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Harnessing Demographic Change for Economic Growth: Insights from Emerging Economies- China, India, Russia and South Africa

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Abstract

This paper examines how demographic transitions influence economic growth in four emerging and transitioning economies: India, China, South Africa, and Russia. As these nations experience shifts in fertility, mortality, and age structures, they enter a window of demographic opportunity marked by a growing working-age population. Drawing on World Bank data from 1990 to 2023, the paper uses panel regression methods to analyse the effects of factors such as the working-age population ratio, education and health expenditure, labour force participation, fertility rate, and structural economic changes on per capita GDP (USD). The results show China has effectively leveraged its demographic dividend, while India and South Africa still lag, and Russia now contends with an aging population. Key determinants of economic growth include education investment, lower fertility, and increased non-agricultural output. However, the presence of a large working-age population alone is insufficient; strategic investment in human capital and job creation is essential. A robustness check reveals that the Fixed-Effect model with robust standard errors yields the most dependable results, reinforcing the need for tailored policy approaches to turn demographic shifts into sustainable growth.

Keywords

Demographic Dividend, Population Growth, Fertility Decline Working-Age Population, Labour Force Participation, Health, Education, Panel Regression

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Introduction

The relationship between population dynamics and economic growth has long been a subject of scholarly interest, particularly in the context of emerging and transitioning economies. Among the most pivotal aspects of demographic change is the transformation in a country's age structure, which can significantly influence economic outcomes. As countries undergo fertility decline and improvements in life expectancy, they often enter a period characterized by a rising share of the working-age population—offering a potential for accelerated economic growth known as the demographic dividend. The world looks optimistically at emerging economies as future growth drivers. One of the reasons behind such expectations is the high share of working-age population leading to a 'youth bulge' experienced by these countries as they have the biggest chance to reap the benefits of a demographic dividend. With development, as the countries undergo different stages of demographic transition, a window of a demographic opportunity opens in the phase of rapidly declining mortality (Misra and Maurya, 2021). Emerging economies are to benefit greatly from a high demographic dividend, since almost half of the population is under 24 and more than a million young people will join the workforce each month until 2030 (Tribune, 2023). For emerging economies such as India, China, South Africa, and Russia, the demographic narrative is both an opportunity and a challenge. These nations represent a spectrum of demographic transitions—from youthful populations with untapped labour potential (India and South Africa), to rapidly aging societies dealing with shrinking labour forces (China and Russia). Understanding how each has navigated demographic changes, and the extent to which these shifts have translated into economic development, is essential for identifying effective policy approaches and avoiding missed opportunities. This paper aims to synthesize empirical and theoretical insights into how demographic changes over time have impacted economic growth in these four diverse economies using time series analysis.

Theoretical Background

The concept of the demographic dividend refers to the accelerated economic growth that may result from a shift in a country's age structure, particularly when the share of the working-age population (15–64 years) rises relative to dependents (children and the elderly). This transition occurs during the demographic shift from high to low fertility and mortality rates—a pattern observed in most industrialized and emerging economies. The theoretical underpinning of this concept was formalized by Bloom, Canning, and Sevilla (2003), who argued that a demographic dividend is not automatic; it requires enabling conditions such as investments in health, education, labour market efficiency, and governance. Their model posits that a large working-age population, if productively employed, can increase per capita output and drive faster economic growth. Building on this, Lee and Mason (2006, 2011) identified two phases of the demographic dividend. The First Demographic Dividend refers to a transitory boost in economic growth resulting from a high proportion of the population being in working age. It typically spans a few decades and depends on the ability of the economy to productively engage this labour force. The Second Demographic Dividend - as the population continues to age, savings tend to rise due to longer retirement horizons, leading to increased capital accumulation and productivity. This dividend is longer-lasting, but requires robust financial institutions and social security systems to be fully realized. Several factors mediate the realization of these dividends such as, Education and Human capital: the more skilled the labour force is, the greater is the potential output; Labor market structure: the ability of economies to absorb large numbers of young workers into productive employment is crucial; Gender equality: Greater female labour force participation significantly enhances the benefits of demographic shifts; Governance and policy environment: Effective institutions are essential for translating demographic potential into growth. The literature underscores that the economic benefits of demographic change are context-specific and depend heavily on how countries adapt their institutions and policies to shifting population dynamics. A decline in fertility increases the share of working age population(15-64) relative to the dependents– this shift, if supported by sound investments in education, health and employment creation can boost per capita income and economic productivity (Bloom et al., 2003). In countries like China, demographic change has historically played a key role in their economic take-off. Conversely, in Russia and South Africa, structural impediments have limited the economic returns from demographic transition. India, with its young population, is at a demographic crossroads, while China and Russia now face the challenges of population aging.

Review of Literature

Demographic change is a critical driver of long-term economic development. Emerging economies, especially in Asia, Africa, and Latin America, are undergoing significant age-structure transitions, characterized by a declining dependency ratio and a rising working-age population. This shift opens a "demographic dividend"—a period when economic growth can be accelerated due to favourable population dynamics. UNFPA (2014, 2017) emphasized that the demographic dividend is not automatic. Realization depends on governance, health, education, employment, gender inclusion, and macroeconomic stability. Studies showing that China exemplifies a successful demographic realization (Cai & Wang, 2005) which contributed significantly to its rapid growth from 1980–2010. However, concerns regarding second stage demographic dividend and sustainability of its benefits were raised by Zeng (2013) and highlighted the diminishing returns of the demographic dividend and the challenge of an aging population. UN DESA (2022) study also showed the similar concerns and projects continued decline in working-age population post-2025. On the other hand, studies show that, although, India is going through the phase of demographic opportunity "youth bulge" but it has not been able to convert it into the growth benefits (Bloom et. al. 2001, Mason, 2005). Aiyar & Mody (2011) found that Indian states with better institutions and education gained more from demographic change. James (2008) cautioned that youth unemployment and poor education could nullify the potential dividend for India. In the case of South Africa, Oosthuizen (2006) showed that the country has yet to fully enter its dividend phase, due to high youth unemployment and health challenges (e.g., HIV/AIDS). Turok & Borel-Saladin (2014) argued that spatial inequality and weak labour absorption hinder dividend gains especially in the case of South Africa. Ashraf, Weil & Wilde (2013) used simulation models to show that most African countries are in the early stages of transition, and without employment generation, may miss the dividend. For realising demographic dividend, Kugler (2005) emphasized that higher investment in education and health during demographic transitions amplifies growth. Bloom & Finlay (2009) showed that secondary and tertiary education increases the likelihood of realizing dividends, whereas, ILO (2018) found countries with flexible and inclusive labour markets (e.g., Malaysia, Vietnam) better absorbed the working-age population into productive employment. Rigid or informal labour markets (e.g., much of Africa and South Asia) often fail to do so. World Bank (2012) and Das & Rastogi (2017) found that increasing female labour force participation significantly magnifies demographic dividend impacts. Moreover, Williamson (2008) pointed out that demographic dividends are more pronounced in countries with stable institutions, good governance, and open trade policies. The literature consistently emphasizes that while demographic change offers opportunities, the demographic dividend is conditional on strategic policy action. The success stories of East Asia, especially China, illustrate the importance of synchronized reforms in education, labour markets, and health. Many emerging economies, especially in Africa and South Asia, still face structural challenges—such as youth unemployment, poor education, and gender inequality—that must be addressed to realize their full demographic potential.

Material and Methods

The present study uses World Bank data on economic indicators for four countries namely- India, China, Russian Federation and South Africa for the period 1974 to 2023 on various economic indicators. For the purpose of analysis, the data is taken for time period 1990-2023, as data before 1990, the data was found to be incomplete for a number of variables such as percentage expenditure on health, GDP per capita (in USD). Though the complete dataset (1974-2023) for Working age population ratio is used to study trends over time. The log per capita GDP (constant 2015 US$) is taken as the output variable for the study. The per capita growth in income is a function of steady state level of income per worker and initial income per worker. The steady state level of income per worker is itself determined by a number of dynamic as well as time invariant factors such as human capital, health status, life expectancy, stock of capital, savings, geography, culture and climate (Bloom and Williamson, 1998). The independent variables include Working Age Population Ratio, Labor Force Participation Rate, Non-agricultural Output, Expenditure on Education (percentage of GDP), Expenditure on Health (percentage of GDP) and Fertility Rate. Fertility is considered as a causal factor as a decline in fertility rate results in changes in the working age population ratio. The data on these variables across four countries hence forms a balanced panel data for the present study and the analysis is done on Python. To analyze the relationship among economic growth and the above stated variables, firstly pooled OLS model is applied on total 136 observations. Since, pooled OLS model ignores the fact that the data is structured as panel data and also fails to identify the unobserved heterogeneity, we have further used panel regression (fixed effect and random effect) model to explain the relationship among the economic indicators. The study has considered F-test for checking the accuracy of pooled OLS and Panel Regression (Fixed-effect model and Random-effect model), Breush- Pagan LM Test for heteroskedasticity and finally Hausman test to choose between Fixed-effect and Random-effect panel regression. Also, in the presence of heteroskedasticity and non-normality of residuals robust standard errors are used.

The general panel regression model is

given as-

$$y_{it} = \alpha + \beta X_{it} + u_{it} \quad (1)$$

Where, y_{it}=outcome variable of i^{th} individual at time t
X_{it}=vector of explanatory variables
β= vector of coefficients
u_{it}=error

In the fixed-effect model of panel regression, the α in equation (1) shows individual specific intercept which captures all time- variant characteristics of unit 'i', whereas in the random-effect model α is the common effect. The Fixed-effect model gives better estimates when individual specific traits may be correlated to the regressor.

Therefore, the equation of the panel regression model for the variables under study can be written as-

$$\begin{aligned} \text{log per capita GDP}_{it} = \alpha \\ &+\beta_1 \text{working age population ratio}_{it} \\ &+\beta_2 \text{labour force participation rate}_{it} \\ &+\beta_3 \text{health expenditure}_{it} \\ &+\beta_4 \text{education expenditure}_{it} \\ &+\beta_5 \text{non-agricultural output } \%_{it} \\ &+\beta_4 \text{fertility rate}_{it} \\ &+u_{it} \quad (2) \end{aligned}$$

For $i = 1, 2, 3, 4$ (for four countries) and $t = 1990$ to 2023 (34 years).

Results

In this section, results from the analysis are presented. Figure 1 shows the ratio

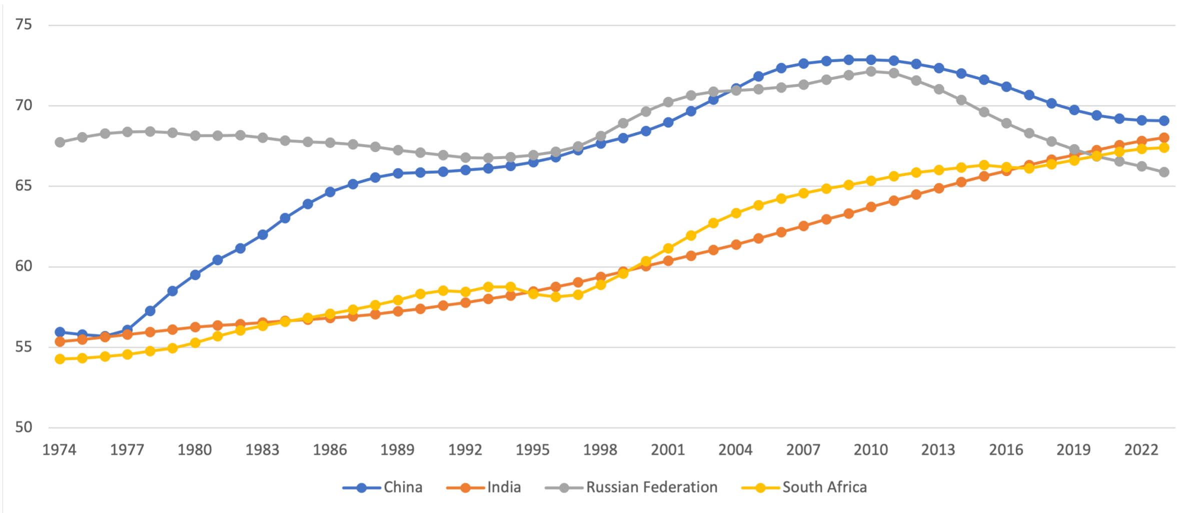

Figure 1. Distribution of Working-age population to total population (%) for China, India, Russian Federation and South Africa (1974-2023)
Data Source: World Bank Group

of working age population to total population for China, India, Russia and South Africa. It is clearly seen that China and Russia reached their peak working-age population shares around 2011-12 whereas India and South Africa have yet to attain their peak of demographic opportunity. It shows that each country may have a different demographic window of opportunity. Unlike South Africa, India shows a linear trend in its working age population ratio. India's demographic window of opportunity started in 2005, has yet to achieve its peak and is expected to continue till 2061 (Goli et al, 2021). Figure 2 shows trends in per capita GDP in USD at constant prices for the four countries. It is evident that the beginning of 1980s was a turning point for China when it started experiencing exponential growth in GDP per capita. Russia also experienced exponential growth in GDP per capita from year 2000 onward. However, India and South Africa are growing with their linear growth trajectory. Evidence suggests that only China has successfully converted its opportunity into dividend. Others are yet to realise the same.

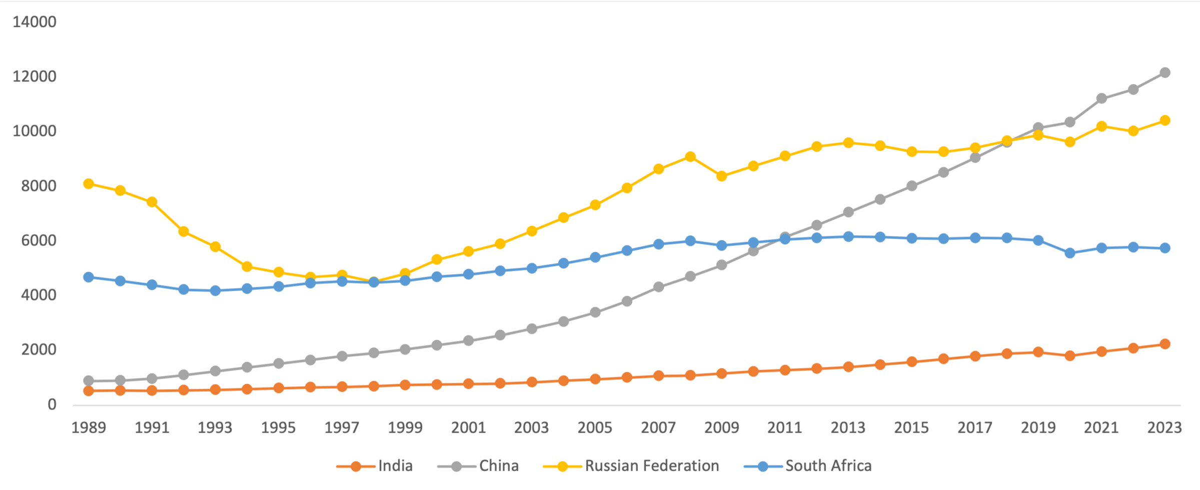

Figure 2. GDP per capita (constant 2015 USD) for China, India, Russian Federation and South Africa (1989-2023)
Data Source: World Bank Group

This provides us with an opportunity to understand the underlying factors which helps a country to realise its demographic dividend as two countries which have already reached to their peak of youth bulge only one could able to realise it. On the other hand, the other two which are yet to experience their peak of youth bulge, one is experiencing faster growth and the other is experiencing an average growth. To understand, these factors in detail, we applied panel data analysis on our selected sample countries. As discussed earlier, the study takes GDP per capita (proxy variable for economic growth) as function of working age population with covariates - health expenditure as percent of GDP, fertility rate, education expenditure as percent of GDP, non-agricultural output (as percent of total GDP capturing the element of structural transformation), and labour force participation rate. Table 1 shows the descriptive statistics of the variables under study. Average health expenditure (as percent of GDP) is 5.31 percent. However, it varies from 2.86 percent to 8.57 percent indicating high volatility in expenditure levels. Similar kind of volatility can be observed in the case of other variables also. Working-age population mean value (66.10%) shows that selected countries are already at their peak of youth bulge.

Pooled OLS Results

The study applies pooled OLS first to understand the basic relationship among the variables. The estimated model is fit as R-squared (Overall) indicates that the model explains 90.1 percent of the variation in GDP per capita. Between R-squared (0.9730) explains strong explanatory power across countries. Within R-squared (0.7310) of the model captures 73.1 percent of the variation within individual countries over time. The F-statistic (195.59, p¡0.01) also shows that model is highly significant, meaning at least one of the predictors has a statistically significant impact on GDP per capita. Our analysis indicates that working age population is negatively associated with per capita GDP, shown in the table below. Although, the coefficient value is small (-0.0147) but statistically significant. It suggests that labour market has already reached to the saturation points. It is also suggested by our trend analysis and descriptive analysis that countries have almost either achieved their peak point of working age population or they are in declining phase. This could be the reason that our study is indicating negative sign between working-age population and per capita GDP.

Table 1. Descriptive Statistics

Statistic	GDP Per Capita (in USD)	Health Expenditure (%)	Fertility Rate	Education Expenditure (%)	Non-Agricultural Output (%)	Labor Force Participation Rate (%)	Working-Age Population (%)
Count	136	136	136	136	136	136	136
Mean	4814.40	5.31	2.16	3.88	83.00	68.15	66.10
Std Dev	3137.81	1.55	0.74	1.08	7.58	8.21	4.37
Min	531.90	2.86	1.16	1.65	64.23	54.37	57.40
25%	1764.44	4.03	1.57	3.27	76.76	61.23	63.34
50%	4802.93	4.97	2.01	3.94	85.87	66.54	66.70
75%	6425.76	6.91	2.54	4.48	88.79	75.51	69.45
Max	12175.19	8.57	4.05	6.55	92.96	84.04	72.86

Health expenditure, although, found positively associated with per capita GDP but its coefficient is not statistically significant. The variables: Education expenditure, non-agricultural output, labour force participation and fertility rate not only have expected sign of relationship with per capita GDP but they are statistically significant also. Among these, a rise in one percent in education expenditure and decline in one unit fertility raises per capita GDP by 0.247 and 0.2465 respectively.

Pesaran's Cross-Sectional Dependence (CD) Test checks for correlation between cross-sectional units (i.e., countries in panel data). The calculated value of CD Statistic is 0.2212 ($p > 0.05$) indicating weak or no cross-sectional dependence in the dataset. This implies that the economic indicators of different countries are not significantly influencing each other, and a pooled OLS model may be appropriate to explain that. However, F-Test (F=195.59, p value =0.000) indicates that the pooled OLS does not account for unobserved heterogeneity across entities. Based on the same, we reject the null hypothesis that a pooled model (OLS) is appropriate and so fails to explain the variation across countries and Panel Regression Model maybe considered further to control for unobserved heterogeneity across countries. Table 4 shows the comparison of the Pooled OLS model, Panel Regression Fixed Effect and Random Effect Model.

However, Hausman Test (chi square test = 1773.3872; $p < 0.01$) results suggest that the Fixed Effect model is preferred over the Random Effect model because the p-value is coming out to be significant ($p < 0.05$).

Table 2. Summary Statistics of the Pooled OLS Model

Dep. Variable:	GDP per capita	Statistic	Value
Estimator:	Pooled OLS	R-squared (Between)	0.9730
No. Observations:	136	R-squared (Within):	0.7310
R-squared:	0.9010	R-squared (Overall):	0.9010
Log-likelihood:	94.028	F- test of poolability	195.59 (p-value= 0.000)

Table 3. Parameter estimates for the Pooled OLS Model

Parameter	Estimate	Std. Err.	T-stat	P-value	Lower CI	Upper CI
Constant	1.6566	0.2499	6.653	0.000**	1.1640	2.1493
Health expenditure	0.0052	0.0129	0.687	0.493	-0.0230	0.0308
Education expenditure	0.2047	0.0213	9.417	0.000**	0.1626	0.2468
Non-agricultural output	0.0220	0.0035	6.267	0.000**	0.0150	0.0289
Labor-force participation Rate	0.0110	0.0025	4.336	0.000**	0.0060	0.0161
Fertility rate	-0.2465	0.0229	-10.773	0.000**	-0.2918	-0.2013
Working age population	-0.0147	0.0036	-4.061	0.000**	-0.0219	-0.0075

** denotes highly significant values of the test statistic ; ***p<0.01

This implies that the individual entity-specific effects (country-level effects) are correlated with the independent variables, making Fixed Effects a better choice. Breusch-Pagan test for heteroscedasticity (LM statistic = 24.2489; $p < 0.01$; F statistic$= -4.6653$; $p < 0.01$) suggests heteroskedasticity in the data, implying that the variance of errors is not constant suggesting that robust standard errors should be used. The Fixed Effects (FE) model accounts for country-specific characteristics that do not change over time, improving the robustness of our estimates compared to Pooled OLS. Since, heteroskedasticity and residuals are not normal, robust standard errors estimates have been used in the final estimations. The application of robust standard errors does not fundamentally alter the model's conclusions but enhances the reliability of statistical inference by accounting for potential heteroskedasticity and autocorrelation. Thus, while the standard Fixed Effects model provides a reasonable estimation, the Fixed Effects model with robust standard errors offers more reliable inference, making it preferable for policy implications and economic analysis. Table 4 and 5 show the analysis summary and parameter estimation done through Fixed Effect Panel Regression Model respectively.

Fixed Effect Panel Regression Model with Robust Standard Errors

The F-test for pool-ability (70.611, p = 0.000) shows fixed effects are appropriate, meaning individual entity characteristics (country-specific effects) significantly influence GDP per capita. The fixed-effects model demonstrates strong explanatory power within entities (R^2 = 0.8760), meaning it effectively captures variations in GDP per capita within countries. However, its explanatory power between entities is lower (R^2 = 0.3163), suggesting differences across countries remain unexplained. The overall R^2 of 0.4829 indicates a moderate fit. The overall model is statistically significant (F-statistic (robust): 119.91, p = 0.000), meaning at least one independent variable significantly predicts per capita GDP.

Table 4. Summary statistics of Fixed Effect Model with robust standard errors

Statistic	Value	Statistic	Value
Dependent Variable	GDP per capita	Estimator	Panel OLS
Observations	136	Entities	4
R-squared (Within)	0.8760	R-squared (Between)	0.3163
R-squared (Overall)	0.4829	F test	70.611 (p-value =0.000**)

Table 5. Parameter Estimates of Fixed Effect Model with robust standard errors

Parameter	Estimate	Std. Error	T-stat	P-value	Lower CI	Upper CI
Constant (Intercept)	0.7104	0.3303	2.1506	0.0334	0.0567	1.3641
Health Expenditure	0.0021	0.0118	0.1784	0.8587	-0.0212	0.0254
Education Expenditure	0.1333	0.0149	8.9658	0.000**	0.1039	0.1627
Non-Agricultural Output	0.0220	0.0024	9.3415	0.000**	0.0173	0.0266
Labor Force Participation	-0.0082	0.0041	-2.0135	0.0462	-0.0162	-0.0001
Fertility Rate	-0.0200	0.0207	-0.9662	0.0358	-0.0610	0.0210
Working Age Population	0.0164	0.0038	4.3433	0.000**	0.0090	0.0239

** denotes highly significant values of the test statistic; ***p<0.01

Health spending has a very weak and insignificant effect on GDP per capita. A 1-unit increase in education expenditure is associated with a 0.1333 unit increase in GDP per capita, indicating a strong positive impact. Non-agricultural output positively impacts GDP per capita, meaning industrial and service sector growth contribute significantly. A higher labour force participation rate is linked to a slight decrease in GDP per capita, possibly due to underemployment or low-productivity employment. This implies that though people are working, they might be poorly paid or without benefits or their jobs might be precarious.

There can also be sectoral misallocation (Alpysbayeva and Vanormelingen, 2022) in working age population, which means that people might be working in the sectors where their skills don't match with their profession e.g., too many individuals in low value agriculture than high value services. This can further be studied considering more indicators such as, earnings, hours worked etc that provide quality input in the explanation.

The negative coefficient value (-0.0200) show that fertility decline has an increasing effect on per capita GDP, however the results are not highly significant, as it was in pooled OLS model. A 1-unit increase in working-age population is linked to a 0.0164 unit increase in GDP per capita, suggesting a strong economic benefit from a larger workforce.

Discussion

We have applied pooled OLS and Fixed Effect Panel Regression Model with robust standard errors. Results from pooled OLS show that education expenditure has the largest positive effect (0.2047) on GDP per capita, emphasizing the role of human capital. Health expenditure is insignificant, meaning it does not have a direct short-term impact on GDP per capita in this dataset. Higher fertility rates negatively impact GDP per capita, likely due to increased dependency ratios. Labor force participation and non-agricultural output positively influence GDP per capita, indicating economic transformation benefits. The negative coefficient on working-age population in the pooled OLS model suggests that having a large working-age group is not enough—employment opportunities and productivity improvements are required. However, as our analysis indicates that the Fixed Effect model with robust standard errors provides more reliable results. We would be concentrating our discussion mainly based on these improved estimates. Working-age population shows a negative effect in Pooled model but positive in Fixed Effects, suggesting different interpretations across models. The conflicting sign of the working-age population coefficient across models (negative in Pooled OLS but positive in Fixed Effects) suggests that different factors are influencing the relationship between the working-age population and GDP per capita when controlling for unobserved heterogeneity across countries. The negative effect in Pooled OLS model might be driven by cross-country differences, where states with larger working-age populations might also be those struggling with unemployment or lower economic productivity like India and South Africa. On the other hand, Fixed Effect model controls for time-invariant differences across countries, revealing that within a particular country, a growing working-age population tends to contribute positively to GDP. The model also suggests that education, non-agricultural output, and fertility rates work as the driving factors and significantly impact GDP per capita which indicates economic growth benefits from a larger workforce with other country-specific factors. The impact of productivity improvements over time and countries with better policies may see benefits from an expanding workforce. Considering the Fixed Effect model (preferred by Hausman Test), it is evident that within each country, an increase in the working-age population is beneficial for GDP growth. However, across countries (as seen in Pooled OLS), a larger working-age population does not automatically translate into economic gains due to structural challenges such as unemployment, skill mismatches, or lack of investment.

Conclusions

The demographic dividend refers to the potential for economic growth that may occur when a country experiences a decline in fertility and mortality rates that leads to a shift in the population's age structure. As a result, higher proportion of individuals enter the working-age population relative to dependents (children and elderly). After a certain transitory time, every country experiences a shift in age structure. As the process progresses, the nation will enter a demographic dividend period characterized by a high proportion of working-age individuals compared to dependent age groups such as the elderly and children. The demographic dividend has positively influenced economic development in most Southeast Asian nations. Consequently, it has been a consistently discussed subject among policymakers, scholars, and other stakeholders. Nevertheless, a demographic dividend is not perpetual. The challenge lies in converting demographic potential into sustainable development. Identifying the socio-economic policy tools that maximize the demographic dividend while preparing for the population ageing is essential.

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