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Health and economic growth in Central Asia

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Abstract

This paper explores how the health-related component of human capital affects economic performance in all five Central Asian countries. In particular, it analyzes the impact of life expectancy on overall GDP and output per worker, which characterizes labor productivity. The time frame includes the period from 2000 to 2021. The methodology is based on a standard growth accounting framework. Findings show that better health conditions, as indicated by the increase in life expectancy, have a significant impact on the productivity of a worker. Nonetheless, its contribution to total output growth remains relatively small. In contrast, capital investment plays a crucial role in boosting labor productivity and fostering economic growth, especially in capital intensive countries such as Kazakhstan and Uzbekistan.

Keywords: human capital, growth, life expectancy, total factor productivity, Central Asia.
JEL classification: I15, O1, O4, O5, P2.

1. Introduction

The role of human capital in the economy is a subject of continuous discussions among different scholars and policy makers. It is commonly accepted that educated and healthy people are more productive, mentally stronger, innovative and resilient to various diseases, and their contribution to production is enormous. On the other hand, a higher level of income implies that people invest more in their education and health, which in turn facilitate better economic performance in the country.

According to the WHO's Commission on Macroeconomics and Health (WHO, 2001) improvements of health and its key element longevity are a fundamental goal of economic development. The linkages of health to poverty reduction and to long-term economic growth are powerful, much stronger than is generally understood. Therefore, theoretical and empirical arguments of the beneficial effect of health on economic outcomes have always been important and timely.

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This paper aims to explore the impact of health on economic performance in all Central Asian countries: Kazakhstan, Kyrgyzstan,[1] Tajikistan, Uzbekistan, and Turkmenistan over the last two decades, using the growth accounting technique. In particular, it analyzes the impact of life expectancy on overall output and labor productivity. In related studies two proxies of health are mainly utilized: life expectancy and infant mortality rates. We choose the first indicator to the second one for a very important reason. Although infant mortality rates are a common health indicator, they pose a unique challenge in growth accounting because they are inverse: improvements in health are reflected by lower infant mortality rates, which may complicate the interpretation of results in a growth accounting framework where positive changes (increases) are typically associated with growth.

We believe this paper will make certain contributions to existing literature. First, Central Asia remains relatively understudied, and life expectancy has not been thoroughly investigated in relation to economic growth in this region. Furthermore, there are very few studies focusing on Turkmenistan. Therefore, this study fills an important gap. By focusing on life expectancy, this paper not only adds a valuable dimension to our understanding of economic performance in Central Asia, but it will also provide a deeper understanding of how health improvements contribute to economic outcomes in the region that has undergone notable transformations in recent decades.

The rest of the paper is organized as follows. Section 2 discusses previous literature with a special focus on the link between health and economic outcomes based on aggregate production function and growth regression techniques. Methodology and data are presented in Section 3. Results are then discussed in Section 4. The final section concludes.

2. Literature review

According to Weil (2007), research showing the relationship between health and economic performance can be analyzed either at individual or national level, which in turn explores two categories of health measures: inputs into health and health outcomes. The first category relates to the physical factors, namely nutritional intakes at different life periods, vulnerability to various diseases as well as access to medical care. While the second one is represented by individual health inputs and genetic background. This may include life expectancy, height, labor productivity and cognitive functioning.

Husain (2010) provides a comprehensive survey of related literature which sheds light on various perspectives on the health and economic outcomes relationship at both the micro and macro level, using production function and growth regression approaches. In this section, we will review a few articles that are relevant to the overall purpose of our study.

The production function approach is based on an extended version of the Solow growth model and endogenous growth theories. According to the Solow model, the three proximate sources of income differences across countries are the physical capital accumulation, labor and total factor productivity (TFP). The labor component of the model is further augmented with the inclusion of human capital

[1] In the text Kyrgyzstan and Kyrgyz Republic are used interchangeably.

in the form of education and health. While some authors consider human capital as a separate factor of production, e.g., Mankiw et al. (1992); Knight et al. (1993); Knowles and Owen (1995), the beneficial effect of health on economic growth is identified in the context of transition to the steady state of economic performance in a given country or a group of countries.

Unlike the neoclassical Solow model, the endogenous growth theorists emphasize that technological progress itself is an economic determinant of the process of capital accumulation. Thus, incorporating primarily education, and subsequently, health, remain a crucial factor in the advancement of technical progress, e.g., Lucas (1988); Barro and Sala-i-Martin (1995); Rebelo (1991).

Bloom et al. (2004) analyze the effect of health on economic growth on the basis of standard production function. Their findings suggest that a one-year improvement in a country's life expectancy leads to a 4% increase in output. This is likely to be a significant effect, implying that investments in health improvements are essential for labor productivity. However, authors could not distinguish the effects of different types of health investments that might influence different groups of cohorts of a country's population.

Referring to the *A–K* endogenous growth model, Howitt (2005) develops a theoretical model in which there are different channels through which a country's improvements in the population's health affects its long-term growth performance in the following way: (i) health induces productive efficiency; (ii) life expectancy affects skill-adjusted death rate; (iii) learning capacity and (iv) inequality affecting the school attendance rate. Life expectancy appears to be an important determinant for the steady-state average skill of the population. However, its impact depends upon the fact whether it prolongs the life-span of workers, or comes from a reduction in infant mortality.

Based on the extension of the Lucas (1988) model, van Zon and Muysken (2005) construct an endogenous growth model which illustrates how the provision of health services influences an economy's growth rates. According to their findings, there is a trade-off between the health state of the population and growth performance. Human capital accumulation is an important growth source, and the health sector also remains essential in it. Authors conclude that cutting health costs may facilitate growth prospects of an economy per se.

We need to admit that several authors applied the growth regression approach to examine the relationship between health and economic growth, in which the common dependent variable refers to income per capita growth. The key explanatory variable is the initial level of health, typically measured by life expectancy, or survival rate and other covariates that reflect trade openness, institutional quality, education attainment, population growth and geographic characteristics. Notable studies in this area include papers by Benhabib and Spiegel (1994); Barro and Sala-i-Martin (1995); Bhargava et al. (2001); Bloom et al. (2000); Gallup and Sachs (2000). Roughly speaking, in all these studies there is an empirical evidence of positive and sizable effect of health indicator, in particular life expectancy on paces of economic growth. Depending on country samples, period of analysis, estimation techniques, etc. the parameter estimate of health indicator is different.

However, growth regressions suffer from multicollinearity and endogeneity problems. For instance, a high level of income may lead to a higher level in investment in health, and improved health may lead to an increase in per capita income.

Although different authors use different instruments to tackle the problem, skepticism remains among scholars (Acemoglu and Johnson, 2007). Another issue with growth regressions is the pooled sample of high and low income countries, where the role of health indicators is different. For example, Weil (2007) argues that the positive effect of health on GDP is significant in poor countries. However, in some other studies on rich nations, the health-related indicator, such as life expectancy, is not influential in growth performance (Knowles and Owen, 1997).

A recent study by Yormirzoev (2023) explored the role of human capital in the form of education and health in economic growth in Central Asia. Results show that, on average, the health inputs are positive with an average of 0.30% across three countries of the region.

Our paper differs in some other aspects. First, all five former Soviet republics of Central Asia are considered. Unlike the previous study, in which the adult mortality rates were chosen, we use life expectancy as a proxy for health. Lastly, we analyze the last two decades where economic situation has stabilized and the region did not suffer from post-Soviet transformation shock as it did during the 1990s.

The relationship between health indicators and economic growth has been extensively explored in economic sciences, with regression analysis being the most commonly used quantitative approach. In this section, we review studies that reflect methodological approaches and empirical findings on health contributions to growth.

The theoretical relationship between health and growth is rooted in human capital theory, proposed by Becker (1964) and Mincer (1974). Their work highlights the role of health as a critical component of human capital, influencing labor productivity and economic performance. Grossman (1972) further developed this framework, emphasizing how health affects individual productivity and the allocation of time between labor and leisure.

Sala-i-Martin and Barro (1995) and Barro (1996) incorporated health indicators into cross-country growth regressions. Their early empirical evidence concluded that health outcomes, such as increased life expectancy and lower mortality rates, are positively correlated with higher growth rates. In health–growth literature, empirical studies mostly employ static and dynamic panel, as well as time-series modeling techniques.

Bloom et al. (2004) used cross-country panel data and the Solow growth model framework with health variables. Their findings indicate that a one-year increase in life expectancy is associated with a 4% increase in per capita income. This study is significant for its use of datasets across multiple countries, and its findings are intuitive, offering policy implications. However, it assumes linearity between health and growth indicators, which may oversimplify the relationship. Additionally, endogeneity issues have not been fully addressed.

Acemoglu and Johnson (2007) explored the causal impact of health using instrumental variable techniques. They argued that health improvements due to epidemiological transitions led to population growth but did not necessarily boost GDP per capita in the short term. By employing well-defined instrumental variables, the study effectively contends with endogeneity and causality issues. However, its findings are context-dependent and cannot be generalized across different countries. Furthermore, reliance on historical health data may constrain its contemporary relevance.

Other authors have applied time-series and panel data methods to explore country-specific and regional relationships. For instance, Weil (2007), through microeconomic regression analysis, concluded that improvements in human height and adult survival rates significantly enhance economic performance. However, reliance on proxy variables such as height may not fully capture the complex nature of health. Additionally, the potential effects of economic growth on human capital are not explicitly addressed. Aghion et al. (2011) applied dynamic panel regression to study the relationship between health, education, and economic growth. They argue that human capital, represented by education and health, plays a vital role in promoting growth. Nonetheless, the complexity of their model raises concerns about reliance on lagged variables and specification errors.

Dynamic models, such as the generalized method of moments (GMM), have been used in some studies on the health–growth relationship. These models account for lagged explanatory variables and control for unobserved heterogeneity. Bloom et al. (2014) analyzed the long-term effects of health on growth using large datasets, but their results are sensitive to model specification and over-identification issues.

In general, regression analysis provides valuable insights into the health–growth relationship but faces limitations such as endogeneity, data quality issues, nonlinear effects, and distinctions between short-term and long-term impacts. Despite these challenges, regression analysis remains important in identifying the relationship between these variables.

Other studies have employed the Solow growth accounting framework. Developed by Solow (1957), this approach provides a theoretical foundation for decomposing economic growth into contributions from capital, labor, and TFP. It has been widely used to investigate the role of health inputs on growth performance, demonstrating its relative flexibility and policy relevance. However, with its simplistic assumptions — such as constant returns to scale, causal inference, omission of institutional arrangements, and its static nature — the framework may not fully account for long-term dynamic effects on innovation and structural transformation. Nevertheless, the Solow model remains essential for understanding the nexus between health and growth.

Our paper differs from existing studies in several key aspects. First, we examine all five Central Asian republics. Unlike the previous study by Yormirzoev (2023), which used adult mortality rates as a proxy for health, we utilize life expectancy. Additionally, we analyze data from the last two decades, a period during which the economic situation in the region stabilized, avoiding the post-Soviet transformation shocks experienced during the 1990s.

3. Methodology and data

Our study employs an extended version of the Cobb–Douglas production function as outlined by Bosworth and Collins (2008):

$$Y = AK^{\alpha}(LH)^{1-\alpha}, \tag{1}$$

where H is introduced as human capital in terms of education attainment, which is used along with L to account for changes of labor quality.

Results are subsequently presented on a per worker basis by decomposing the growth in output per worker $\Delta\ln(Y/L)$ as components of capital per worker $\Delta\ln(K/L)$, changes in educational attainment per worker $\Delta\ln(H)$, and improvements in TFP $\Delta\ln(A)$:

$$\Delta\ln\left(\frac{Y}{L}\right) = \Delta\ln(A) + \alpha\left[\Delta\ln\left(\frac{K}{L}\right)\right] + (1-\alpha)[\Delta\ln(H)]. \quad (2)$$

To incorporate the health component into this model, we adopt the empirical framework proposed by Weil (2007), which expands the concept of human capital to include both education and health aspects:

$$H = h_i v_i L_i, \quad (3)$$

where h_i represents human capital per-worker in the form of education, v_i shows human capital per-worker in the form of health, and L_i is the number of workers or simply labor force. Additionally, i is an index of a country. The variable v_i does not cover all aspects of individuals' health but only those that affect the production of output (Weil, 2007).

The next step is to integrate the human capital component into equation (2). By substituting H into the equation and applying logarithmic properties, we obtain the following result:

$$\ln(H) = \ln(h_i v_i L_i) = \ln(h_i) + \ln(v_i) + \ln(L_i). \quad (4)$$

After computing the change in logarithms and multiplying it by the weight of $(1 - \alpha)$, we get:

$$(1-\alpha)\Delta\ln(H) = (1-\alpha)(\Delta\ln(h_i) + \Delta\ln(v_i) + \Delta\ln(L_i)). \quad (5)$$

As $\Delta\ln(Y/L)$ already takes labor into consideration, we deduct $\Delta\ln(L)$ from this equation. However, we need to admit that while the Soviet Union provided a standardized education system, the level of implementation and post-independence reforms varied significantly across countries (Kanzaki Izawa et al., 2021). For example, Kazakhstan, with its higher GDP per capita, invests significantly more in education infrastructure and quality compared to Tajikistan, which struggles with underfunded education systems. Kazakhstan allocates a larger percentage of its GDP to education (4–5%) than Tajikistan (2–3%), resulting in differing levels of educational outcomes (World Bank, 2022). Following Barro and Lee (2013) approach that accounts for average years of schooling across countries to be a relevant proxy for human capital in the form of education, we assume that educational attainment is homogenous across the Central Asian region and it is zero. Thus, by incorporating time component, we obtain the following equation:

$$\Delta\ln(y_t) = \Delta\ln(A_t) + \alpha[\Delta\ln(k_t)] + (1-\alpha)[\Delta\ln(v_t)], \quad (6)$$

where y and k reflect output and capital stock per worker and v shows the health component respectively.

Our final equation can be expressed as follows:

$$g_y = g_A + \alpha g_K + (1 - \alpha)g_v, \quad (7)$$

where g_y, g_A, g_K, and g_v denote the growth rates of output, TFP, capital stock and health component of human capital.

To calculate which proportion of the output growth is accounted for by capital, the health-related component of human capital, and TFP, the following formulas have been used:

$$\left(\frac{\alpha g_K}{g_y}\right) \times 100\%; \quad (8)$$

$$\left(\frac{(1 - \alpha)g_v}{g_y}\right) \times 100\%; \quad (9)$$

$$\left(\frac{g_A}{g_y}\right) \times 100\%. \quad (10)$$

In this study, life expectancy is used as proxy for the health indicator as it is extensively used in related literature (Behrman and Rosenzweig, 2001).

Other variables include total output, represented by real GDP, and gross fixed capital formation, which serves as a proxy for capital stock. Both are expressed in terms of 2015 constant prices. TFP is a residual term that can be best interpreted as a measure of the gains from efficient use of factor inputs. Alpha denotes the proportion of output allocated to capital, which is usually in the range of $^1/_3$ and $^2/_5$, accordingly (Hall and Jones, 1999; Bosworth and Collins, 2008 and Yormirzoev, 2023).

Hence, changes in total output are reflected as potential contributions from physical and human capital (the latter is expressed in the form of life expectancy), and TFP.

Data for our analysis are taken from several online sources: World Bank World Development Indicators (WDI),[2] International Labor Organization Statistics (ILOSTAT),[3] and Penn World Tables [10.1] version.[4]

Total output is measured by the real gross domestic product (GDP) using the 2015 U.S. pricing levels. Physical capital accumulation was quantified as gross fixed capital formation (GFCF), representing spending on fixed assets within an economy, excluding depreciation. This indicator serves as a credible measure of a country's investment in physical capital and provides an understanding of the economy's productive capacity. It is also measured using the 2015 U.S. price levels. The availability of data on capital was limited to Kazakhstan and Uzbekistan exclusively, while for other nations it was calculated based on the GDP deflator. Labor was defined as the total number of individuals actively participating in the workforce.

[2] https://databank.worldbank.org/source/world-development-indicators

[3] https://www.ilo.org/data-and-statistics

[4] https://www.rug.nl/ggdc/productivity/pwt/

Data quality in Central Asian countries is often compromised due to several factors, including the prevalence of the informal economy, inconsistent statistical practices, and political influences. These issues affect the reliability of economic indicators like GDP, employment, and social statistics. The informal sector constitutes a significant portion of the economy, particularly in Tajikistan, Kyrgyzstan, and Uzbekistan, leading to under-reported GDP and employment figures. Estimates suggest the informal economy accounts for 30–50% of GDP in some countries (Medina et al., 2018). Due to weak statistical capacity and reliance on outdated data collection methods, GDP figures may not capture full economic activity, particularly in agriculture and small-scale industries (IMF, 2021).

Since the study examines changes in the overall economy and labor productivity, all variables were also measured on a per-worker basis, which allows us to analyze the impact of health on worker's productivity.

Output per worker is a measure of labor productivity that represents the average amount of products and services produced by an individual worker. The capital to labor ratio shows workers are provided with appropriate amount of tools, machinery, equipment and technology, which have a positive impact on their productivity.

To get life expectancy per worker, we first calculated the potential years of work by subtracting the year an individual enters the labor force from the retirement age. Afterwards, by taking into account the labor force participation rate, we computed the life expectancy per worker, which represents the projected lifespan of those who are actively engaged in the labor force.

3. Results and discussions

This section presents our findings for all Central Asian republics. The time period is divided into two decades: 2000–2010 and 2011–2021. We also conduct a comprehensive analysis of the entire time span ranging from 2000 to 2021. When analyzing ten-year periods, it is crucial to explore the role of business cycles, as these cycles in Central Asia are often asynchronous due to differences in economic structures. Resource-rich countries like Kazakhstan and Uzbekistan experience commodity-driven cycles, while remittance-dependent economies such as Kyrgyzstan and Tajikistan are more influenced by external demand and exchange rate fluctuations (Kanzaki Izawa et al., 2021). External shocks, such as the global financial crisis or the COVID-19 pandemic, affect these countries differently depending on their level of integration with global markets and fiscal resilience. Additionally, structural reforms or policy shifts during specific stages of a business cycle — such as privatization or exchange rate liberalization — can have long-term effects that are not uniformly reflected across the Central Asian republics.

The growth accounting is derived with the capital income share alpha, equal to either $^1/_3$ or $^2/_5$. Our analysis of growth rates is conducted at the macroeconomic level, which examines the overall economy, as well as on a per worker basis, e.g., labor productivity.

Table 1 presents estimates of the growth rate of real GDP divided by the contributions from the growth rates of capital and life expectancy, as well

Table 1
Sources of growth in aggregate economy with α at $^1/_3$.

Period	Country	Growth rate of output	Contribution of capital (K)	Contribution of life expectancy (H)	TFP growth rate
2000–2010	Kazakhstan	0.083	0.047 (56%)	0.003 (4%)	0.033 (60%)
	Kyrgyzstan	0.041	0.030 (74%)	0.001 (2%)	0.010 (24%)
	Tajikistan	0.081	0.044 (54%)	0.004 (5%)	0.033 (41%)
	Turkmenistan	0.077	0.024 (31%)	0.003 (4%)	0.050 (65%)
	Uzbekistan	0.068	0.038 (56%)	0.003 (5%)	0.026 (39%)
2011–2021	Kazakhstan	0.032	0.017 (55%)	0.001 (5%)	0.013 (40%)
	Kyrgyzstan	0.034	0.001 (3%)	0.002 (6%)	0.030 (90%)
	Tajikistan	0.070	–0.004 (–5%)	0.003 (5%)	0.071 (100%)
	Turkmenistan	0.064	–0.021 (–33%)	0.001 (1%)	0.084 (132%)
	Uzbekistan	0.060	0.042 (69%)	0.001 (2%)	0.017 (29%)
2000–2021	Kazakhstan	0.058	0.031 (54%)	0.002 (4%)	0.025 (43%)
	Kyrgyzstan	0.038	0.013 (34%)	0.001 (4%)	0.024 (62%)
	Tajikistan	0.076	0.021 (28%)	0.004 (5%)	0.051 (67%)
	Turkmenistan	0.074	0.003 (4%)	0.002 (3%)	0.069 (93%)
	Uzbekistan	0.065	0.038 (59%)	0.002 (4%)	0.024 (37%)

Note: Numbers in brackets show the share of output growth attributable to factor inputs.
Source: Authors calculations.

as the residual component representing TFP growth. The first column shows the annual increase in real GDP. Between 2000 and 2011, Kazakhstan enjoyed the highest rate of output increase at 8.3%. However, between 2011 and 2021, output rapidly fell to 3.2%, resulting in a 5.8% annual growth rate over the whole time frame. The Kyrgyz Republic experienced a decrease in real output growth, dropping from 4.1% to 3.4% during the same time period. Its overall growth rate of output was very modest, averaging 3.8%. Tajikistan had a decline in its yearly output growth, changing from 8.1% in the initial period to 7.0% in the subsequent period, resulting in an overall growth rate of 7.6% for the whole period. In the case of Uzbekistan, there was a slight reduction in the rate of output growth from 6.8% to 6.0% in the second decade, with an average growth rate of

6.5% from 2000 to 2021. Like other nations, Turkmenistan had a decline in its growth rates, dropping from 7.7% during the period of 2000–2011 to 6.4% in the period of 2011–2021. The average yearly growth rate for the entire time was 7.4%. According to the table, all five countries had a growth rate of real output over the entire period, though it was lower in the second decade.

The remaining columns reflect the rate at which capital investment, life expectancy, and TFP growth, as well as the proportional contribution of each variable to output growth. For example, the percentage contribution of capital indicates the extent to which investments in capital contribute to the overall rate of output growth. Kazakhstan demonstrated consistent positive capital growth during the whole period. However, the growth rate declined from 4.7% during the years 2000–2010 to 1.7% in 2011–2021. In the second decade, the growth rate of TFP declines from 3.3% to 1.3%. In terms of life expectancy, there is a slight increase of 0.3% in the first decade and a 0.1% increase in the second decade, resulting in an average growth rate of 0.2%. Throughout the entire period, capital makes the largest contribution — an average of 54%. TFP accounts for approximately 43% of the overall growth, whereas the impact of life expectancy on growth is rather small, initially accounting for 4% and then slightly increasing to 5% in the second decade. On average, it consistently maintained an average contribution of 4%.

In the case of the Kyrgyz Republic, there was a significant decline in the rate of capital growth, dropping from 3% in the first decade to 0.1% in the second decade. Consequently, capital contribution also declined from 74% to just 3% during the 2011–2021 period. Thus, the country experienced a marked increase in the growth rate of TFP, which was only 24% in the period of 2000–2010, but skyrocketed to 90%. As in Kazakhstan, an increase in life expectancy had a moderate growth rate, averaging 0.1% throughout the entire time. The health component's contribution to the total output was initially 2%, but it rose to 6% in the second period. On average, it accounted for 4% of the total output.

Over the period of 2000–2010, Tajikistan experienced a significant annual growth rate of capital — 4.4%, and its contribution to the country's overall economic growth was 54%. However, the growth rate and the contribution of capital declined in the second decade, with a decrease of –0.4% and –5%, respectively. The situation may indicate the inefficiency of capital or its overcapacity. Given the decrease in capital input, it is obvious that there were some other factors that led to an increase in output. In terms of the health component, there was a consistent increase of 0.4%, accounting for 5% of the overall contribution.

Uzbekistan is the only country among the Central Asian countries that experienced a rise in capital growth rates, growing from 3.8% to 4.2% in the second decade. As a result, there was a direct and ongoing dependence on capital investment, with contributions rising from 56% to 69%, and averaging 59% over the entire period. The average growth rate of TFP was 2.4%, although its contribution declined from 39% to 29%. With respect to the health component, there was a small decline in its growth rate from 0.3% to 0.1% in the second decade. The contribution from life expectancy remained reasonably consistent and low, at 5% over two periods.

Turkmenistan, like Tajikistan, had a substantial decline in the capital's growth rates during the second period, dropping from 2.4% to a negative –2.1%. As a result, the rate of growth of TFP increased from 5% to 8.4%. The capital contribution experienced a fall from 31% to –33% between 2011 and 2021, whereas on average the contribution of TFP was 93% for the entire period. In terms of health, growth and contribution rates were comparable to other Central Asian nations, averaging 0.2% and 3%, respectively.

Table 2 reflects estimates of the growth rates of output, including the contributions of capital, life expectancy, and TFP at alpha being equal to $^2/_5$. In this table we also see a significant decline in growth rates and the contribution of capital for all nations, except Uzbekistan. The TFP growth rate decreased slightly as

Table 2
Sources of growth in aggregate economy with α at $^2/_5$.

Period	Country	Growth rate of output	Contribution of capital (K)	Contribution of life expectancy (H)	TFP growth rate
2000–2010	Kazakhstan	0.083	0.056 (68%)	0.003 (3%)	0.024 (29%)
	Kyrgyzstan	0.041	0.036 (89%)	0.001 (1%)	0.004 (10%)
	Tajikistan	0.081	0.052 (64%)	0.004 (5%)	0.025 (31%)
	Turkmenistan	0.077	0.028 (37%)	0.003 (4%)	0.046 (59%)
	Uzbekistan	0.068	0.004 (67%)	0.003 (5%)	0.019 (28%)
2011–2021	Kazakhstan	0.032	0.021 (67%)	0.001 (4%)	0.009 (29%)
	Kyrgyzstan	0.034	0.001 (4%)	0.002 (6%)	0.030 (90%)
	Tajikistan	0.070	–0.004 (–6%)	0.003 (4%)	0.072 (102%)
	Turkmenistan	0.064	–0.025 (–39%)	0.001 (1%)	0.088 (138%)
	Uzbekistan	0.060	0.050 (83%)	0.001 (2%)	0.009 (15%)
2000–2021	Kazakhstan	0.058	0.037 (64%)	0.002 (3%)	0.019 (33%)
	Kyrgyzstan	0.038	0.016 (41%)	0.001 (3%)	0.021 (56%)
	Tajikistan	0.076	0.026 (34%)	0.004 (5%)	0.047 (61%)
	Turkmenistan	0.074	0.003 (5%)	0.002 (2%)	0.069 (93%)
	Uzbekistan	0.065	0.046 (71%)	0.002 (4%)	0.016 (25%)

Note: Numbers in brackets show the share of output growth attributable to factor inputs.
Source: Authors calculations.

a result of increased capital input. As for the health component, it continues to have positive but moderate growth rates, and its contribution to overall output remains relatively low, typically ranging from 2 to 5% on average.

In Table 3, we present a detailed analysis of the growth accounting on a per-worker basis for all Central Asian republics over a two-decade period. Particularly, it examines the contributions of capital per worker, life expectancy per worker, and TFP growth rate. Findings highlight the impact of changes in capital efficiency, health advancements, and TFP on labor productivity growth.

Overall, all five countries of the region experienced positive growth rates in output per worker, which indicates that the amount of output produced per unit of labor input increased over the period under study.

Table 3
Sources of growth on a per-worker basis with α at $^1/_3$.

Period	Country	Growth rate of output per worker	Contribution of capital per worker (K)	Contribution of life expectancy per worker (H)	TFP growth rate
2000–2010	Kazakhstan	0.068	0.041 (61%)	0.005 (7%)	0.022 (32%)
	Kyrgyzstan	0.025	0.025 (98%)	0.005 (19%)	–0.004 (–18%)
	Tajikistan	0.055	0.035 (62%)	0.005 (9%)	0.016 (29%)
	Turkmenistan	0.058	0.017 (30%)	0.005 (8%)	0.036 (62%)
	Uzbekistan	0.046	0.031 (66%)	0.005 (11%)	0.011 (23%)
2011–2021	Kazakhstan	0.026	0.016 (60%)	0.003 (10%)	0.008 (30%)
	Kyrgyzstan	0.026	–0.001 (–5%)	0.003 (10%)	0.025 (95%)
	Tajikistan	0.051	–0.009 (–19%)	0.003 (5%)	0.058 (114%)
	Turkmenistan	0.055	–0.023 (–43%)	0.003 (5%)	0.075 (138%)
	Uzbekistan	0.047	0.037 (79%)	0.003 (5%)	0.007 (16%)
2000–2021	Kazakhstan	0.047	0.027 (57%)	0.004 (8%)	0.017 (35%)
	Kyrgyzstan	0.027	0.009 (34%)	0.004 (13%)	0.014 (53%)
	Tajikistan	0.053	0.014 (26%)	0.004 (7%)	0.036 (67%)
	Turkmenistan	0.060	–0.001 (–2%)	0.004 (6%)	0.058 (96%)
	Uzbekistan	0.046	0.032 (69%)	0.004 (8%)	0.011 (23%)

Note: Numbers in brackets show the share of output growth attributable to factor inputs.
Source: Authors calculations.

However, the growth rate of output per worker in Kazakhstan fell from 6.8% between 2000 and 2010 to 2.6% during the period of 2011–2021. Next, as for the Kyrgyz Republic, its growth rate was at 2.5% during the period of 2000–2010 and had a small rise to 2.6% in the years 2011–2021. Tajikistan experienced a very consistent growth rate, reaching 5.5% in the initial period and 5.1% in the second. Uzbekistan, like Tajikistan, steadily achieved a 4.6% average growth rate in output per worker. In Turkmenistan, the growth rate of output per worker remains stable, ranging from 5.8% to 5.5%.

In Kazakhstan, the capital per worker contribution remained stable, with a minor decrease from 61% in the first decade to 60% in the next decade. This suggests an enduring dependence on capital investment for improvements in productivity. The TFP growth rate fell from 2.2% to 0.8%. Nevertheless, the average contribution of TFP was at 35% over the entire period. The growth rate of life expectancy per worker remained at 0.4% for this period. The contribution of health improvements to labor productivity increased from 7% to 10%, indicating an increasingly valuable impact on productivity.

In 2011–2021, the Kyrgyz Republic experienced fluctuations in growth rates of capital per worker. The growth rate of capital per worker contracted from 2.5% to –0.1%. As a result, its contribution plummeted from 98% to –5%, suggesting either big losses or a dramatic change in the economic structure. Notwithstanding, the TFP growth rate showed stable growth, starting with a negative rate of –0.4% and subsequently rising to a positive 2.5% in the second period. The TFP contribution had a major change from a negative 18% to a positive 95%, indicating substantial variations in productivity efficiencies over a two-period decade. Throughout the entire period, the growth rate of life expectancy remained balanced at 0.4%. Its contribution ranged from 19% to 10%, indicating a beneficial effect on labor productivity.

Tajikistan experienced an increase in capital per worker of 3.5% during the initial period; however, it faced a substantial drop to –0.9% in the following period. As a result, the capital per worker contribution first increased by 62% but then fell sharply to –19%, suggesting possible overinvestment or a low return on capital. Furthermore, TFP demonstrated a substantial and positive growth rate, with its contribution increasing from 29% to 114% in the second decade. Lastly, the average rate of growth in life expectancy was 0.4%, with its contribution varying from 9% initially to 5% thereafter. However, compared to other countries in the region, the contribution of health was the lowest.

The growth rate of capital per worker in Uzbekistan remained constant at an annual rate of 3.2% over the entire period. It displayed a continuous and gradual increase from 66% to 79%, indicating a continued and rising dependence on capital investment. The TFP growth rate saw a slight plunge, decreasing from 1.1% in 2000–2010 to 0.7% in 2011–2021. Similarly, its contribution dropped from 23% to 16%. Next, the average increase in life expectancy was 0.4% over the entire period. Initially, its contribution was approximately 11%, but later decreased to 5%. Overall, it had a negligible impact on labor productivity.

Turkmenistan experienced a significant decrease in the growth rate of capital per worker. In the first period, the growth rate was 1.7%, but in the second period, it declined to –2.3%. The contribution of capital per worker plummeted from

30% to –43%, indicating substantial inefficiencies or mismanagement of capital. The TFP growth rate stayed at a high level over a two decade-period, averaging at 5.8%. Its contribution ranged between 62% and 138%. The average annual rate of increase in life expectancy for the entire period was 6%. Initially, its contribution was consistently around 8% and then decreased to 5%. This indicates a positively stable effect on labor productivity.

Table 4 shows findings on a per worker basis with a different alpha value set at $^2/_5$. Overall, there are no noticeable differences in per-worker growth results compared to Table 3.

In general, in Central Asia, a region defined by diverse economic structures and socio-political contexts, the relationship between health and economic

Table 4
Sources of growth in per-worker Basis with α at $^2/_5$.

Period	Country	Growth rate of output per worker	Contribution of capital per worker (K)	Contribution of life expectancy per worker (H)	TFP growth rate
2000–2010	Kazakhstan	0.068	0.050 (73%)	0.004 (7%)	0.014 (20%)
	Kyrgyzstan	0.025	0.030 (118%)	0.004 (17%)	–0.009 (–35%)
	Tajikistan	0.055	0.041 (75%)	0.004 (8%)	0.009 (17%)
	Turkmenistan	0.058	0.021 (36%)	0.004 (8%)	0.033 (57%)
	Uzbekistan	0.046	0.037 (79%)	0.004 (10%)	0.005 (11%)
2011–2021	Kazakhstan	0.026	0.019 (72%)	0.002 (9%)	0.005 (19%)
	Kyrgyzstan	0.026	–0.002 (–6%)	0.002 (9%)	0.025 (97%)
	Tajikistan	0.051	–0.011 (–22%)	0.002 (5%)	0.060 (117%)
	Turkmenistan	0.055	–0.028 (–52%)	0.002 (4%)	0.080 (148%)
	Uzbekistan	0.047	0.044 (95%)	0.002 (5%)	0.000 (0%)
2000–2021	Kazakhstan	0.047	0.033 (69%)	0.003 (7%)	0.011 (24%)
	Kyrgyzstan	0.027	0.011 (41%)	0.003 (12%)	0.013 (47%)
	Tajikistan	0.053	0.017 (31%)	0.003 (6%)	0.033 (63%)
	Turkmenistan	0.060	–0.002 (–3%)	0.003 (5%)	0.059 (98%)
	Uzbekistan	0.046	0.038 (83%)	0.003 (7%)	0.005 (10%)

Note: Numbers in brackets show the share of output growth attributable to factor inputs.
Source: Authors calculations.

growth has been particularly significant. Kazakhstan, with relatively high healthcare expenditure (4% of GDP) and a robust healthcare system, has leveraged improvements in health to support economic growth, especially in non-oil sectors such as services and manufacturing (Kanzaki Izawa et al., 2021). In Uzbekistan, reforms in healthcare financing and rural health infrastructure have led to better health outcomes, boosting agricultural productivity and labor force participation (EBRD, 2020). By contrast, Tajikistan and the Kyrgyz Republic face significant challenges due to limited healthcare funding (approximately 2% of GDP) and high out-of-pocket expenses (World Bank, 2022). In Turkmenistan, where data availability is limited, the full impact of health on economic growth remains unclear (IMF, 2021).

4. Conclusions

In this paper, we analyzed the patterns of economic performance in Central Asia over the past two decades. In doing so, we applied an extended version of the standard growth accounting methodology, at both the aggregate level and on a per-worker basis.

Results from the first analysis show that over the entire period under study, on average, the growth rates of TFP range from 2.5% (1.9%) for Kazakhstan, 2.4% (2.1%) for the Kyrgyz Republic, 5.1% (4.7%) for Tajikistan, 6.9% for Turkmenistan and to 2.4% (1.6%) for Uzbekistan, depending on two values of alpha. As for per-worker basis, the growth rates of TFP did not change either: values of this indicator became smaller.

The contribution of capital to growth was not influential in the region, albeit in some republics capital inputs were negative. This may be due to the full utilization of Soviet inherited capital stock and the lack of a sound investment into existing and new sectors of economies. In particular, it can be seen in the case of Tajikistan and Kyrgyz Republic for the period of 2011–2021.

With respect to the role of life expectancy we can say that it has consistently improved in Central Asia, both in the economy as a whole and on an individual worker basis. Its contribution to the growth rate of total output was quite small and ranged from one and to five percent. Similarly, a study by Acemoglu and Johnson (2007) examines the correlation between life expectancy and economic growth and finds that advances in this health indicator have little effect on growth. Yormirzoev (2023) explores the effects of human capital on economic growth of Kazakhstan, the Kyrgyz Republic, and Tajikistan. His findings also show that the health component does not have a substantial impact on output expansion.

As for the individual worker, health significantly affects the rate of the growth of labor productivity. The contribution of life expectancy to the amount of output produced per unit of labor input ranged from 5% to 19%. This is comparable to the broader literature, which indicates that improvements in health generally result in economic advantages, mainly through boosting labor productivity (Weil, 2014; Benhabib and Spiegel, 1994).

While every country in Central Asia has seen an increase in life expectancy, the impact of this upturn on productivity varies across countries. Tajikistan and Turkmenistan consistently demonstrate the lowest impact, suggesting that health improvements have limited influence on labor productivity. Life expectancy contributions in Kazakhstan and Uzbekistan have shown an increase. As for the Kyrgyz Republic, it has the highest level of contribution. Nevertheless, these values are small and suggest that factors such as capital investment and TFP have a much greater impact on economic outcomes in the region.

We need to admit that our study is subject to the reverse causality between health inputs and economic growth. Indeed, physical health can contribute to increased productivity and then economic growth, but, conversely, rising income can lead to increases in the availability and the quality of health component of human capital.

Secondly, findings of the paper are based on official data, while almost in all countries of the region about a third of economically active part of population is engaged in cash-based activities (Medina and Schneider, 2018).

The chosen method used in the paper is based on the Solow residual approach, which decomposes output growth into contributions from labor, capital, and TFP. It directly attributes growth to factor accumulation and productivity, providing a straightforward decomposition of growth sources. However, TFP, as a residual, is subject to mismeasurement, and factor shares are assumed to reflect marginal products, which may not always hold in practice.

Alternatively, the regression-based approach extends traditional growth accounting by statistically estimating the contribution of different factors to growth. This method allows for empirical testing of growth determinants and the inclusion of additional independent variables, such as institutions and policies. However, empirical results are sensitive to the choice of control variables, estimation techniques, and sample selection. Moreover, capital, labor, and productivity are often jointly determined, making causal inference challenging.

Future research could focus on analyzing a larger set of countries, incorporating relevant dummy variables to account for shared characteristics in regression analyses. Given the common historical background of Central Asian republics, there may be unobserved factors, such as cultural influences, conflicts, and political instability, that significantly impact economic outcomes. Another valuable extension of this study could involve examining the role of male life expectancy on economic performance across all five countries of the region, where patriarchal traditions dominate nearly every aspect of economic activity.

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