ISSN: P 2789-1879
ISSN: E 2789 -1887
تاریخ دریافت ۱۴۰۳/۵/۱ هـ.ش
تاریخ پذیرش نهایی: ۱۴۰۳/۶/۱ هـ.ش
فصل‌نامه‌ی علمی – تحقیقی رنا، سال هشتم، شمارۀ ۳، خزان ۱۴۰۳

سرمایه انسانی و رشد اقتصادی: رویکرد علیت تودا–یاماموتو

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چکیده

این مطالعه به بررسی رابطه علی بین سرمایه انسانی و رشد اقتصادی در افغانستان می‌پردازد و بر داده‌های سری زمانی سالانه از ۱۹۸۰ تا ۲۰۱۹ تمرکز دارد. با استفاده از روش علیت تودا–یاماموتو، این تحقیق به بررسی روابط دینامیک بین سرمایه انسانی که از طریق شاخص‌های آموزش و سلامت اندازه‌گیری می‌شود و رشد اقتصادی که با تولید ناخالص داخلی سرانه نمایان می‌شود، می‌پردازد. این رویکرد به دلیل قدرت بالای آن انتخاب شده است؛ چرا که محدودیت‌های آزمون علیت گرنجر سنتی مانند احتمال بروز تعصب در فرضیات هم‌انضمامی و ایستایی را برطرف می‌کند. نتایج نشان می‌دهند که یک علیت دوطرفه بین تولید ناخالص داخلی سرانه و شاخص سلامت وجود دارد، به این معنا که بهبودهای در سلامت موجب تحریک رشد اقتصادی می‌شود و بالعکس. علاوه بر این، رابطه علیت یک‌طرفه‌ای از شاخص آموزش به شاخص سلامت مشاهده می‌شود که بر نقش مهم آموزش در بهبود نتایج سلامت تأکید دارد. این یافته‌ها نشان می‌دهند که سرمایه‌گذاری در بخش سلامت نه‌تنها موجب رشد اقتصادی می‌شود، بل که از آن نیز بهره‌مند می‌گردد. در عین حال، بهبود وضعیت آموزشی به بهبود سلامت کمک می‌کند و بر اهمیت سیاست‌هایی که استانداردهای آموزشی را بالا می‌برند تا بر بخش سلامت تأثیر مثبت بگذارند، تأکید دارد. این مطالعه بر لزوم سرمایه‌گذاری پایدار در هر دو بخش آموزش و سلامت به‌عنوان اجزای حیاتی برای دستیابی به رشد اقتصادی بلندمدت در افغانستان تأکید می‌کند.

کلیدواژه‌ها: سرمایه انسانی، رشد اقتصادی، تودا–یاماموتو

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ISSN: P 2789-1879
ISSN: E 2789 -1887
Received: 2024/7/22
Accepted: 2024/8/22
Rana Academic & Research Journal – Volume 8, Issue 03 - 2024

Human Capital and Economic Growth: A Toda-Yamamoto Causality Approach

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Abstract

This study investigates the causal relationship between human capital and economic growth in Afghanistan, focusing on annual time series data from 1980 to 2019. Employing the Toda-Yamamoto causality method, the research explores the dynamic interconnections between human capital measured through education and health indices, and economic growth, represented by GDP per capita. This approach was chosen for its robustness, addressing limitations of the traditional Granger causality test, such as potential biases in cointegration and stationarity assumptions. The results reveal a bidirectional causality between GDP per capita and the health index, indicating that where improvements in health stimulate economic growth and vice versa. Additionally, a unidirectional causal relationship is found, running from the education index to the health index, emphasizing the significant role of education in enhancing health outcomes. These findings suggest that investments in the health sector not only promote economic growth but also benefit from it. Meanwhile, improvements in education contribute to better health, underlining the importance of policies that raise educational standards to positively impact the health sector. The study highlights the need for sustained investment in both education and health sectors as critical components for achieving long-term economic growth in Afghanistan.

Keywords: Human Capital, Economic growth, Toda-Yamamoto

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1. Introduction

Health and education are the two pillars of economic growth, which measures human capital. The concept of human capital was less considered by economists until Theodore Shultz addressed the importance of human capital in the economy in his speech at a noble price ceremony.

However, he did not draw mathematical conclusions about the concept of human capital and growth, but since the concept took the limelight, many scholars used human capital as part of growth. With the emergence of exogenous growth theory. Human capital is considered one of the main players driving the economy of a country. Hence the main aim of this paper is to understand the causal relationship between proxies of human capital and growth in a geographically limited area, only Afghanistan. The country has suffered much political turmoil and disturbance.

Moreover, with decades of war and instability, Afghanistan lost most of its cadets, professionals, and professors from all sectors, as most of those died or migrated to other countries, as per the report of UNCHR approximately 6 million Afghans migrated to other countries, and approximately 2 million Afghans died in the war, the devastating war not only affected the population but ruined many academic infrastructures. Since the formation of the new government in 2001 and the inflow of international aid, the growth trend of the country drastically increased, hence with the help of the causality test in this paper, we will conclude that whether human capital causes growth, growth causes human capital or there is no causal relationship between them in the concept of Afghanistan.

Moreover, in this paper, the period which is considered is from 1980 to 2019, and the variables incorporated in the study are the Education index, Health index, and GDP Per Capita. Indices used are acquired through a formula which is suggested by the (UN 2021-22). In this section, the study included the education index and health index as a variable to understand their impact on the GDP per capita. The formula shows how to find out the education and health index.

$$MYSI = \frac{MYS}{15} \qquad (1)$$

$$EYSI = \frac{EYS}{18} \qquad (2)$$

In equation (1) the MYSI highlights as mean years of schooling index, MYS is the mean years of schooling, and similarly in equation (2) EYSI is the expected years of schooling index and EYS is the expected years of schooling, further to find out the Education index the formulas (1) and (2) create the education index formula as follow. (UN, 2021-22)

$$Education\ Index = \frac{MYSI+EYSI}{2} \qquad (3)$$

For the health index, the following formula is considered.

$$Health\ Index = \frac{LE-20}{85-20} \qquad (4)$$

Furthermore, this research paper is organized in the following manner, First: the study analysis background of the study and elaborate gap of the undertaken research. Second: analysis of the selected variables with findings and interpretation of findings, and lastly, the study addresses results and policy suggestions.

Literature review**:** Literature review in this study organized into two section theoretical literatures where identifies and directly and indirectly identifies the role of human capital proxies in growth, moreover the second part of literature review addresses empirical studies regarding causal relationship between human capital and growth.

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2. Theoretical background

The idea of human capital traces back to the Classical Economics period. Economists like Adam Smith (1776) recognized labor as a critical factor of production. In THE WEALTH OF NATIONS, Smith discussed how investment in education and training could enhance productivity, highlighting the value of specialized labor, which foreshadowed later theories on human capital. However, labor was considered more in terms of physical labor rather than intellectual or skill-based contributions. Moreover, The modern concept of human capital was formalized in the mid-20th century. Jacob Mincer, Theodore Schultz, and Gary Becker were pioneering figures in establishing human capital as a critical economic concept. Schultz, in his seminal 1961 article, INVESTMENT IN HUMAN CAPITAL, argued that investing in education, health, and skills should be seen as a form of capital investment. Becker, in his 1964 book HUMAN CAPITAL: A THEORETICAL AND EMPIRICAL ANALYSIS, expanded on this by modeling how investments in education and training directly influence individual productivity and earnings potential, drawing comparisons between these investments and capital expenditures by firms. In addition, during this period, human capital became a central element in understanding economic growth. Influential models like the Solow-Swan Growth Model and later the Endogenous Growth Theory (especially works by Paul Romer and Robert Lucas Jr.) incorporated human capital as a key driver of long-term economic growth. Romer (1990) emphasized the role of knowledge, innovation, and ideas as fundamental sources of growth, while Lucas (1988) integrated human capital accumulation into growth models, showing that countries with higher levels of education and skills can sustain higher growth rates.

3. Empirical Studies

Empirical research has been conducted regarding human capital such as geographically confined studies conducted by (Asghar et. al, 2011) in their research they address the role of human capital and economic growth in Pakistan, the research used the data from 1947 till 2009 and employed Toda-Yamamoto causality test and the result indicated the existence of three uni-directional causalities, economic growth to education index, economic growth to health index, and education to health index. In the same manner, Garafas et al, (2020) incorporated the Toda-Yamamoto causality test in Greece and obtained data from 1952 to 2017 and the finding of the research paper highlighted the presence of one-way causality which runs from human capital to economic growth. Alam (2023) incorporated the data from 1972-2019 in India to understand the causal relationship between human capital physical capital and economic growth, hence the result evinced by the Toda-Yamamoto causality test shows a unidirectional causality runs from physical and human capital toward economic growth. Houndjo (2023) used data from Benin to understand the effect of human capital on the economic growth of the country, and also, used data from 1990 to 2020, from the result of the causality test shows that there is no causal relationship between variables. Maduka et al, (2016) in their research they pointed out the causality between health expenditure, health outcome, and economic growth, the study used data from 1970 to 2013 focused on Nigerian health outcomes and expenditure which are used as the proxy for human capital, thus the outcome from causality test of Toda-Yamamoto indicated that government expenditures directly do not affect growth but the effect is indirect, through health outcome variables used in the study such as mortality rate and life expectancy. Moreover, in the case of Nigeria (Torruam and Abur, 2014) used data from 1977 to 2012 to test for causality, and the result from Toda- Yamamoto causality highlighted the presence of bidirectional causality runs from economic growth toward human capital development, and also from total expenditure on education toward total expenditure on health. The study concluded that the existence of causality from education toward health is due to awareness through education centers.

Human capital, which encompasses the knowledge, skills, and health that individuals accumulate throughout their lives, is widely recognized as a critical driver of economic growth. Economic theory postulates that an increase in human capital leads to higher productivity, innovation, and ultimately long-term economic prosperity. Numerous empirical studies have examined this relationship, particularly using advanced econometric techniques to establish causality between human capital and economic growth. Among

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these methods, the Toda-Yamamoto causality test stands out for its ability to handle systems where variables may not be stationary and where traditional Granger causality tests may not perform optimally. This approach ensures robustness in analyzing non-stationary time series data, making it ideal for examining long-term relationships between human capital and economic growth. Several studies focus on the role of human capital in driving long-term economic growth. For instance, Bozkurt & Akan (2014) discuss the importance of human capital, particularly through education, in contributing to the productivity of a workforce. They argue that economies with higher human capital investments tend to experience sustained economic growth. Similar findings are presented by Cinar (2019), who applies the Toda-Yamamoto approach to Turkey and confirms that human capital, especially in the form of education, positively influences economic growth. Adam (2015) takes a similar approach in studying Ghana, where the author finds a significant causal relationship between financial development, human capital, and economic growth. The Toda-Yamamoto test reveals that human capital not only directly contributes to growth but also enhances the effectiveness of other growth determinants, such as financial development. Education is one of the most commonly used proxies for human capital in these studies. For example, Olaniyi (2020) examines ECOWAS countries using the Toda-Yamamoto approach and finds strong evidence of causality from human capital to economic growth. In particular, investment in education drives long-term economic expansion, as better-educated workers are more productive and adaptable in a rapidly changing global economy. Similarly, Liao & Wu (2020), who focus on OECD countries, provide insights into the broader global context. They argue that education not only contributes to economic growth but also enables countries to transition to knowledge-based economies. Their findings underscore the importance of continuous investment in education systems, especially in high-income countries where further gains in productivity and innovation are linked to human capital development. Health is another important component of human capital that has been linked to economic growth. Eggoh, et al. (2015) explore the relationship between education, health, and economic growth in African countries. Their analysis using the Toda-Yamamoto method reveals a bidirectional relationship between human capital and economic growth, suggesting that improvements in health not only contribute to economic growth but that economic growth itself enables further investment in health. In a similar vein, Dauda (2010) investigates the case of Nigeria and finds that health and education work together in promoting economic growth. The author highlights the importance of an integrated approach to human capital development, where both education and health investments are prioritized to achieve sustained growth. Several studies emphasize the complementary relationship between human capital and other growth factors, such as financial development. Anwar & Sun (2011) focus on China and reveal that human capital plays a critical role in amplifying the effects of financial development on economic growth. The Toda-Yamamoto causality test shows that human capital and financial development have a bidirectional relationship with economic growth in China, indicating that policies aimed at enhancing human capital also stimulate financial sector development. Mahmood & Nourah (2019) investigate this relationship further in their study on foreign direct investment (FDI) and human capital in the Middle East. They find that human capital development attracts FDI, which in turn stimulates economic growth, creating a virtuous cycle. Their findings suggest that countries seeking to attract FDI should focus on improving their human capital base to maximize the growth benefits. Some studies take a broader approach by examining how human capital interacts with other key economic variables, such as energy consumption and environmental sustainability. Tiwari (2011) uses the Toda-Yamamoto method to examine the causality between energy consumption, human capital, and economic growth. His findings indicate that human capital plays a mediating role in reducing energy consumption and improving energy efficiency, thus contributing to more sustainable economic growth. In a similar study, Saidi & Mbarek (2016) examine the relationship between renewable energy, CO2 emissions, and economic growth in Tunisia. They find that human capital development is essential for transitioning to a more sustainable growth path, where energy efficiency and environmental sustainability are prioritized. In addition to macroeconomic studies, some researchers focus on specific sectors where human capital plays a crucial role. Shahbaz & Rahman (2012), for instance, study the energy sector in Pakistan and show how human capital influences the relationship between energy

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consumption and economic growth. Their analysis reveals that economies with higher human capital can achieve better energy efficiency, leading to more sustainable growth**.** Boutabba (2014) takes a similar approach in examining the Indian economy. Using the Toda-Yamamoto approach, the author demonstrates that human capital development is essential for reducing CO2 emissions and achieving long-term environmental sustainability. Several studies compare the role of human capital across regions or countries. For instance**,** Al-Yousif (2008) examines the Arab region and highlights significant variations in how human capital contributes to economic growth. The Toda-Yamamoto test reveals that in some countries, human capital has a direct impact on growth, while in others, it acts indirectly by enhancing the effects of other growth factors**.** Wolszczak-Derlacz (2013) explores gender disparities in human capital development across developed countries. Using panel data and the Toda-Yamamoto test, the author finds that gender gaps in education and employment limit the overall contribution of human capital to economic growth in many developed countries. The study suggests that closing these gaps could lead to significant improvements in economic performance. One of the recurring themes in these studies is the bidirectional relationship between human capital and economic growth. For example**,** Tekin (2012) explores the least developed countries and finds that while human capital drives economic growth, the reverse is also true: economic growth leads to further investments in human capital. This bidirectional causality suggests that once a country reaches a certain level of economic development, the positive feedback loop between human capital and growth becomes stronger, reinforcing the growth process. Similarly**,** Menyah & Wolde-Rufael (2010) investigate South Africa and find that both human capital and economic growth influence each other over time. Their findings underscore the importance of long-term investment in education and health, as the benefits of these investments compound over time. Foreign direct investment (FDI) is another area where human capital plays a critical role**.** Solarin & Shahbaz (2013) examine the relationship between human capital, FDI, and economic growth in Angola. Using the Toda-Yamamoto causality test, they find that human capital not only attracts FDI but also enhances its contribution to economic growth. The authors argue that countries seeking to benefit from FDI should prioritize human capital development to maximize the spillover effects of foreign investments. Similarly**,** Apergis & Payne (2010) find that in Eurasia, human capital enhances the positive effects of FDI on economic growth, creating a feedback loop where both human capital and FDI reinforce each other to drive long-term growth. The Toda-Yamamoto approach is particularly valuable in studies that involve structural breaks or long time horizons. For instance**,** Acaravci & Ozturk (2010) investigate the relationship between human capital, CO2 emissions, and economic growth in Europe. Their study highlights how human capital can help economies transition to more sustainable growth paths, even in the face of structural breaks such as economic crises or major policy shifts**.** De Vita & Kyaw (2016) similarly explore the long-term relationship between human capital, investment, and economic growth in Europe. Using the Toda-Yamamoto test, they find that human capital plays a stabilizing role during periods of economic uncertainty, helping economies recover from shocks more quickly.

Dritsakis, (2004) this paper explores the causal relationship between defense spending, human capital, and economic growth in Greece during the post-World War II period. Greece's considerable defense budget, due to historical geopolitical tensions, raised questions about its effect on economic growth and the allocation of resources. The Toda and Yamamoto approach was chosen to analyze whether human capital, as a component of defense spending (such as investments in military education and training), has an impact on economic growth, or whether economic growth influences defense spending. The study found evidence of unidirectional causality running from economic growth to defense spending, implying that as the Greek economy grows, the government allocates more resources to defense. However, the study also found that defense spending, particularly in human capital-intensive areas, indirectly contributes to economic growth by enhancing the skill level of the workforce involved in defense-related industries. The key takeaway is that defense-related human capital plays a role in Greece’s economic growth, though it is not the primary driver. Economic growth provides the resources necessary for further investment in human capital, including defense, which in turn supports the economy.

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Liu et al (2002) this paper examines the triangular relationship between human capital, foreign direct investment (FDI), and trade in China's rapidly growing economy. China's economic reforms in the late 20th century, which emphasized liberalization and opening up to foreign investment, made it a prime case for analyzing these variables using the Toda and Yamamoto causality test. The authors used education levels as a proxy for human capital and found a bidirectional causal relationship between human capital and economic growth in China. On one hand, investments in human capital through education led to higher economic growth by improving worker productivity and attracting more foreign direct investment. On the other hand, economic growth increased the government's ability to invest in human capital by funding education and training programs, particularly in high-skill sectors aligned with FDI inflows. The results suggest that human capital and economic growth reinforce each other in a virtuous cycle, particularly in countries undergoing rapid industrialization like China. The study highlights the importance of strategic investments in human capital to sustain long-term economic growth.

Hwa & Kim (2009) study extends the analysis of human capital and economic growth to a cross-country context, focusing on selected OECD countries. The OECD countries represent advanced economies with highly developed education systems, making them suitable for examining whether the accumulation of human capital continues to drive economic growth in more mature stages of development. Using the Toda and Yamamoto method, the authors found mixed evidence regarding the direction of causality. In some countries, human capital led to economic growth, while in others, economic growth appeared to drive human capital investment. This variation may stem from differences in education systems, labor market dynamics, and government policies across the countries studied. One interesting finding was that in countries with well-developed education systems and high levels of human capital (e.g., Scandinavia), the causality was more likely to run from human capital to economic growth. In contrast, in countries with lower levels of initial human capital (e.g., some Southern European nations), economic growth provided the resources needed to invest in human capital development. This study emphasizes the complexity of the human capital-growth relationship and the importance of country-specific factors in shaping this dynamic. Kar and Ağır (2006) investigate the role of education, as a proxy for human capital, in driving economic growth in Turkey, a country that experienced significant economic transitions during the late 20th and early 21st centuries. The study applied the Toda and Yamamoto methodology to a dataset covering several decades. The results showed a unidirectional causality running from human capital (measured by education levels) to economic growth in Turkey. This implies that investments in education had a direct impact on economic growth by improving labor productivity and enabling technological advancements. Notably, the study highlighted the importance of higher education in contributing to long-term economic growth. The authors concluded that Turkey's economic growth could be accelerated by further investments in education, particularly in higher education and vocational training programs aligned with the needs of the labor market. This study reinforces the notion that human capital accumulation is a crucial driver of economic growth, especially in emerging economies like Turkey.

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4. Methodology

i. Data Source, Description and Analysis

This study acquired secondary data from various sources including GDP per capita was calculated by the author by acquiring the GDP and Population of Afghanistan from World Bank Open source data, Macrotrends, and Knoema. The education and health index was calculated by the author through UN accepted equations (3) and (4), and the data collected from Knoema, Indexmundi, Global Data Lab, and human progress.org.

The data gathered are encompassing from 1980 till 2019, the study attempts to investigate the causal relation between selected variables of human capital and economic growth, the variables that are selected to measure human capital are the education index and health index, and for economic growth, the study selected GDP per capita which is a suitable proxy when measuring economic growth. This study employs the Toda-Yamamoto causality to find out the causal relation between variables, to employ the Toda-Yamamoto causality it is

suggested to understand the maximum integration order of variables. Hence to understand the integration level of variables the study used Augmented Dicky -fuller (ADF) Unit root tests.

ii. Variables

a) Education Index

The Education Index measures the extent of educational achievement within a country. It is based on two key factors:

Mean Years of Schooling (MYS): The average number of years that people aged 25 and older have spent in formal education.

Expected Years of Schooling (EYS): The number of years a child entering the school system can expect to spend in education, assuming current enrollment rates

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Mean Years of Schooling (MYS):

Definition: MYS reflects the number of years, on average, adults (25 years and older) have spent in schooling. It serves as a proxy for the actual educational attainment of a population.

Importance: MYS is crucial for assessing the skills and educational background of the labor force, as higher levels of schooling correlate with better employment opportunities and productivity.

Upper Bound: MYS is capped at 15 years in the calculation of the Education Index. This limit represents the time it takes to complete secondary education and some tertiary education.

Source: MYS data is typically gathered through national household surveys, censuses, and reports from the UN Educational, Scientific and Cultural Organization (UNESCO).

Expected Years of Schooling (EYS):

Definition: EYS estimates how many years a child at the age of school entry can expect to spend in the education system, assuming that the child will experience current age-specific enrollment rates throughout their schooling years.

Importance: EYS captures the future potential of educational development within a country and indicates the opportunities available to younger generations.

Upper Bound: EYS is capped at 18 years, representing the time required to complete primary, secondary, and tertiary education.

Source: EYS is typically calculated based on school enrollment ratios at various levels (primary, secondary, and tertiary) and data provided by UNESCO.

Method of Calculation:

The Education Index is calculated as the arithmetic mean of the normalized values of MYS and EYS:

$$MYSI = \frac{MYS}{15} \qquad (5)$$

$$EYSI = \frac{EYS}{18} \qquad (6)$$

In equation (1) the MYSI highlights as mean years of schooling index, MYS is the mean years of schooling, and similarly in equation (2) EYSI is the expected years of schooling index and EYS is the expected years of schooling, further to find out the Education index the formulas (1) and (2) create the education index formula as follow. (UN, 2021-22)

$$Education\ Index = \frac{MYSI+EYSI}{2} \qquad (7)$$

Where:

- **MYS** is the mean years of schooling (maximum 15 years),
- **EYS** is the expected years of schooling (maximum 18 years).

Normalization:

Both MYS and EYS are normalized by dividing them by their respective maximum values (15 and 18). The use of maximum values ensures that countries with high levels of education (e.g., developed nations) do not score above 1, and it allows meaningful comparison across countries. The final result of the Education Index is a number between 0 and 1:

0 represents no education,

1 represents the maximum possible educational attainment (15 years of MYS and 18 years of EYS).

b) Health Index (Life Expectancy Index)

The Health Index, also known as the Life Expectancy Index, captures the overall health and longevity of a population. It is based on a single indicator: life expectancy at birth. Life expectancy is a widely recognized measure of the overall health of a population, as it reflects the general conditions of healthcare, nutrition, living standards, and societal well-being.

Life Expectancy at Birth:

Definition**:** Life expectancy at birth refers to the average number of years a newborn is expected to live, assuming that current mortality rates at every age will remain constant throughout their life.

Importance: Life expectancy is one of the most reliable and broad indicators of public health, as it reflects factors such as disease prevalence, access to medical care, nutrition, sanitation, and lifestyle choices. Higher life expectancy generally indicates better overall health and quality of life within a country.

Upper Bound: The UN sets the maximum life expectancy at **85 years** to calculate the Health Index. This upper limit is based on observed maximum life expectancy in countries with the highest health outcomes.

Lower Bound: The minimum life expectancy for the index is **20 years**, which is an assumed worst-case scenario based on global historical data.

Method of Calculation:

The Health Index (Life Expectancy Index) is calculated using the following formula:

$$Health\ Index = \frac{LE-20}{85-20} \qquad (8)$$

Where:

- **LE** is the life expectancy at birth,
- **20** is the minimum value for life expectancy,
- **85** is the maximum value for life expectancy.

Normalization:

The normalization formula ensures that life expectancy is scaled between 0 and 1, where:

- **0** corresponds to a life expectancy of 20 years, which is considered the minimum feasible value in modern contexts,
- **1** corresponds to a life expectancy of 85 years, which is considered the maximum achievable in present-day conditions.

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Interpretation:

- A higher Health Index score indicates better health outcomes, longer life expectancy, and superior healthcare systems.
- A score close to 1 means that a country's population enjoys a long and healthy life, which is often the result of high-quality medical care, preventive health measures, and good living conditions.
- A low score, on the other hand, implies poor health conditions, lower life expectancy, and challenges in healthcare access.

Both the Education Index and Health Index are critical measures in assessing human development. They form the foundation of the Human Development Index (HDI) and help policymakers, economists, and researchers to analyze the progress of nations in providing essential services to their populations.

- **The Education Index** assesses the current and future educational attainment of a population, reflecting both the historical investments in education and the opportunities available for the next generation.
- **The Health Index** (Life Expectancy Index) evaluates the overall health of a population, highlighting the effectiveness of healthcare systems, nutrition, and living conditions.

These indices are more than just statistical measures; they are essential for guiding policy decisions that aim to improve the quality of life, raise educational standards, and enhance healthcare services. When countries improve on these indices, they typically experience faster economic growth, better social cohesion, and higher levels of well-being.

c) Gross Domestic Product Per Capita (GDPpc)

The **GDP per capita (GDPpc)** is a key economic indicator that measures the average economic output (or income) per person in a country. It is calculated by dividing a country's Gross Domestic Product (GDP) by its total population. The GDP per capita is commonly used as a measure of a nation's standard of living and economic performance.

Economic Well-being: GDPpc provides a snapshot of the average income of individuals in a country. A higher GDPpc typically indicates a higher standard of living, more disposable income, and better access to goods and services.

Indicator of Prosperity: Countries with high GDPpc tend to have better infrastructure, technology, and institutional frameworks that contribute to overall well-being. It correlates with improvements in other social indicators like education and health.

Comparison Between Countries: GDPpc allows for direct comparison between countries of different sizes. It normalizes GDP data by population, making it a useful tool for understanding the relative wealth of countries and the material living conditions of their citizens.

Policy Making: Governments use GDPpc as an essential metric for evaluating economic policies, resource allocation, and developmental goals. Higher GDPpc often gives countries the financial capacity to invest in education, healthcare, and social welfare.

Human Development: While GDPpc is not a perfect measure of development (as it doesn't capture income inequality, environmental degradation, etc.), it still serves as an important economic foundation for human development, facilitating better education and healthcare systems.

d) Using GDP Per Capita with the Education and Health Index

GDPpc, **Education Index**, and **Health Index** are interconnected in understanding the holistic development of a country. Together, they provide a more comprehensive picture of human development, as measured by the **Human Development Index (HDI),** which includes all three indicators (GDPpc, education, and health). Here's how they relate and how you can use them together:

Investment in Education: Higher GDPpc often means more government revenue, which can be used to invest in the education sector. Wealthier countries tend to spend more on their educational systems, which leads to better educational infrastructure, resources, and access.

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Quality of Education: Countries with higher GDPpc tend to offer higher-quality education, with better-trained teachers, access to technology, and more diverse educational opportunities.

Effect on Education Outcomes: Countries with higher GDPpc generally have higher **mean years of schooling (MYS)** and **expected years of schooling (EYS),** which contribute directly to a higher Education Index.

Healthcare Spending: A higher GDPpc enables a country to allocate more resources to healthcare. This can lead to the construction of hospitals, the availability of medical professionals, and affordable healthcare services, all of which contribute to improved health outcomes.

Life Expectancy: GDPpc is positively correlated with **life expectancy** (the key indicator of the Health Index). Countries with higher GDPpc can afford better healthcare services, healthier diets, and improved living conditions, leading to longer lives.

Preventive Healthcare: In wealthier countries, preventive care like vaccinations, health education, and early diagnosis are more common, reducing mortality rates and improving life expectancy.

5. Analysis Discussion

- **Unit Root Test**

A unit root test is used to determine whether a time series variable is non-stationary and possesses a unit root. In other words, it helps to assess whether a time series is a random walk or has a stochastic trend and there are various methods to understand the stationarity of the data and also to remedy any unit root problem. Some of the common, accurate, and suitable test used in the study is the Augmented Dicky -fuller (ADF) Unit root test.

ADF Test (Augmented Dickey-Fuller Test):

Null Hypothesis: The time series has a unit root (i.e., it is non-stationary).

Alternative Hypothesis: The time series does not have a unit root (i.e., it is stationary).

Approach: It tests the null hypothesis by estimating a regression model and checking whether the coefficient on the lagged level of the series is zero. If it is not significantly different from zero, the null hypothesis of a unit root cannot be rejected.

The result from the ADF test indicates that variables have mixed stationarity levels and the max integration level is the 2nd difference for the Education index EDU, finding the stationarity level is an important part of causality, to employing the causality test the maximum order of integration is two.

Table 1: Augmented Dicky Fuller Test

Variables	T-statistic	At level	T-statistic	First Difference	T-statistic	Second Difference
GDPPC	-1.293044 > (critical value - 3.621023)	0.6225	-4.376456 < (critical value -3.615588)	0.0013	-	-
EDU	-1.368239 > (critical value -3.621023)	0.5871	-1.927563 > (critical value -3.615588)	0.3166	-8.200778 < (critical value -3.621023)	0.0000
HEA	-10.28852 < (critical value -3.621023	0.0000				

Source: Computed by Author

- **Toda Yamamoto Causality test**

This study used the Toda-Yamamoto Causality test instead of the traditional Granger Causality test. The Toda-Yamamoto introduced by Toda and Yamamoto (1995), is a method used to test for Granger causality in time series data without needing to worry about whether the variables are stationary or integrated of different orders. Traditional Granger causality testing assumes that the variables are stationary or they need to be co-integrated if integrated. The Toda-Yamamoto test overcomes this by using a modified version of the Granger

causality framework that works even when variables are integrated or non-stationary. Moreover, steps are to be considered incorporating the causality test.

The First step is to find out the higher integration order for the variables whether they are integrated at order 0, 1, or 2. Further, for example, if one variable is stationary I(1)and another is integrated of order I(2), then dmax=2

Once the study determines the d_{max}, the following estimate a vector autoregressive (VAR) model by adding lag lengths equal to d_{max} to the optimal lag length (k) of the model. So the VAR model looks like the following

$$K + D_{max} \quad (9)$$

Where

K = lag length

Dmax= Order of Integration

The Toda-Yamamoto approach uses Wald tests to assess the significance of the coefficients associated with the lagged variables. Importantly, only the coefficients for the first k lags are tested for causality. The additional dmax lags are included to ensure the asymptotic distribution of the test statistic is valid.

The lag order for the series is determined by the VAR test and suggested by the criterion is 5 lags. According to the criterion the lowest value while choosing lag orders is preferred, hence the lowest value in the test is AIC which shows that 5 lags is the optimal lag order.

Figure 2: Lag Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-68.96924	NA	0.013841	4.233484	4.368163	4.279414
1	185.3999	448.8867	7.49e-09	-10.19999	-9.661278	-10.01628
2	258.8123	116.5961	1.72e-10	-13.98896	-13.04620	-13.66745
3	317.9496	83.48803*	9.33e-12	-16.93821	-15.59142*	-16.47892
4	330.8019	15.87632	7.97e-12*	-17.16482	-15.41399	-16.56773*
5	340.1121	9.857872	8.81e-12	-17.18306*	-15.02820	-16.44819
6	347.3764	6.409693	1.18e-11	-17.08096	-14.52207	-16.20831

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Computed by author

After understanding the optimal lag and integration order, the study re-estimate the VAR model in the levels, and according to the formula (k+ d_{max}) which adds 2 lag more with optimal lags of each variable, it means a total of 7 lags for each variable. Finally, the study performed a Wald test to test the Granger non–causality but without including the d_{max} additional lags of each variable. the result from the Toda-Yamamoto causality in Figures 3 and 4 indicates the presence of causality between health index and GDP per capita it means if the health increases the GDP also increase and if the GDP per capita increases the health index also increase the cause and effect is from both variables, and also a one side causality is between education and health, it means if the education increases the health will increase as well but not the opposite.

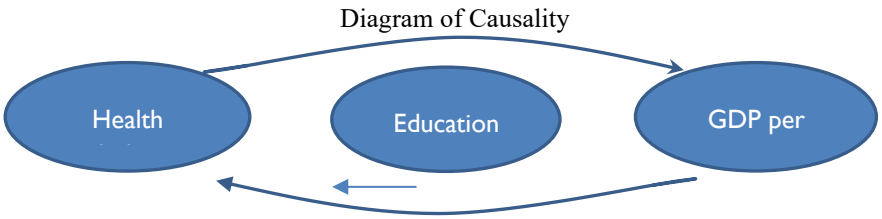

Figure 3: Causality test

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 09/19/24 Time: 16:14
Sample: 1980 2019
Included observations: 33

Dependent variable: GDPPC

Excluded	Chi-sq	df	Prob.
HEA_I	15.65630	5	0.0079
EDU_I	3.710610	5	0.5918
All	17.52011	10	0.0636

Source: Computed by author

Figure 4: Causality test

Dependent variable: HEA_I

Excluded	Chi-sq	df	Prob.
GDPPC	26.14504	5	0.0001
EDU_I	13.47037	5	0.0193
All	37.50746	10	0.0000

Dependent variable: EDU_I

Excluded	Chi-sq	df	Prob.
GDPPC	1.864580	5	0.8675
HEA_I	3.743161	5	0.5870
All	19.31050	10	0.0365

Source: Computed by author

6. Findings and Conclusion

The study's main aim is to understand the causal relationship between human capital and economic growth. Therefore, the research gathered the annual time series data from 1980 to 2019. The study employed the Toda-Yamamoto causality method to understand the causality of selected human capital and economic growth proxies. In this study, human capital is measured by the education and health index, and economic growth is measured by Gross Domestic Product Per capita. In the context of Afghanistan, many studies used the traditional Granger causality test, hence this study used the Toda-Yamamoto Causality approach due to its robustness for cointegration and stationarity properties Toda and Yamamoto(1995) criticized and raised concerns about the VECM-based causality test, suggesting that its results might be flawed due to potential biases in the preliminary tests for cointegration and first difference stationarity, which could lead to incorrect causality conclusions. Moreover, the result from causality indicated a bidirectional relationship between GDP per capita and the health index, and also there is a unidirectional causal relationship running from the education index to the health index. Furthermore, the result sheds light on how to deal with policy, the health and economic growth relation has shown that health sectors have been utilized properly in the country, moreover, the bidirectional relationship between GDP per capita and the health index suggests a dynamic relation between economic growth and the health sector, where improvements in one stimulate growth in the other. This mutual relationship highlights the importance of sustained investments in health to drive the economy. On the other hand, the unidirectional causality from the education index to the health index indicates that improvements in education have a significant impact on the health sector. This suggests that policies focusing

on enhancing education standards can also lead to better health outcomes, another notion to focus on is the higher the education the better the health, which means spreading awareness through education centers and increasing knowledge of the community can help to boost the health.

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