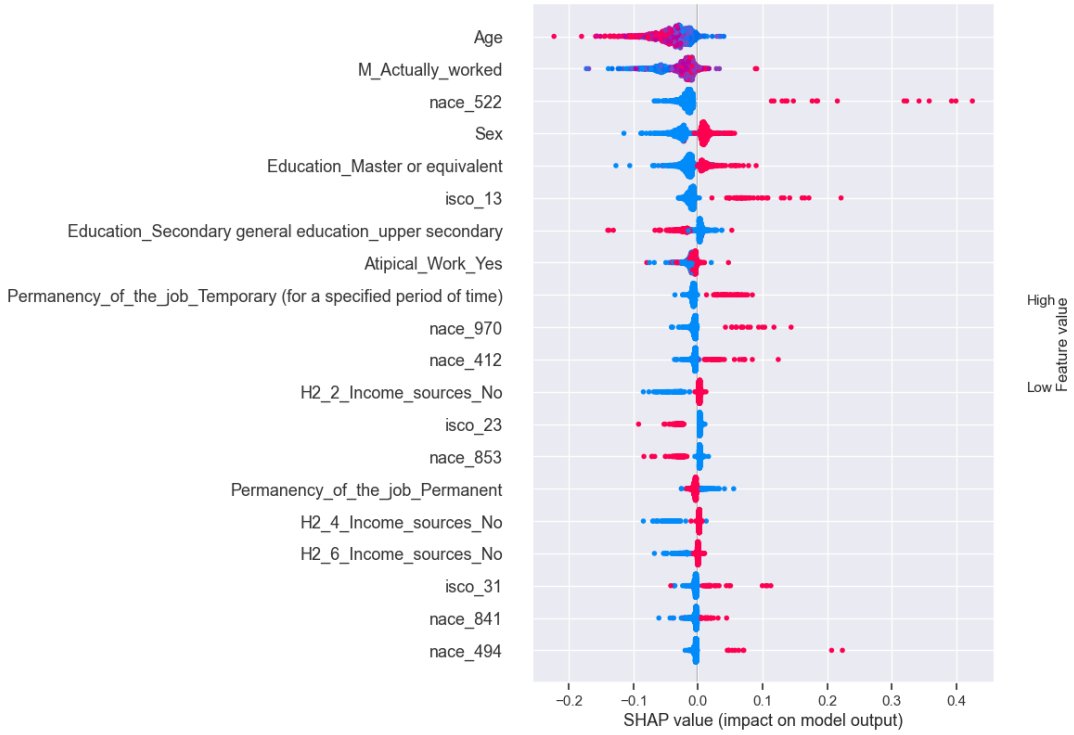


Diagram 2. 2022-year model summary plots for individual classes

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

6. Conclusion and Recommendations

The examination of the previous period reveals that the contemporary global and national economies are characterized by a new, distinctively confrontational nature of globalization. Amidst confrontational globalization, heightened uncertainty emerges as a pivotal macrosystemic challenge, underscoring the critical importance of maintaining stability within the socio-economic systems of individual countries. Human capital remains crucial in the face of confrontational globalization.

Spending on human capital may not immediately affect economic growth due to long-term effects and structural inefficiencies. Developing social infrastructure like healthcare and social security is vital for overall well-being and economic growth.

Countries that invest in human capital tend to achieve higher GDP per capita. Conversely, countries with rising GDP per capita are more likely to increase their spending on human capital.

One potential explanation for the phenomenon is that investments in human capital - such as education, healthcare, and environmental protection - lead to a healthier and more educated population. These individuals are better equipped to contribute to the economy. Conversely, countries with higher GDP per capita are often already on a path of development and tend to prioritize human capital factors like education, healthcare, and environmental sustainability.

The results show that in Georgia, higher GDP per capita causes more expenditure on human capital, which combines education, healthcare, and environment. However, during the detailed analysis, more impact was visible on the spending on healthcare and the environment. Spending on the environment can be explained by the recent interest in climate issues, as climate-related risks create additional pressure on the economy. Hence, countries realized that it is crucial to consider climate aspects and increase environmental financing. On the other hand, spending on healthcare is vital as it affects productivity and can affect economic activity. At the same time, countries with high GDP per capita are more concerned about the improvement of the healthcare system in the economy.

The study showed that Georgia needs a holistic approach to human capital development. Initial levels of education may not strongly impact worker earnings, emphasizing the need for quality institutions. Professional education should be integrated and elevated within the broader education system.

As a result, the study recommends that to overcome the uncertainty surrounding the future workforce, the education of business founders and professionals should prioritize the development of skills oriented to future trends, with a focus on facilitating the forming of adaptation skills.

The next research focus will be on examining how digital transformation and AI influence human capital development and economic growth. Additionally, it will comprehensively explore the impact of life expectancy on economic growth, the effect of education quality on economic activity, and the influence of the environment on productivity.

References

Acemoglu, D. (2002). Technical change, inequality, and the labor market. *Journal of Economic Literature*, 40(1), 7-72. https://doi.org/10.1257/jel.40.1.7

Altmann A., Tolo L., Sander O. & Lengauer T. (2010). Permutation importance: a corrected feature importance measure, *Bioinformatics*, 26(10), 1340-1347. https://doi.org/10.1093/bioinformatics/btq134

Barro R. J. (2001). Human capital and growth. American Economic Review (Papers and Proceedings), 91(2), 12-17. https://doi.org/10.1257/aer.91.2.12

Barro, R. J. (1991). Economic Growth in a Cross Section of Countries. *Quarterly Journal of Economics*, 106(2), 407-443. https://doi.org/10.2307/2937943

Becker, G.S. (1964). Human Capital. - Columbia University Press.

Bedianashvili, G. (2021). Macroeconomic and Cultural Determinants of the COVID-19 pandemic crisis. *Bulletin of the Georgian National Academy of Sciences*, 15(2), 191-197. https://doi.org/10.2139/ssrn.4228000

Bedianashvili G. (2023). Macrosystemic Challenges of Uncertainty under the Conditions of Confrontational Globalization. *Bulletin of the Georgian National Academy of Sciences*. 17(2), 174-179. https://doi.org/10.2139/ssrn.4609000

Bedianashvili, G., Tsartsidze, M., Mikeladze, N., & Gabroshvili, Z. (2023). Modern Globalization, Human Capital and Economic Growth in Georgia: Macro Aspect. *Ekonomisti*, 19(3), 60-84 (In Georgian).

Bedianashvili, G., & Kokhreidze, G. (2024). Global Sustainable Competitiveness for Countries on the Way Toward EU Integration. *TEM journal*, 13(2), 1684-1694. https://doi.org/10.18421/TEM132-81

Berestycki, C., Carattini, S., Dechezleprêtre, A., & Kruse, T. (2022). Measuring and assessing the effects of climate policy uncertainty. OECD. Economics Department Working Papers, No. 1724, OECD Publishing, Paris, https://doi.org/10.1787/34483d83-en

Blaug, M. (1976). The Empirical Status of Human Capital Theory: A Slightly Jaundiced Survey. *Journal of Economic Literature*, 14(3), 827-855.

Bloom, D.E., Canning, D., & Sevilla, J. (2004). The Effect of Health on Economic Growth: A Production Function Approach. *World Development*, 32(1), 1-13. https://doi.org/10.1016/j.worlddev.2003.07.002

Breiman, L. (2001). Random Forests. *Machine Learning*, 45, 5-32. https://doi.org/10.1023/A:1010933404324

Bulina, A., Mozgovaya, K., & Pakhnin, M. (2020). Human capital in economic growth theory: Classical models and new approaches. *St Petersburg University Journal of Economic Studies*, 36(2), 163-188. https://doi.org/10.21638/spbu05.2020.201

Chakrabarty N. & Biswas S. (2018). A Statistical Approach to Adult Census Income Level Prediction. International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), Greater Noida, India, 207-212. https://doi.org/10.1109/ICACCCN.2018.8748528

Deming, D.J. (2022). Four Facts about Human Capital. *Journal of Economic Perspectives*, 36(3),75-102. https://doi.org/10.1257/jep.36.3.75

EaP (2022). Developing Long-Term Climate Strategies in the EU Eastern Partnership countries. UNDP. https://doi.org/10.1787/34483d83-en

Galor, O., & Weil, D.N. (2000). Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond. *American Economic Review*, 90(4), 806-828. https://doi.org/10.1257/aer.90.4.806

Hanushek, E.A., & Woessmann, L. (2008). The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature*, 46(3), 607-668. https://doi.org/10.1257/jel.46.3.607

Jones, B.F. (2014). The Human Capital Stock: A Generalized Approach. *American Economic Review*, 104(11), 3752-3777. https://doi.org/10.1257/aer.104.11.3752

Kuznets, S. (1955). Economic Growth and Income Inequality. *American Economic Review*, 45(1), 1-28.

Lee, J.W. (2001). Education for Technology Readiness: Prospects for Developing Countries. *Journal of Human Development*, 2(1), 115-151. https://doi.org/10.1080/14649880120050

Lucas, R.E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), 3-42. https://doi.org/10.1016/0304-3932(88)90168-7

Lucas, R.E. (2015). Human Capital and Growth. American Economic Review: Papers and Proceedings, 105(5), 85-88. https://doi.org/10.1257/aer.p20151065

Lundberg S. M., & Lee S.-I., (2017). A Unified Approach to Interpreting Model Predictions. In I. Guyon, U. V. Luxburg, S. Bengio, H. Wallach, R. Fergus, S. Vishwanathan, & R. Garnett (Eds.), Advances in Neural Information Processing Systems 30, 4765-4774. Curran Associates, Inc. http://papers.nips.cc/paper/7062-a-unified-approach-to-interpreting-model-predictions.pdf

Lundberg, S.M., Erion, G., Chen H., DeGrave, A., Prutkin, J.M., Nair, B., Katz, R., Himmelfarb, J., Bansal, N. & Lee, S.I. (2020). From local explanations to global understanding with explainable AI for trees. *Nat Mach Intell*, 2, 56-67. https://doi.org/10.1038/s42256-019-0138-9

Mankiw N.G., Romer D., & Weil D.N. (1992). A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics*, 107(2), 407-437. https://doi.org/10.2307/2118477

Manuelli, R.E., & Seshadri, A. (2014). Human Capital and the Wealth of Nations. *American Economic Review*, 104(9), 2736-2762. https://doi.org/10.1257/aer.104.9.2736

Mincer, J. (1958). Investment in Human Capital and Personal Income Distribution. *Journal of Political Economy*, 66(4), 281-302. https://doi.org/10.1086/258055

Nelson, R., & Phelps, E. (1966) Investment in Humans, Technological Diffusion, and Economic Growth. *The American Economic Review*, 56, 69-75.

Papava, V. (2022a). Pandemic, War and Economic Sanctions: From Turbulent to Confrontational Globalization. Available at SSRN https://doi.org/10.2139/ssrn.4119601

Papava, V., (2022b). On Illegal Globalization, or Can Globalization Ever End? Eurasia Review, December 19. https://www.eurasiareview.com/19122022-on-illegal-globalization-or-can-globalization-ever-end-oped/

Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., Thirion, B., Grisel, O., Blondel, M., Prettenhofer, P., Weiss, R., Dubourg, V., Vanderplas, J., Passos, A., Cournapeau, D., Brucher, M., Perrot, M., & Duchesnay, E. (2011). Scikit-learn: Machine Learning in Python. *Journal of Machine Learning Research*, 12, 2825-2830.

Psacharopoulos, G., & Patrinos, H.A. (2004). Returns to Investment in Education: A Further Update. *Education Economics*, 12(2), 111-134. https://doi.org/10.1080/0964529042000239140

Romer, P.M. (1990). Endogenous Technological Change. *Journal of Political Economy*, 98 (5, Part 2), 71-102. https://www.jstor.org/stable/2937632

Sachs, J., Lafortune, G., Kroll, C., Fuller, G., & Woelm, F. (2022). From Crisis to Sustainable Development: the SDGs as Roadmap to 2030 and beyond. Sustainable Development Report 2022. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781009210058

Schultz, T.W. (1961). Investment in Human Capital. *American Economic Review*, 51(1), 1-17.

Shapley, L. (1951). Notes on the N-Person Game - II: The Value of an N-Person Game. RAND Corporation.

Sharma, R. (2018). Health and economic growth: Evidence from dynamic panel data of 143 years. *PLoS ONE*, 13(10), 1-20, e0204940. https://doi.org/10.1371/journal.pone.0204940

Smith, A. (1938). *An Inquiry into the Nature and Causes of the Wealth of Nations*. Translated from English by F. Gogichaishvili. State University Press. Tbilisi (In Georgian).

Solow, R.M. (1991). Growth Theory. In: Companion to Contemporary Economic Thought. M. Bleaney, D. Greenaway, I. Stewart (eds.). London, Routledge.

Solow, R.M. (1956). A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics*, 70(1), 65-94. https://doi.org/10.2307/1884513

Swan, T.W. (1956). Economic Growth and Capital Accumulation. *Economic Record*, 32(2), 334-361. https://doi.org/10.1111/j.1475-4932.1956.tb00434.x

Tahir, M., Hayat, A., Rashid, K., Afridi, M.A., &Tariq, Y.B. (2020). Human capital and economic growth in OECD countries: some new insights. *Journal of Economic and Administrative Sciences*, 36(40), pp. 367-380. https://doi.org/10.1108/JEAS-07-2019-0073

The World Bank Group (2021). Climate Risk Country Profile: Georgia, February 7, at online. https://openknowledge.worldbank.org/handle/10986/36382

The World Bank Group. (2022). The Climate Change Action Plan 2021-2025: Supporting Green, Resilient, and Inclusive Development. January 11, at online https://reliefweb.int/report/world/world-bank-group-climate-change-action-plan-2021-2025-supporting-green-resilient-and?gclid=CjwKCAiAuaKfBhBtEiwAht6H7-hqp9BfcaxQMLEDDL74uQXAtAakZUxz1ENm0eKyaJAs-MslKcRZXxoCqisQAvD_BwE

UNDP (February 19, 2015). What is Human Development? https://hdr.undp.org/content/what-human-development

Uzawa H. (1965). Optimum Technical Change in an Aggregative Model of Economic Growth. *International Economic Review*, 6(1), 18-31. https://doi.org/10.2307/2525621

Weil, D. (2007). Accounting for the effect of health on economic growth. *The Quarterly Journal of Economics*, 122(3), 1265-1306. https://doi.org/10.1162/qjec.122.3.1265

World Bank. (2018). The Human Capital Project. © World Bank, Washington, DC. http://hdl.handle.net/10986/30498

World Bank. (2020). The Human Capital Index 2020 Update: Human Capital in the Time of COVID-19. © World Bank, Washington, DC. http://hdl.handle.net/10986/34432

Authors Contributions: Conceptualization: *Givi Bedianashvili*; methodology: *Givi Bedianashvili; Tsartsidze Murman; Nino Mikeladze; Zviad Gabroshvili*; data analysis: *Givi Bedianashvili; Murman Tsartsidze; Nino Mikeladze; Zviad Gabroshvili;* writing—original draft preparation: *Givi Bedianashvili; Murman Tsartsidze; Nino Mikeladze; Zviad Gabroshvili*; writing; review and editing: *Givi Bedianashvili; Nino Mikeladze*; visualization: *Givi Bedianashvili; Nino Mikeladze; Zviad Gabroshvili*. All authors have read and agreed to the published version of the manuscript.

ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2024 Volume 12 Number 1 (September)
http://doi.org/10.9770/jesi.2024.12.1(19)

Givi BEDIANASHVILI is Dr. Sc. oec., Professor (associate) at Ivane Javakhishvili Tbilisi State University (Georgia); Professor at Grigol Robakidze University; Professor at European University. His research interests include macroeconomics, econometrics, economic modeling, economic growth, human capital, green economy and sustainable development, entrepreneurship, systems research, digital economy and business, cultural factor in economy and business.
ORCID ID: https://orcid.org/0000-0003-4521-737X

Murman TSARTSIDZE is Dr. Sc. oec., Professor (associate) at Ivane Javakhishvili Tbilisi State University (Georgia). His research interests include labor market, labor productivity, human capital, macroeconomics, employment and unemployment problems.
ORCID ID: https://orcid.org/0000-0003-2681-6713

Nino MIKELADZE is PhD student at Ivane Javakhishvili Tbilisi State University (Georgia). Her research interests include economic analysis, fiscal policy, applied econometrics, economic forecasting, human capital, and developing countries.
ORCID ID: https://orcid.org/0009-0008-1214-7241

Zviad GABROSHVILI is a Master of Economics, Ivane Javakhishvili Tbilisi State University (Georgia). His research interests include macroeconomics, machine learning, economic growth, public debt, computational economics, and human capital.
ORCID ID: https://orcid.org/0009-0007-7597-5987