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Research Article

POPULATION AGING AND REGIONAL INEQUALITIES IN UZBEKISTAN'S ECONOMY

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ABSTRACT

This paper examines the economic implications of Uzbekistan's demographic transition by analyzing how population age structures, human capital, and regional disparities shape growth. Using municipal-level data from Uz.Stat (2000–2023) and econometric methods, it identifies the prime working-age group (35–49) as the main driver of productivity, while younger (0–19) and older (65+) cohorts create dependency pressures. Urban-rural divides further mediate these effects, with population density both constraining and enhancing economic performance. Educational attainment emerges as a crucial factor mitigating demographic pressures and supporting growth. The study highlights the need for targeted policies to harness Uzbekistan's demographic dividend and manage aging challenges through investments in education, healthcare, and labor market reforms particularly for women and older workers offering insights for fostering inclusive and sustainable development across emerging economies.

Keywords: Demographic dividend, Population aging, Uzbekistan, Economic growth, Regional analysis.

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INTRODUCTION

By 2050, Uzbekistan's population aged 60 and above is expected to double, potentially straining social protection systems and healthcare budgets, yet also creating new economic opportunities in care services and the silver economy (World Population Prospects, 2023). In 2024, the country stands at a pivotal demographic juncture, with a youthful population of 36.36 million and a median age of 27 (World Bank, 2023). However, declining fertility rates (3.5 children per woman) and rising life expectancy (72.5 years) signal significant demographic shifts ahead (Stat.uz, 2024). These transitions mirror the experiences of more advanced economies, such as Japan and South Korea, which have faced similar aging challenges. Unlike these countries, Uzbekistan's economic trajectory is shaped by a combination of rapid reforms, such as privatization and energy sector investments, and persistent socio-economic disparities (Asian Development Bank, 2024).

Uzbekistan's economy is projected to grow by 5.3% in 2024, maintaining its status as one of the fastest-growing economies in the Europe and Central Asia region (World Bank, 2024). This growth is driven by ongoing structural reforms and economic liberalization. Yet, the country faces challenges, including uneven urbanization, skills shortages, and reliance on remittances, which are expected to decline due to reduced labor migration to Russia (ILO, 2023). While improvements in fiscal consolidation and inflation targeting demonstrate the government's commitment to economic modernization, these efforts must be carefully aligned with demographic shifts to ensure long-term sustainability (World Bank, 2024).

Countries undergoing demographic transitions often face complex challenges. Japan and South Korea exemplify how strategic investments in education, healthcare, and labor market reforms can enable nations to harness their demographic dividend—the economic growth potential that arises when the working-age population expands relative to dependents, creating opportunities for higher productivity and investment (Bloom, Canning, & Sevilla, 2003). These nations achieved sustained economic growth despite pressures such as aging populations and urbanization (Bloom & Canning, 2004). Uzbekistan now finds itself at a similar crossroads, requiring proactive strategies to capitalize on its demographic dividend while preparing for the socio-economic pressures of an aging population.

Since its independence in 1991, Uzbekistan has implemented significant economic reforms, achieving an average annual GDP growth rate of 7% between 2000 and 2020 (Stat.uz, 2024). However, regional inequalities, underutilization of the female workforce, and challenges in labor migration hinder the full realization of the country's potential (ILO, 2023). The opportunities presented by a youthful population may wane if demographic transitions are not managed with targeted policies, leaving Uzbekistan unprepared for the fiscal and social pressures associated with an aging population (UNFPA, 2023).

This study investigates the economic impact of demographic shifts, including declining fertility rates and an aging population, on regional economic performance in Uzbekistan. The analysis spans 208 municipalities across 14 regions from 2000 to 2023, examining the interplay between demographic factors, human capital, and urban-rural disparities (Stat.uz, 2024). Figure 1 (Appendix) illustrates

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Uzbekistan's GDP growth trends alongside its demographic profile, highlighting the importance of adapting policies to these evolving population dynamics (World Bank, 2024). Similarly, Figure 2 (Appendix) demonstrates stark regional variations in population density, indicating the need for tailored regional policies to mitigate rural-urban disparities (Asian Development Bank, 2024).

Female labor force participation, as shown in Figure 3 (Appendix), is another critical factor in Uzbekistan's demographic transition. The data reveals that, despite declining fertility rates, gender disparities in labor force participation persist, particularly in rural areas (ILO, 2023). Expanding opportunities for women in the workforce will be essential for fully capitalizing on Uzbekistan's demographic dividend.

Finally, targeted policies to address rural-urban disparities are vital for ensuring inclusive economic growth. Figure 2 (Appendix) presents the population distribution across Uzbekistan's regions from 2000 to 2023, highlighting contrasts in urbanization levels and regional economic potential (Stat.uz, 2024). Rural areas often experience limited access to education and healthcare, which hampers their ability to contribute fully to economic productivity (UNFPA, 2023). Strategic investments in these sectors can help bridge these divides and promote balanced regional development.

This study contributes to the literature by addressing key gaps. First, while much research explores demographic transitions at the national level, this paper examines the regional and municipal-level economic effects of age structures in Uzbekistan, revealing important disparities (Lutz et al., 2008). Second, the analysis integrates age cohorts with measures of human capital, such as educational attainment, to highlight how these factors interact to shape economic outcomes (Bloom & Canning, 2004). Finally, drawing lessons from Japan and South Korea, this study situates Uzbekistan's demographic transition within broader theoretical frameworks, offering transferable insights for other emerging economies navigating similar shifts (Asian Development Bank, 2024).

By exploring these issues, this study provides a deeper understanding of Uzbekistan's demographic dynamics and offers actionable insights for policymakers. The ability to harness its demographic window could determine whether Uzbekistan emerges as a model for managing demographic transitions or faces heightened economic disparities and stagnation.

The paper is structured as follows. It outlines the demographic context and key regional trends. The literature review discusses existing studies on fertility decline, age structure, labor participation, and urban-rural disparities. The methodology explains the data, variables, and econometric approach used in the analysis. Empirical evidence presents the main findings, while the discussion interprets these results in the broader context of Uzbekistan's development. Finally, the conclusion and policy recommendations summarize the study's key insights and suggest measures to harness the demographic dividend and address aging challenges.

LITERATURE REVIEW

The concept of the demographic dividend arises from the demographic transition, where a decline in both birth and death rates shifts the age structure of a population, increasing the proportion of the working-age group (15–59) rela-

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tive to dependents (0–14 and 60+). This transition offers significant economic opportunities if the additional labor force is effectively utilized (Bloom et al., 2011; Lee & Mason, 2010). The theoretical foundation of this concept links to Coale and Hoover's (1958) work on population growth and economic development, which was later refined by studies emphasizing age structure changes, such as Bloom and Williamson (1998) and Higgins and Williamson (1997).

While much of the global literature emphasizes broad mechanisms through which demographic transitions shape growth, recent research underscores the importance of regional and institutional contexts. For example, in post-Soviet Central Asia, demographic shifts have been closely tied to structural legacies of planned economies, high labor migration, and uneven regional development (Nazarov, 2021; Olimova & Bosc, 2003). Studies by UNFPA (2022) and the World Bank (2023) highlight that Uzbekistan's fertility decline has occurred more gradually than in neighboring Kazakhstan, where rapid urbanization accelerated demographic transition. Meanwhile, Kyrgyzstan and Tajikistan continue to experience higher fertility and stronger dependency burdens, particularly in rural areas (ADB, 2020; Spoor, 2019). This suggests that Uzbekistan occupies a middle ground within the region's demographic spectrum, facing both opportunities from its sizable working-age population and challenges related to premature aging and rural stagnation.

The potential benefits of a demographic dividend include several interconnected advantages. First, an expanded labor force results from a larger working-age population, which produces more than it consumes, thereby driving economic productivity (Bloom et al., 2011). Second, declining fertility rates contribute to improved female labor force participation by freeing women to engage in paid employment (Lee & Mason, 2010). In the Central Asian context, however, female labor force participation is shaped by cultural norms and structural constraints, with Uzbekistan showing lower female employment in industry and services compared to Kazakhstan (ILO, 2023; Abdurakhmanova, 2018). Third, with fewer children to support, families and governments can allocate more resources to health, education, and skills, leading to increased investment in human capital (Birdsall et al., 2003). Yet, regional disparities in Uzbekistan reveal that rural households often remain excluded from these gains due to weaker access to healthcare and education (UNDP, 2021; Pomfret, 2019).

Finally, higher savings rates emerge as working-age individuals save more in preparation for retirement, contributing to national savings and capital formation (Bloom et al., 2003). However, empirical studies show that in Uzbekistan, labor migration and remittances play a far greater role in shaping household savings and investments than pension-based savings (Mansoor & Quillin, 2007; EBRD, 2022). This divergence from the "classic" demographic dividend pathway underscores the need for region-specific analysis.

However, this dividend is not automatic and depends on policy measures such as investments in education and health, labor market flexibility, governance, and macroeconomic management (Lee & Mason, 2006; Bloom et al., 2011). Without these, the demographic dividend can give way to economic stagnation and social instability. As fertility declines and populations age, these initial benefits give way to challenges, including labor shortages, increased dependency ratios, and fiscal pressures on pension and healthcare systems.

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Countries in Eastern Europe and Latin America provide relevant comparative lessons for Uzbekistan. Following the collapse of the Soviet Union, nations like Poland, Hungary, and Bulgaria experienced rapid demographic transitions. These countries faced significant challenges in maintaining economic growth amidst population aging and emigration. For instance, Bloom et al. (2011) found that Eastern European countries struggled with shrinking labor forces and savings rates, leading to slower economic growth. Despite these challenges, targeted policies focusing on education and labor market reforms have shown moderate success in mitigating the adverse effects of aging populations.

In Latin America, countries such as Brazil and Argentina have also grappled with declining fertility rates and an aging workforce. Lam and Duryea (1999) demonstrated that in Brazil, investments in education and healthcare, coupled with efforts to increase female labor force participation, significantly improved economic outcomes during their demographic transition. These examples underscore the importance of proactive strategies to address regional disparities and improve labor market efficiency.

Declining birth rates and economic growth

Declining fertility rates are a global phenomenon, with significant consequences for future economic growth. Lutz et al. (2008), using demographic modelling to project long-term labor supply under scenarios of declining fertility, underscore the long-term implications of declining fertility on labor supply and economic stagnation if not counterbalanced by technological innovation or immigration. Acemoglu and Johnson (2007) argue that while reduced fertility rates can initially boost per capita output, the eventual decline in the labor force undermines these gains unless mitigated by policy changes.

However, Uzbekistan's demographic profile exhibits both opportunities and pressures. The fertility rate has declined to 3.5 children per woman as of 2024, signaling a gradual demographic transition consistent with global trends. This aligns with the long-term projection shown in Figure 1 (Appendix). At the same time, life expectancy has risen to 72.5 years, reflecting improvements in healthcare (World Bank, 2023). These trends, while positive in some respects, pose significant economic challenges as the share of the population aged 60 and above is projected to double by 2050 (UNFPA, 2023).

Population age distribution and economic growth

Aging populations disproportionately affect emerging economies due to weaker social welfare systems. Harper (2016) examined global aging trends through policy analysis and found fiscal pressures mounting on pensions and healthcare systems in countries without robust safety nets. Bloom et al. (2011) used cross-country regression models to quantify the relationship between aging and economic growth, emphasizing that emerging economies face structural inefficiencies that hinder effective responses.

In Uzbekistan, the UN (2023) projects that the share of people aged 60 and above will double by 2050. Without reforms to strengthen the pension system and healthcare infrastructure, such demographic shifts may exacerbate economic inequalities and constrain growth. The World Bank (2024) recommends increasing labor participation among older workers through upskilling programs and flexible employment policies to offset these trends.

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Female labor force participation and economic growth

The role of women in economic development is well-documented. Goldin (1995) analyzed historical labor force data and identified a U-shaped relationship between female labor force participation and economic development, concluding that empowering women improves GDP growth and resilience. Estevez-Abe (2006) employed comparative case studies across welfare states to explore how social policies impact women's workforce participation.

The labor market in Uzbekistan reflects stark regional disparities. Female labor force participation has improved, rising from 37% in 2000 to 48% in 2022 (ILO, 2023). However, rural women remain significantly underrepresented in the workforce, particularly in high-productivity sectors like industry and services. This is compounded by limited access to education and healthcare in rural areas, which exacerbates regional inequalities. Addressing these disparities is crucial for enabling Uzbekistan to fully harness its demographic dividend.

Urban-rural disparities and dependency ratios

Urbanization drives productivity and innovation, as shown by Henderson (2003) and Fujita et al. (2001). These studies emphasize the role of urban centers in attracting skilled labor and facilitating economic development. However, rural areas often face stagnation due to limited access to resources and infrastructure. In terms of dependency ratios, as these ratios rise, economies face increasing burdens on working-age populations. Lee and Mason (2010) highlight that countries with high dependency ratios experience slower growth due to reduced savings and increased fiscal pressures on public resources. Regional disparities further complicate the economic impact of aging populations, particularly in areas with varying fertility and migration rates.

Similarly, Uzbekistan's population distribution reflects significant urban-rural disparities. Data from the ADB (2024) shows that urban areas experience higher economic activity and labor force participation, while rural regions suffer from underinvestment and outmigration. Bridging this gap requires targeted investments in rural education, healthcare, and infrastructure to ensure equitable development. Additionally, Uzbekistan's dependency ratio varies across regions. Southern and rural areas face higher dependency ratios due to younger populations, while urban centers experience lower ratios, according to Stat.uz (2024). These regional differences call for tailored economic strategies to address localized challenges, such as promoting labor mobility and equitable resource distribution.

While existing literature provides extensive insights into global demographic trends, there remains limited research on the specific regional dynamics of aging in Uzbekistan. For example, UNFPA (2025) outlines Uzbekistan's trajectory: the working-age population (15–64 years) is projected to increase significantly, yet the share of the 65+ cohort is also expected to grow rapidly, suggesting that harnessing a demographic dividend will require both human-capital investment and age-sensitive policy reform. Similarly, Tóth and Molnár (2020) compare Uzbekistan's situation with that of South Korea, arguing that proactive labor-market reforms, greater female employment, and investments in education are essential to convert age-structure advantages into sustained economic growth. Incorporating these country-specific studies helps fill the gap in the literature regarding Uzbekistan's aging population, regional inequalities, and

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policy responses. Thus, this paper aims to address this gap by examining how demographic transitions impact regional economies within Uzbekistan, focusing on labor market dynamics, gender participation, and rural-urban disparities.

METHODOLOGY

This study adopts a comprehensive econometric approach to analyze the demographic and socio-economic determinants of economic growth in Uzbekistan at the municipal level. The primary goal is to examine how age structures, human capital, and geographic factors contribute to variations in per capita GDP growth, while addressing potential biases and heterogeneities inherent in the data.

The econometric framework builds on the theoretical underpinnings of demographic transition economics, where shifts in population structures influence labor supply, dependency burdens, and productivity (Bloom & Canning, 2003; Lee & Mason, 2010). By leveraging municipal-level data, the analysis captures localized effects of demographic changes, highlighting regional disparities and the interplay between urbanization and economic outcomes.

The core model can be expressed as:

$$GDP.Growth_i = \beta_0 + \sum\nolimits^{J}_{j=1} \beta_j\, AgeCohort_{ijt} + \beta_1\, Edu_{it} + \beta_2\, dens_{it} + X_{it}\Upsilon + \varepsilon_{it}$$

Where $GDP.Growth_{it}$ represents the per capita GDP growth for municipality i in year t, $AgeCohort_{ijt}$ denotes the population share of age cohort j (e.g., 0–19, 20–34, etc.), and includes socio-economic covariates such as trade openness, capital per worker, and economically active population ratios. The model incorporates controls for fertility rates, mortality rates, life expectancy, and municipality-level fixed effects to account for unobserved heterogeneity.

To enhance the explanatory power of the analysis and address key economic dynamics, the study expands the baseline model in several ways.

First, lagged versions of demographic and socio-economic variables are introduced to capture delayed effects. Economic responses to changes in age structures, such as shifts in labor market participation or dependency burdens, often take time to materialize (Bloom et al., 2011). For instance, a larger young-age cohort today may contribute positively to economic growth in the future as this group transitions into the labor force. Similarly, lagged fertility and mortality rates provide insights into the temporal relationships between demographic shifts and economic performance.

Second, instrumental variables (IVs) are employed to address potential endogeneity concerns. Endogeneity may arise if GDP growth influences age structures or socio-economic factors, such as migration patterns or fertility decisions, creating reverse causality (Acemoglu & Johnson, 2007). To mitigate this issue, birth and death rates from prior periods serve as instruments for age cohort shares, ensuring that the estimated relationships reflect causal effects rather than spurious correlations.

Third, the analysis disaggregates municipalities into urban and rural contexts to explore spatial heterogeneities. Urbanization plays a pivotal role in shaping economic outcomes by concentrating human capital and facilitating agglomeration effects (Henderson, 2003). However, rural areas often face infrastructure and resource constraints that limit their capacity to capitalize on demographic dividends. By running separate regressions for urban and rural areas and including interac-

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tion terms, the study provides a nuanced understanding of how demographic and socio-economic factors influence economic growth in different settings.

Finally, the inclusion of dependency ratios—defined as the proportion of young (ages 0–14) or elderly (ages 65+) populations relative to the working-age population (ages 15–64)—enriches the analysis by highlighting the economic pressures associated with non-working age groups. While younger cohorts may pose immediate fiscal burdens, they also hold the potential for future economic contributions through labor force participation and human capital development (Lutz et al., 2008). Conversely, higher old-age dependency ratios are typically associated with increased healthcare and pension costs, which can constrain growth (Harper, 2016).

Empirical analysis

The analysis employs ordinary least squares (OLS) for baseline estimates and two-stage least squares (2SLS) to address endogeneity concerns, with lagged birth and death rates serving as valid instruments for demographic variables. These instruments are exogenous to current GDP growth, ensuring robust causal interpretations. OLS models establish baseline relationships between age cohorts, socio-economic factors, and GDP growth. However, to address endogeneity, the 2SLS framework uses birth and death rates as instruments for age cohort shares, ensuring more reliable causal inferences.

The analysis incorporates municipal-level fixed effects to control for unobserved heterogeneity, such as regional policies or geographic characteristics, that could influence economic outcomes. Additionally, the use of lagged demographic and socio-economic variables accounts for delayed economic responses, enhancing the temporal accuracy of the estimates.

The disaggregated urban-rural analysis reveals how demographic shifts interact with local economic structures. For instance, in rural areas, younger and older age groups demonstrate positive contributions to GDP growth, potentially reflecting labor force expansion and savings contributions, respectively. Conversely, the 20–34 age group exerts a negative influence, likely due to employment integration challenges or outmigration pressures. Urban municipalities, however, exhibit greater variability in the effects of demographic factors, with middle-aged populations (50–64) consistently driving growth through skilled employment, entrepreneurship, and human capital utilization.

Data and variables

This study investigates how demographic shifts, such as declining fertility and population aging, influence Uzbekistan's regional economic performance. Data was collected from Stat.uz (2023), including population and employment datasets, which were acquired directly from the national statistical agency. This unique access to high-resolution municipal-level data enables a more detailed analysis of 14 regions and 208 districts from 2000 to 2023. The dataset encompasses age distributions, socio-economic indicators, and geographic characteristics, with municipalities categorized as urban or rural based on Stat.uz's 2020 classifications. This granular data makes the study particularly distinctive in its ability to uncover localized economic dynamics within Uzbekistan.

The dependent variable is the per capita gross regional product (GRP), calculated by dividing the total GRP of a municipality by its population, serving as a proxy for economic performance. Key independent variables include age cohorts, human capital, geographic factors, and municipality type. Age cohorts are divided into six categories: 0–19 (childhood and adolescence), 20–34 (early adulthood), 35–49 (prime working years, the reference group), 50–64 (middle age), 65–79 (old age), and 80+ (advanced old age). These cohorts are expressed as percentages of the total population, following a methodology similar to Lindh and Malmberg (1999). The reference group, 35–49, serves as a baseline for interpreting the effects of other age groups.

Table 1
Descriptive statistics

Variable name	Observation	Mean	Standard Deviation	Min	Max
Population age-groups					
0_2	1984	30528.160	153701.696	390	2631509.000
3_5	1984	281013478	141070.388	371	2219697.000
6_7	1984	18005.991	903262648	260	1432017.000
8_15	1984	63554.731	319210.176	908	5154170.000
16_17	1984	14384.503	72144.729	151	1120467.000
18_19	1984	14885.678	74851.323	201	1259509.000
20_24	1984	40924.885	205551.401	613	3238978.000
25_29	1984	43417.202	217336.603	517	3212525.000
30_34	1984	40039.671	200975.976	571	3163221.000
35_39	1984	33384.910	168061.140	566	2870778.000
40_49	1984	53244.735	267.140.7119	1020	4253017.000
50_59	1984	42091.235	210882.503	907	3259652.000
60_69	1984	23740.809	121086.136	530	2231559.000
70_74	1984	4842.630	25353.492	95	546980.000
75_79	1984	3508.452	17710.122	29	280489.000
80_84	1984	2110.973	10681.244	33	172456.000
85+	1984	1663.393	8553.695	30	139280.000
total_ population	7070	389.277	1948.937	7.2	36024.900

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employment_ district	4835	166.905	833.109	1.7	13706.200
Control variables					
birth_rate	1990.000	23.665	3.454	11.000	45.200
death_rate	1989.000	4.849	1.137	1.700	30.700
education_pr	360.000	755.611	154153.000	32.000	9454.000
employment	345.000	1559.398	2764.518	248.300	13706.200
capital	345.000	1959.273	3364.692	15.800	20619.800
pop_density	360.000	631.705	1674.634	7.100	7699.605
divorce	345.000	3194.145	6100.640	407.000	48733.000
econ_active_ pop	345.000	1643.481	2930.421	249.300	15038.900
fertility	210.000	2.562	0.365	1.916	3.538
fertility_rural	196.000	2.759	0.417	1.596	4.276
fertility_urban	210.000	2.381	0.466	1.622	5.219
infant_ mortality	345.000	12.525	3.882	4.791	24.900
life_ expectancy	345.000	72.795	1.803	67.500	78.000
marriage	345.000	33975.983	614336439.000	3910.000	311379.000
mortality_ urban	345.000	515.983	929.804	64.000	5354.000
trade	345.000	111.672	87342.000	89.900	135.500
unemployment	345.000	4.625	3.346	7341.000	11.100
female_labor	345.000	696.421	1232003.000	105.839	6189.238
gdp_ex	435.000	23797.700	83251.154	9.700	888341.680

Source: Stat.uz (2023), calculated by author

Human capital, measured by the percentage of the population with a college education, reflects the role of education in enhancing economic output, aligning with studies like Kotschy and Sunde (2018). Population density, calculated as the number of people per square kilometer, is used as a proxy for urbanization and agglomeration effects. A binary variable distinguishes between urban (1) and rural (0) municipalities, allowing for differentiation between economic dynamics in these contexts.

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Additional control variables include fertility rates (average number of births per woman), mortality rates (deaths per 1,000 people), the youth dependency ratio (proportion of population below 20 to working-age population), employment rates (percentage of the economically active population), life expectancy (proxy for health outcomes), and infant mortality rates (deaths of infants under one year per 1,000 live births).

Given the unavailability of prospective aging statistics and limited data for specific periods, the analysis focuses on retrospective components of aging. The population is divided into six age cohorts: 0–19, 20–34, 35–49, 50–64, 65–79, and 80+. These cohorts represent key life stages, with working-age groups covering early adulthood, prime age, and middle age, and the oldest cohorts reflecting old age and advanced old age. Although age 60 is typically used to distinguish between employed and non-employed individuals, the average retirement age in Uzbekistan is 60 years, making this a practical reference point for the analysis, according to Daryo.uz (2023).

EMPIRICAL EVIDENCE

Demographic and socio-economic determinants of GDP growth

For this analysis, I employ simple regressions incorporating several covariates, including education, population density, trade openness, the economically active population ratio, and capital per worker. To address potential reverse causality issues, lagged versions of the age structure variables are included in the study. Additionally, the analysis is refined at the district level using two-stage least squares (2SLS) models with a range of alternative instruments, such as birth and death rates from five years earlier.

Table 2 presents the initial results of the empirical analysis. In models (1) and (2), the natural logarithm of the population aged 0–19 positively impacts GDP growth, suggesting that a larger youth population is associated with greater economic growth. However, this effect is no longer statistically significant in model (3), though it re-emerges as significant at the 10% level in model (4). In contrast, the 20–34 age cohort negatively impacts GDP growth (see Table 2) due to employment challenges. However, its significant role in urban growth (see Figure 2 (Appendix)) underscores the need for targeted labor market policies, strongly indicating that a larger population in this age cohort corresponds to slower economic growth. This trend may reflect financial strains from prolonged education or challenges in integrating individuals in this age range into the labor market.

The older age groups (50–64 and 65–79) display mixed results. For the 50–64 cohort, GDP growth is positively correlated, suggesting that the expertise and productivity of individuals in this group may contribute to economic expansion. Conversely, the 65–79 age group negatively affects GDP growth, likely due to rising healthcare and pension costs associated with an aging population. The oldest cohort, individuals aged 80 and above, exerts a consistently negative influence on GDP growth, although this effect is statistically significant only in model (3). These findings suggest that the economic pressures exerted by this demographic are persistent but vary in magnitude across models.

The inclusion of socio-economic covariates in models (2) and (4) provides further insights into the factors influencing GDP growth. Education growth and trade openness, while intuitively important, do not achieve statistical signifi-

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cance in these models, implying minimal direct effects on economic growth during the analyzed period. In contrast, population density growth demonstrates a negative relationship with GDP growth in both expanded models, indicating that rapid population increases may place significant pressure on infrastructure and resources, thereby constraining economic expansion. Capital growth and economic activity emerge as critical drivers of GDP growth, with strong positive correlations observed in all models.

The analysis underscores the significant role of demographic factors in shaping economic growth, with distinct and often contrasting effects exerted by different age groups. The findings also highlight the nuanced interplay between socio-economic variables and demographic structures. For instance, the adverse relationship between population density growth and GDP growth may reflect challenges related to urbanization and inefficiencies in local governance.

Table 2
Individual effects of population age structures on regional economic growth

Dependent var.:	**OLS**		**2SLS**	
	Main (1)	**Expanded (2)**	**Main (3)**	**Expanded (4)**
Income per capita growth				
ln_Age_0_19	0.832 (0.557)	1.697*** (0.533)	0.370 (0.643)	1.156** (0.602)
ln_Age_20_34	-3.014*** (0.720)	-4.563*** (0.831)	-3.620*** (0.644)	-4.279*** (0.819)
ln_Age_50_64	4.109*** (0.388)	1.943*** (0.448)	4.828*** (0.312)	2.136*** (0.467)
ln_Age_65_79	-1.391*** (0.250)	-0.835*** (0.252)	-1.324*** (0.223)	-0.789*** (0.243)
ln_Age_80_plus	-0.283** (0.126)	-0.032 (0.104)	-0.299*** (0.105)	-0.048 (0.105)
pop_density_growth	-0.212*** (0.022)	-0.102*** (0.026)	-0.203*** (0.019)	-0.123*** (0.026)
trade_growth		0.261 (0.283)		0.039 (0.284)
econ_active_growth		1.824*** (0.450)		1.779*** (0.434)
capita_growth		0.314*** (0.049)		0.276*** (0.053)
mortality_growth	-0.261*** (0.067)	-0.050 (0.057)		0.012 (0.060)
birth_rate_growth			1.948*** (0.338)	0.946*** (0.349)
death_rate_growth			0.431 (0.311)	0.475* (0.285)

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municipality	-1.775*** (0.250)	-0.338 (0.261)	-1.078*** (0.164)	-0.263 (0.279)
contant	2.692*** (0.687)	9.798*** (3.184)	-2.298* (1.207)	8.119** (3.157)
First-stage F-statistic	66.032***	87.673***	27.795***	32.961***
p-value	0.000***	0.000***	0.000***	0.000***
Multiple R-Squared	0.807	0.899	0.861	0.908
Adjusted R-Squared	0.795	0.889	0.850	0.897
Wald test (p-value)			0.000***	0.000***
Excluded instruments			2	2
Observation	135	120	120	120
Diagnostic tests:				
Weak instruments (birth_lag)			0.000***	0.000***
Weak instruments (death_lag)			0.000***	0.000***
Wu-Hausman			0.0795*	0.0944*
Breusch-Pagan test (p-value)	0.000***	0.000***	0.000***	0.0005175***
Durbin-Watson test (p-value)	0.000***	0.000***	0.000***	0.000***

Source: Author's calculation based on Stat.uz (2023) statistics

Note: Table 2 shows the regression results of age group effects on economic growth. Models (1) and (2) represent the OLS results, while (3) and (4) indicate 2SLS estimates. Model (2) is an expansion of model (1) with additional socio-economic covariates. Models are controlled for time effects with municipality covariates. Standard errors are clustered at the country level and reported in parentheses. Diagnostic test results are also included. Asterisks (*** for 1%, ** for 5%, and * for 10%) are used to indicate the significance levels.

Moreover, the increasing R-squared values across models—ranging from 78% to 90%—indicate that the inclusion of additional covariates enhances the explanatory power of the analysis, capturing a greater portion of the variation in GDP growth.

In summary, economic growth appears to be heavily influenced by demographic considerations, with younger and older populations exerting divergent effects. While younger cohorts are generally associated with growth, older populations pose economic challenges, particularly in the form of healthcare and pension costs. These findings emphasize the importance of aligning policies with demographic realities to foster sustainable economic development.

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Urban and rural effects of population aging

This section examines the distinct effects of demographic changes on economic growth in rural and urban municipalities, as reflected in Table 3. The models differentiate between urban and rural contexts to provide a nuanced understanding of how population age groups influence economic outcomes in these settings.

In rural areas, the results reveal a complex relationship between age demographics and economic growth. Younger age groups (0–19) and older populations (50–64, 65–79) show positive coefficients, suggesting their potential contributions to economic growth. Younger cohorts may drive growth through an expanding labor force, while older groups might provide economic benefits through accumulated savings and expertise that support productivity. Conversely, the 20–34 age group consistently exhibits a negative impact on GDP growth across all rural models, likely reflecting challenges in integrating this population into stable employment. Additionally, socio-economic factors such as population density growth are negatively correlated with GDP growth in rural areas, pointing to infrastructure and resource limitations or the adverse effects of rapid densification.

In contrast, urban models display more variability in the relationship between age groups and economic growth, with larger standard errors and reduced statistical significance for some demographic categories, particularly the 0–19 and 20–34 age groups. This variability may stem from differing economic roles played by urban populations or the diverse effects of urbanization and economic structures. Notably, the 50–64 age group consistently contributes positively to GDP growth in urban areas, highlighting the role of middle-aged individuals in driving economic activity, potentially through skilled employment or entrepreneurial ventures. However, the negative effect of population density growth, significant at the 10% level, mirrors the rural findings, suggesting that rising population pressures pose challenges to both urban and rural regions.

Table 3

Urban and Rural Area Effect on Economic Growth by Age Groups

Dependent var.:	Urban			Rural			
	OLS (1)	OLS (2)	2SLS (3)	OLS (1)	OLS (2)	2SLS (3)	2SLS (4)
Income per capita growth							
ln_Age_0_19	-13.874 (12.741)	-15.642 (14.801)	-11.289 (5.37)	1.837*** (0.475)	1.665*** (0.571)	0.220 (0.650)	1.322** (0.638)
ln_Age_20_34	-1.035 (19.401)	10.049 (26.998)	2.247 (8.147)	-4.816*** (0.498)	-4.551*** (0.891)	-3.410*** (0.651)	-4.513*** (0.872)
ln_Age_50_64	9.89 (5.231)	11.461 (6.375)	9.131 (2.189)	4.898*** (0.349)	2.001*** (0.484)	4.786*** (0.315)	2.038*** (0.503)
ln_Age_65_79	1.864 (8.114)	0.495 (9.488)	1.905 (3.379)	-1.817*** (0.236)	-0.869*** (0.263)	-1.325*** (0.228)	-0.808*** (0.252)
ln_Age_80_plus	9.154 (3.217)	6.716 (4.994)	6.987 (1.574)	-0.124 (0.122)	-0.031 (0.111)	-0.314*** (0.107)	-0.011 (0.115)
edu_growth		-0.694 (0.960)			-0.051 (0.060)		0.035 (0.065)

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pop_density_growth	-16.093* (4.498)	-10.155 (9.691)	-10.743 (2.728)	-0.177*** (0.021)	-0.104*** (0.027)	-0.205*** (0.020)	-0.125*** (0.028)
trade_growth					0.304 (0.300)		0.044 (0.299)
econ_active_growth					1.819*** (0.493)		1.898*** (0.472)
capita_growth					0.308*** (0.053)		0.282*** (0.058)
birth_rate_growth						1.948*** (0.352)	1.040*** (0.367)
death_rate_growth						0.536 (0.329)	0.711** (0.316)
Constant	102.438 (266.811)	-48.177 (369.862)	8.252 (115.756)	0.811 (0.856)	8.895** (3.495)	-4.692*** (1.303)	7.845** (3.358)
R squared	0.993	0.995	0.999	0.751	0.875	0.837	0.888
Adjusted R squared	0.97	0.961	0.995	0.738	0.863	0.824	0.875
Residual Std. Error	0.086	0.099	0.036	0.281	0.203	0.230	0.194
F Statistic	44.681	29.247			59.762***	70.999***	

Source: Author's calculation based on Stat.uz (2023) statistics

Note: Table shows the regression results for urban and rural municipalities, measuring the population age structure effect on economic growth. For each urban and rural municipality, there are OLS and 2SLS models indicated. In parentheses, robust standard errors are indicated. Asterisks (*** for 1%, ** for 5%, and * for 10%) are used to indicate the significance levels.

While the models offer valuable insights, the high R-squared values and limited sample sizes raise concerns about overfitting, particularly in urban contexts. Caution is advised when interpreting these results, and additional validation is necessary to strengthen the conclusions drawn from these findings.

Young – or old-age ratio: which age group has more effect on income change?

The regression analysis examines the impacts of young-age and old-age dependency ratios on income per capita growth, using both OLS and 2SLS methods. These dependency ratios represent the proportion of young (ages 0–14) and elderly (ages 65 and older) populations relative to the working-age population (ages 15–64). The models incorporate a robust set of control variables, including education levels, capital growth, trade growth, economic activity, life expectancy, female labor participation, and municipality classifications.

To address potential endogeneity concerns, the analysis employs alternative instruments such as lagged life expectancy and fertility rates, which help mitigate issues of reverse causation. For instance, economic growth may influence fertility rates or migration patterns, altering age structure dynamics. Additionally, municipality-specific controls account for fixed effects and alleviate biases as-

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sociated with the Generalized Method of Moments (GMM) approach, which can suffer from specification and endogeneity issues.

The results reveal a clear distinction in the economic impacts of demographic shifts. A higher young-age dependency ratio is associated with a significant negative immediate effect on economic growth, as evidenced across OLS and 2SLS models. This finding underscores the short-term economic pressures posed by a younger dependent population. However, the lagged analysis indicates a positive effect of the young-age dependency ratio, suggesting that a younger population may contribute to economic expansion in the long term, potentially due to increased future labor force participation and productivity gains.

In contrast, the old-age dependency ratio consistently exerts a negative effect on economic growth in all models, particularly in the short term. This is likely due to the economic burdens associated with an aging population, such as increased healthcare and pension expenditures. Over time, however, the negative impact may attenuate, as suggested by the positive coefficients observed in the lagged old-age dependency ratio in certain models. This could reflect the accumulation of savings and shifts in the labor market as older generations continue to contribute economically for longer periods.

Table 4

Young-age and old-age effects on economic growth

Dependent var.:	**OLS (1)**	**2SLS (2)**	**OLS (3)**	**2SLS (4)**
Income per capita growth				
GDP_growth	2.489e+01 (1.876)	24.412*** (1.697)	25.607*** (1.835)	24.412*** (1.706)
ln_young_age_ dependency_ratio	-10.286 (6.263)	270.896*** (101.692)	-5.952 (6.254)	270.907*** (126.161)
ln_old_age_ dependency_ratio	-16.178*** (4.582)	-70.771*** (12.377)	-22.008*** (4.886)	(20.750)
young_age_dependency_ ratio_lag5		-5.610*** (2.062)		-5.611*** (2.545)
old_age_dependency_ ratio_lag5		4.475*** (0.878)		4.475*** (1.707)
edu_lag	0.001** (0.001)	0.001 (0.001)	0.0002 (0.001)	0.001 (0.001)
capita_growth	-3.004*** (0.969)	-3.210*** (0.863)	-3.344*** (0.946)	-3.210*** (0.867)
econ_active_growth	2.443 (1.511)	2.255** (1.335)	2.403 (1.464)	2.254* (1.341)
trade_growth	12.235*** (5.128)	9.991** (4.645)	10.394** (5.010)	9.991*** (4.704)
life_expectancy	0.700*** (0.277)	0.866*** (0.251)	0.836*** (0.273)	0.866*** (0.252)

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municipality			-6.896*** (2.413)	-0.001 (4.568)
female_labor	-0.003*** (0.001)	-0.002*** (0.001)	-0.002 (0.001)	-0.002*** (0.001)
Constant	-67.193 (40.666)	-802.854*** (300.935)	-56.519 (39.578)	(381.063)
First-stage F-statistic	94.094***	91.022***	53.38977***	48.50881***
p-value	0.000***	0.000***	0.000***	0.000***
Multiple R-Squared	0.885	0.912	0.8931	0.912
Adjusted R-Squared	0.8756	0.903	0.8832	0.9021
Wald test		101.7		9.24E+01
Excluded instruments		2		2
Observation	120	120	120	120
Diagnostic tests:				
Breusch-Pagan test (p-value)	0.001881***	0.0009426***	0.006371***	0.001501***
Durbin-Watson test (p-value)	7.11E-01	2.37E-01	7.63E-01	2.36E-01

Source: Author's calculation based on Stat.uz (2023) statistics

Note: Table shows the regression results of age groups, especially young age and old age effects on economic growth. Models (1), (3) represent the OLS results, while (2) and (4) indicate 2SLS estimates. The last 2 models are fixed for municipality effects. All specifications include control for time effects. Standard errors are clustered at the country level and reported in parentheses. Asterisks (*** for 1%, ** for 5%, and * for 10%) are used to indicate the significance levels.

Across models, additional variables exhibit diverse effects on economic growth. Education, for example, shows a negligible or positive lag effect, indicating a complex relationship with economic performance. Capital growth consistently displays a negative relationship with GDP growth, possibly due to high short-term costs outweighing immediate returns. On the other hand, trade growth and economic activity positively contribute to economic outcomes, highlighting their critical role in driving development. Longer life expectancy is consistently associated with higher economic growth, reflecting improved health and living conditions that enhance productivity.

The inclusion of municipality-specific variables adds a geographic dimension to the analysis. While the coefficient for municipality is strongly negative in one model, it is not significant in another, suggesting that specific local policies or structural characteristics may, in some cases, impede economic growth. In terms of model performance, high R-squared and Adjusted R-squared values indicate that the selected variables account for a substantial proportion of the variation in GDP growth. Notably, models incorporating lagged demographic data demon-

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strate a slightly improved fit, emphasizing the importance of considering dynamic effects in economic growth analyses.

Overall, the findings underscore the dual and evolving nature of demographic impacts on economic performance. While young-age dependency initially presents challenges, its long-term benefits are evident, contrasting with the predominantly negative effects of old-age dependency. These results are consistent with prior studies on cross-national differences in economic growth but provide a nuanced understanding of how demographic shifts influence economic trajectories in Uzbekistan.

Robustness check

Robustness checks include the use of 2SLS to address endogeneity concerns, with lagged life expectancy and fertility rates as instruments. Also, it includes subgroup analyses for urban and rural regions, revealing consistent patterns across contexts. While heteroskedasticity-corrected models were not feasible due to data constraints, the use of clustered standard errors and fixed effects minimizes potential biases. While additional tests such as heteroskedasticity corrections were not feasible due to data constraints, subgroup analyses for urban and rural contexts suggest the findings are consistent across different economic environments. Addressing potential endogeneity concerns, age structure variables were instrumented using lagged life expectancy and fertility rates. This approach mitigates reverse causality, ensuring that the observed relationships reflect causal effects rather than spurious correlations.

Variations in regression results between rural and urban areas raised concerns about heteroskedasticity. Gujarati (2009) emphasizes that heteroskedasticity in regression models can lead to inefficient estimators and unreliable hypothesis testing. White's general heteroscedasticity test (White, 1980) was applied, and the results indicated that heteroskedasticity is not a significant issue in rural municipalities. However, for urban municipalities, significant heteroskedasticity was detected. To address this, heteroskedasticity-consistent standard errors were used, ensuring the reliability of coefficient estimates.

A correlation matrix was also constructed to assess the relationships between key variables. Figure 4 provides a correlation matrix showing relationships among demographic and economic variables. The negative correlation between the 20–34 age cohort and GDP growth is particularly striking, supporting the hypothesis that this group's economic contribution is constrained by labor market mismatches. Similarly, the positive correlation for the 50–64 cohort underscores its role as a driver of economic growth. As shown, the correlation coefficients between independent variables do not suggest severe multicollinearity, confirming the appropriateness of their inclusion in the regression model. The matrix further highlights expected relationships, such as a negative correlation between certain age groups and GDP growth, aligning with the regression results.

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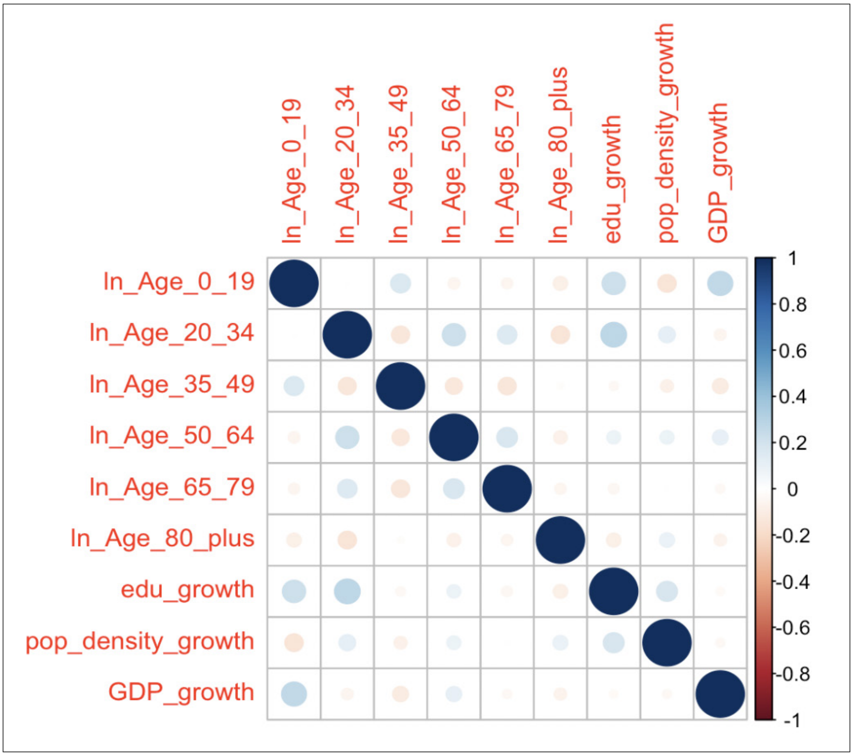
Figure 4
Correlation matrix



Source: Author's calculation based on Stat.uz (2023) statistics

Note: this is a correlation matrix for the population age structure of Uzbekistan along with education, density and GDP growth.

DISCUSSION

The drivers of aging are rooted in behavioral, biological, and societal factors, including shifts in fertility, life expectancy, and female labor force participation. These dynamics shape workforce entry, labor market behavior, and, ultimately, economic growth. The empirical results presented earlier illustrate these effects, as evidenced by the varying impacts of different age groups on economic performance.

The positive coefficients observed for certain age groups highlight their beneficial contributions to GDP growth, likely reflecting their active participation in the labor force and economic productivity. However, the negative and significant coefficients for lag factors and specific age groups, such as the very young and the elderly, suggest potential long-term economic challenges. These findings align with the financial pressures associated with sustaining non-working-age populations. These results may also point to measurement errors or underscore the need to consider behavioral and policy responses to demographic shifts. For instance, government spending, labor force participation, savings, and investment patterns adapt in response to changes in age distribution, emphasizing the importance of context-sensitive analysis.

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Given well-documented life-cycle behavioral variations, demographic transitions inevitably influence macroeconomic outcomes. As individuals move through different life stages, their labor market participation, educational attainment, and savings behavior evolve. In Uzbekistan, this phenomenon is particularly pronounced. Younger cohorts (under 25), who are less inclined to save, negatively affect aggregate savings rates. However, as individuals transition to middle and older working ages (40–70), savings rates peak, reflecting a critical window for economic contributions.

Beyond these accounting impacts, aging has broader behavioral implications. Generational crowding where large cohorts compete for limited resources, can distort labor supply and relative wages (Bloom et al., 1988). Similarly, the decline in fertility and youth dependency rates is often linked to rising labor market participation, particularly among women (Bloom et al., 2011). In this study, regression results controlling for female labor force participation revealed a small but significantly negative effect on income. This outcome could signal that women are entering lower-paying industries or that job creation is insufficient to accommodate their growing labor market presence. Such dynamics may heighten competition for jobs, suppressing wage growth, or reflect underutilized productivity gains from a more diverse workforce. Addressing these disparities requires a deeper exploration of barriers hindering the effective integration of women into the economy and their translation into higher incomes. These findings directly inform the policy recommendations that call for enhancing female labor force participation through targeted measures, such as childcare support, gender-sensitive workplace reforms, and skill upgrading programs.

Life expectancy, a proxy for population health, also plays a pivotal role in economic dynamics. As health improves, labor output increases, suggesting a potential growth-enhancing effect. However, rising life expectancy brings about changes in life-cycle behaviors, such as prolonged working lives and larger retirement savings (Bloom et al., 2011e). These adaptations may offset some economic challenges associated with aging, as healthier, longer-lived populations contribute to sustained economic activity.

In summary, while demographic changes present challenges, they also open avenues for policy interventions to harness economic benefits. For Uzbekistan, fostering savings and productivity among key age groups, enhancing labor market opportunities for women, and adapting to health-driven life-cycle shifts will be crucial in navigating the economic implications of an aging population.

CONCLUSION

The aging of populations is becoming an increasingly prominent issue as nations transition through demographic stages, with significant implications for economic growth. In the case of Uzbekistan, as the country progresses through demographic transitions, the once-advantageous large working-age population risks becoming a challenge due to the projected decline in the working-age cohort. This shift, which initially fostered economic growth by increasing the working-age share, now presents the possibility of slowing economic growth as the working-age population diminishes, particularly in the coming decades.

This study explored the effects of population age structures on Uzbekistan's economic growth, utilizing data from 1950 to 2015. Through the application of

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both OLS and 2SLS methods, we examined the impact of the aging population, differentiating between prospective and retrospective views of population cohorts. The analysis suggests that while a decrease in the working-age population is likely to hinder economic growth, the potential for mitigating these effects through improvements in functional capacity and working life expectancy remains significant.

Our results show a positive relationship between working-age populations and economic growth, particularly in the 50–64 age cohort in Uzbekistan. However, the negative effects of the lagged working-age population, higher mortality rates, and the older-age cohorts highlight the importance of implementing policies that actively engage older populations in the workforce and other productive activities. The findings also emphasize that labor shortages resulting from demographic shifts can be addressed through increased automation, labor market adjustments, and greater inclusion of older workers.

Despite the promising potential of Uzbekistan's demographic dividend, the overall impact of aging on economic development may not be as severe as some projections suggest, provided that the workforce's functional capabilities continue to improve. However, migration and technological advancements alone will not suffice to counterbalance demographic challenges. Therefore, policy reforms aimed at enhancing older workers' participation, increasing functional abilities, and fostering a more inclusive labor market are essential for maintaining economic growth in the face of these demographic transitions.

Policy recommendations

Given the demographic changes Uzbekistan is facing, it is imperative that policymakers take proactive measures to address the aging population. A strategic policy framework should be designed to enhance workforce participation, improve economic resilience, and ensure equitable growth. Importantly, the following recommendations are directly informed by the empirical findings of this study:

1. **Promote workforce participation of older cohorts:** Our results show that the 50–64 age group contributes positively to GDP growth, yet lagging working-age cohorts have a negative effect. This suggests the need to better integrate older workers into productive activities. Extending the retirement age, offering retraining opportunities, and providing incentives for continued work will help maximize the contributions of older cohorts and reduce the dependency burden.

2. **Invest in education and training across the life course:** Findings on savings and productivity differences across age groups highlight the importance of human capital development. Lifelong learning and upskilling programs can ensure that younger cohorts, who currently save less and contribute less to aggregate income, are better equipped to participate productively in the economy.

3. **Enhance female labor force participation:** Regression results revealed that higher female participation is currently associated with a negative income effect, likely due to concentration in lower-paying industries and labor market segmentation. Policies must therefore focus not only on raising participation but also on improving job quality for women. Childcare

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support, workplace flexibility, and gender-sensitive labor market reforms can help translate female labor force participation into higher productivity and wages.

4. **Strengthen savings and investment policies:** The life-cycle pattern identified in this study - low savings among the young and peak savings among older working-age individuals - indicates the need for policies that encourage savings earlier in life. Targeted financial literacy programs, matched savings schemes, and pension reforms can smooth savings behavior and enhance national financial stability.

5. **Healthcare and healthy aging:** Longer life expectancy was found to enhance economic productivity but also implies greater long-term dependency if not matched with functional capacity. Investments in preventive healthcare, workplace health programs, and active aging initiatives are crucial to ensuring that increased longevity translates into sustained labor force participation and productivity.

6. **Social security and pension reforms:** The negative effects associated with dependency ratios and lagged working-age shares underscore the importance of sustainable pension systems. Adjusting eligibility criteria, benefit formulas, and retirement financing in line with longer life expectancy will help safeguard fiscal sustainability while supporting an aging population.

7. **Public health and mortality reduction:** Elevated mortality rates were found to dampen economic growth. Strengthening healthcare systems, expanding preventive medicine, and reducing regional disparities in health access will not only improve life expectancy but also mitigate the negative economic effects of premature mortality.

By addressing these areas, Uzbekistan can better navigate the challenges posed by an aging population while fostering sustainable and inclusive economic development.

Limitations

While this paper provides valuable insights into the relationship between age structures and economic growth in Uzbekistan, several limitations should be acknowledged. First, the reliance on historical data constrained the inclusion of certain key variables, such as regional healthcare expenditures, particularly for the 1990–2000 period. Second, although robustness checks included heteroskedasticity tests, the study did not employ more advanced panel data methods, such as Generalized Method of Moments (GMM), which could account for endogeneity and dynamic effects. Applying such techniques could strengthen causal inference and should be considered in future research. Finally, the analysis focused primarily on aggregate and regional patterns, while further disaggregation—for example, by gender, sector, or household-level data—would provide a richer understanding of how demographic transitions interact with socioeconomic development.

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Ethical Commission Approval

This study did not require approval from an ethics committee as it did not involve human participants, animals, or sensitive personal data. All data used in this research were obtained from publicly available sources.

Conflict of Interest Statement

There is no conflict of interest with any institution or person within the scope of this study.

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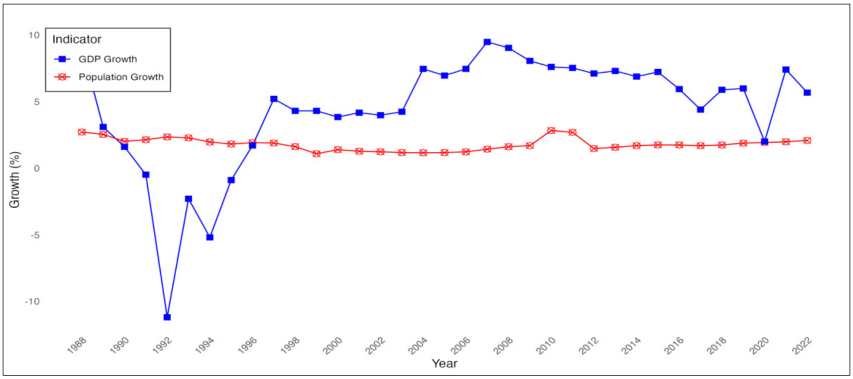
Appendix:

Figure 1

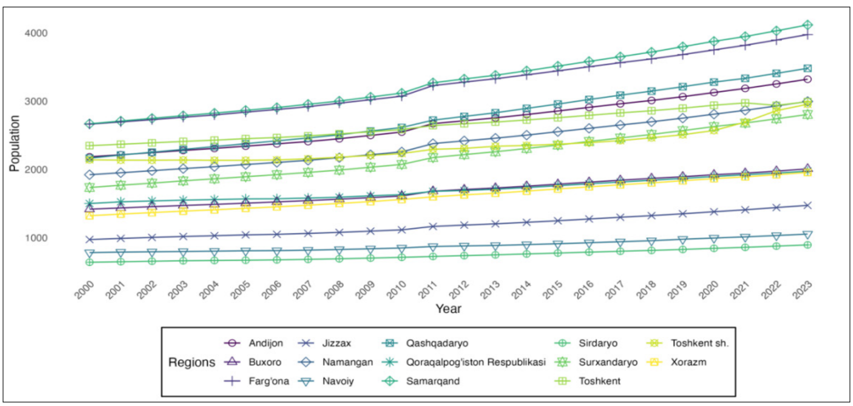
Uzbekistan GDP growth and demographic profile (1988-2022)



Note: These graphs show Uzbekistan's economic growth and population changes to support the arguments provided above. Graphs are represented on a yearly basis for 1990-2020 for economic growth and 1988-2022 for population historical changes. Source: Macrotrends (2023).

Figure 2

Regional population changes, 2000 – 2023



Note: This figure shows the population distribution in 14 regions of Uzbekistan. Data is derived from (Stat.uz, 2024) and plotted by the author.

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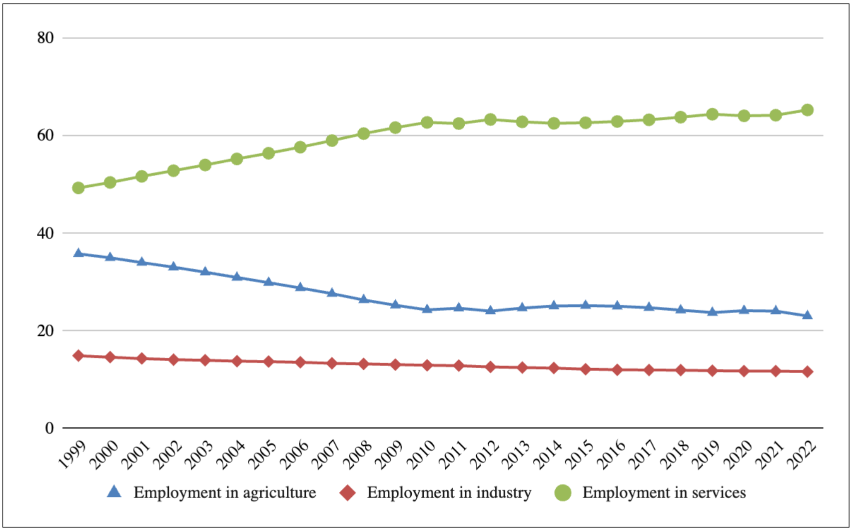
Figure 3

Female employment by sector, 1999-2022



Note: The graph shows trends in female employment by 3 sectors: agriculture, service and industry in Uzbekistan (1999–2022). Data: World Bank (ILO estimates).