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*Research Article*

# Demographic Drivers of Economic Growth: A Comparative Pooled Study of India and China

**B. Vijay Raj [1*], Dr. K. Suresh [2]**

[1] PhD (Part-Time) Research Scholar, PG & Research Department of Economics, Ramakrishna Mission Vivekananda College (Autonomous), Mylapore, Chennai, Tamil Nadu, India

[2] Assistant Professor PG & Research Department of Economics, Ramakrishna Mission Vivekananda College (Autonomous), Mylapore, Chennai, Tamil Nadu, India

**Corresponding Author:** *B. Vijay Raj

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**Abstract**

This study investigates the relationship between population dynamics and economic growth in India and China over the period 1960 to 2023, focusing on major demographic indicators such as population growth, birth rates, working-age population share, elderly population proportion, and age dependency ratios. Using pooled OLS regression analysis, the research evaluates how demographic transitions have influenced economic outcomes in the two fastest-growing Asian economies. The findings indicate that an expanding working-age population has played a crucial role in accelerating GDP growth, particularly in India, where the demographic dividend continues to provide economic advantages. In contrast, China's early demographic transition, shaped significantly by its one-child policy, has led to a rapidly ageing population, rising dependency burdens, and emerging labour shortages. These demographic shifts pose long-term challenges for sustaining growth. The study highlights that investments in education, healthcare, and skill development are essential to maximise the benefits of demographic changes. It further suggests that India can learn valuable lessons from China's experience in managing demographic transitions to ensure sustainable development. Overall, this comparative analysis offers important insights for policymakers aiming to align population trends with long-term economic planning and achieve balanced, inclusive growth in both countries.

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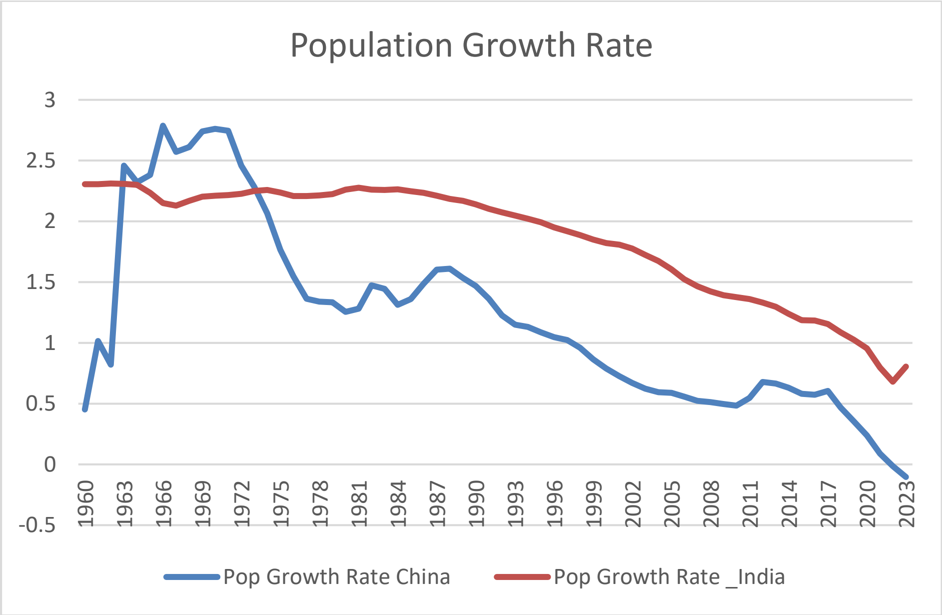
**KEYWORDS:** Demographic Transition, Population Dynamics, Economic Growth, Working-Age Population, Ageing Population, Dependency Ratio, Pooled OLS Analysis, Demographic Dividend, India, China, Policy Implications

## 1. INTRODUCTION

The relationship between population dynamics and economic growth has long been a focus of academic and policy discourse, particularly in populous countries like India and China. These two nations, which represent the largest populations globally, provide a unique opportunity to study how demographic transitions influence economic trajectories. While both countries have undergone significant population shifts since the 1960s, their approaches to managing demographic changes have varied substantially. China implemented rigorous population control measures, including the one-child policy introduced in 1979, which expedited its demographic transition. India, on the other hand, has experienced a more gradual decline in fertility and a delayed demographic dividend, resulting in a different set of economic outcomes.

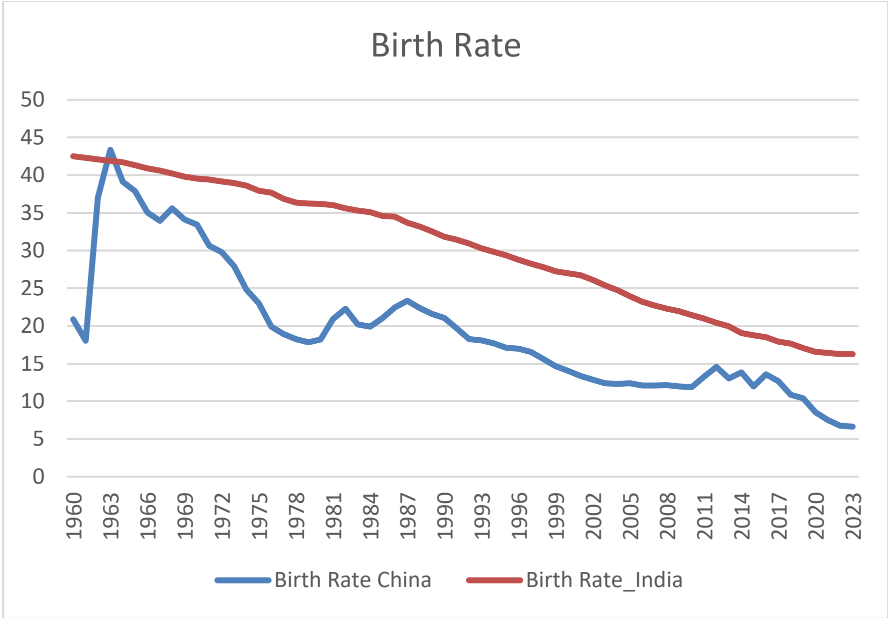
Demographic transitions, characterised by shifts in age structure, including an expanding working-age population, declining birth rates, and an increasing share of the elderly, have significant implications for economic performance. Countries in the third stage of demographic transition often experience a "demographic dividend"—a phase where a larger share of the population enters the workforce, reducing dependency ratios and potentially accelerating economic growth. However, the extent to which this dividend is realised depends on effective policy interventions, investments in health, education, and skill development, and the ability to sustain productivity.

Figure 1 illustrates the population growth rates of India and China from 1960 to 2023. While both countries show a steady decline in growth rates, China's population growth rate decreased sharply after the introduction of the one-child policy, compared to India's more gradual decline. This divergence highlights the contrasting population policies adopted by the two nations.



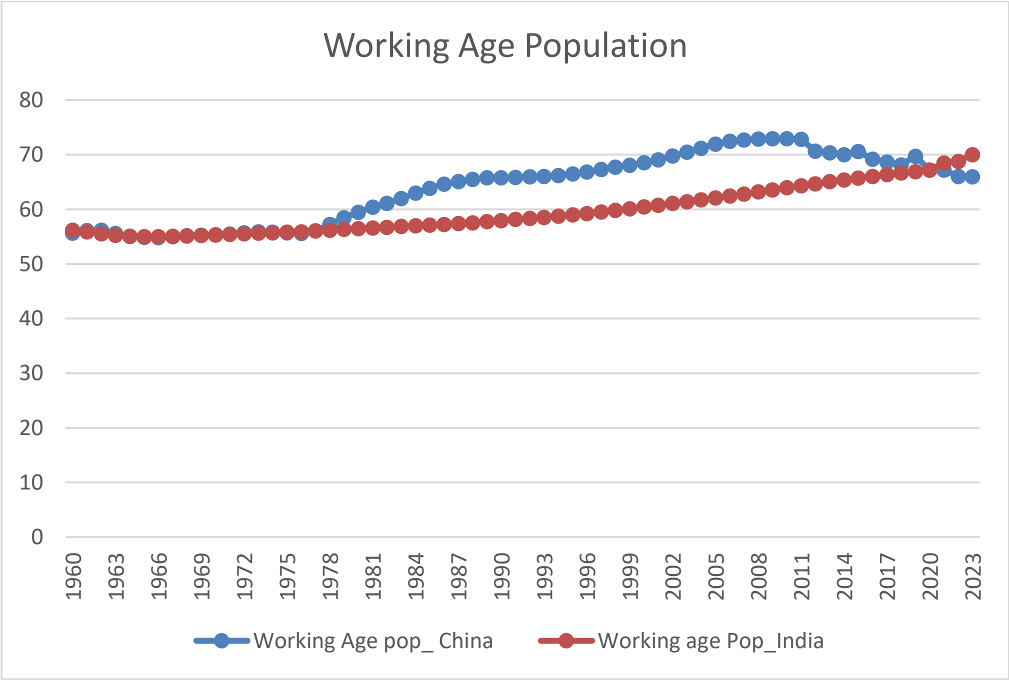

**Source:** Author's Calculation based on World Bank Data

Figure 2 shows the trends in birth rates for India and China over the same period. China experienced a rapid decline in birth rates post-1979, reflecting the direct impact of its strict population policy control measures. India's birth rates, though declining, followed a slower trajectory, consistent with its more gradual demographic transition.



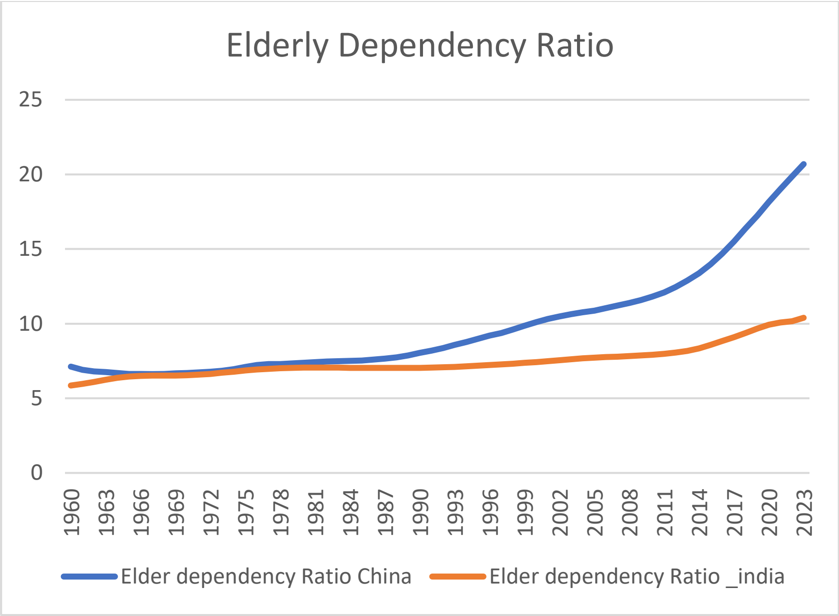

**Source:** Author's Calculation based on World Bank Data

Figures 3 illustrate the trends in working-age populations for China and India. China's working-age population expanded rapidly during the late 20th century, peaking around 2010, and has since begun to decline. In contrast, India's working-age population continues to grow steadily, reflecting its ongoing demographic transition. This divergence in trends has critical implications for workforce productivity and economic output, with India poised to benefit from a longer demographic dividend compared to China.




**Source:** Author's Calculation based on World Bank Data

Figure 4 presents the elderly dependency ratios for both countries. It reveals that China's elderly population has grown significantly faster than India's, a byproduct of its earlier demographic transition. This trend underscores the challenges of an ageing population, including increased economic dependency and healthcare demands.




**Source:** Author's Calculation based on World Bank Data

China's rapid economic growth has been widely attributed to its demographic policies, robust industrial sector, foreign direct investment, and trade liberalisation. In contrast, India's economic growth has been driven more by its service sector, with a less pronounced impact of demographic changes on its GDP growth. According to World Bank data, China's per capita income has increased sevenfold since the 1990s, significantly outpacing India's twofold growth during the same period. Additionally, China has managed to reduce its poverty levels more effectively than India, showcasing the potential of strategic demographic and economic policies. Despite sharing similar demographic opportunities, the two countries differ in their ability to harness the demographic dividend. Studies highlight that while the working-age population positively impacts GDP growth, rising elderly dependency ratios and limited productivity among the youth in some regions pose challenges. This paper seeks to analyze the impact of demographic changes on economic growth in India and China, focusing on key factors such as GDP growth rate, population growth, birth rate, working-age population, elderly population share, and dependency ratios. The study also compares the population policies of both nations to understand how these policies have shaped their demographic transitions and economic trajectories. By examining the successes and challenges faced by each country, this research aims to provide actionable insights for leveraging demographic trends to achieve sustainable economic development.

## 2. REVIEW OF LITERATURE

The relationship between population dynamics and economic growth has been extensively explored in economic literature, with the demographic transition theory serving as a foundational framework. This theory posits that countries transition from high birth and death rates to lower rates as they develop, leading to shifts in population growth patterns and economic outcomes *(Bloom & Williamson, 1998).* During this process, as fertility rates decline and life expectancy rises, an expansion of the working-age population occurs, potentially resulting in a "demographic dividend"—a period when economic growth accelerates due to a larger share of productive workers *(Bloom, Canning, & Sevilla, 2003).*

Studies have shown that East Asian countries, particularly China, leveraged their demographic dividend during the late 20th century to achieve rapid economic growth. Factors such as increased labor participation, capital accumulation, and improved productivity played a significant role in translating demographic advantages into economic outcomes *(Cai, 2010). Similarly, Mason (2001)* emphasized the importance of sound economic policies and investments in education and health as critical enablers for countries to capitalize on their demographic potential. India's demographic transition has been more gradual, with economic benefits expected to persist over the coming decades *(James, 2008).* However, challenges remain, particularly regarding job creation, skill development, and regional disparities in demographic opportunities (*Aiyar & Mody, 2011).* In contrast, China faces a shrinking workforce and a rapidly ageing population due to its one-child policy, raising concerns about economic stagnation and dependency burdens *(Cai & Lu, 2013). Lee and Mason (2010)* argue that rising old-age dependency ratios can offset the benefits of a growing working-age population by increasing healthcare and pension costs. Other studies, such as *Kelley and Schmidt (2005),* highlight the significance of investments in human capital and governance to sustain the benefits of demographic changes. Despite extensive literature on these aspects, comparative studies focusing on India and China remain limited. This study addresses this gap by examining how demographic changes have influenced economic growth in both countries, offering actionable insights for policymakers.

## 3. OBJECTIVES

The primary objective of this study is to analyse the impact of population dynamics on economic growth in India and China over the period 1960 to 2023. Specifically, the study aims to:

1. Compare the demographic transitions of India and China and examine their influence on GDP growth, focusing on differences in economic outcomes due to variations in population growth, birth rates, and working-age population trends.
2. Evaluate the role of the working-age population in driving economic growth and assess whether both countries have benefited from a demographic dividend, with a particular focus on India's recent growth phase and China's earlier demographic shift.

### 3.1 Hypotheses

1. H1: A higher working-age population positively contributes to GDP growth.
2. H2: Gross fixed capital formation (GFCF) has a significant positive impact on GDP.
3. H3: Dependency ratios (young and elderly) negatively affect GDP due to economic burdens.

## 4. DATA AND RESEARCH METHODOLOGY

This study employs a quantitative approach, using pooled ordinary least squares (OLS) regression analysis to investigate the demographic-economic nexus in India and China over the period 1960 to 2023. By adopting a comparative framework, the research explores differences in demographic transitions and economic growth patterns in the two countries. Data for the analysis is sourced from reliable databases, including the World Bank, the International Monetary Fund (IMF), the United Nations Population Division, and OECD statistics. The dependent variable in the pooled OLS analysis is GDP growth rate, with additional models incorporating GDP per capita growth as a robustness check. The independent variables include population growth rate, working-age population, elderly population share, birth rate, old-age dependency ratio, and gross fixed capital formation (GFCF) as a percentage of GDP, representing demographic and economic factors essential for understanding growth trajectories. The pooled OLS regression model identifies shared patterns and country-specific differences in the demographic-economic nexus, allowing for comparative insights. To address potential multicollinearity, advanced techniques such as Ridge Regression and Principal Component Analysis (PCA) are employed in supplementary analyses, ensuring robust results. This approach highlights the impact of demographic transitions on economic growth and offers actionable recommendations for policymakers in both countries.

The pooled OLS regression model is formulated as:

$$log(GDP_{it}) = \beta_0 + \beta_1 log(Working\ Age\ Pop_{it}) + \beta_2 log(GFCF_{it}) + \beta_3 log(Birth\ Rate_{it}) + \beta_3 log(Young\ Dependency) + \varepsilon_{it.}$$

Where $i$ represents the country (India or China), $t$ represents the year and $\varepsilon$ captures the error term.

By pooling data from India and China, the study identifies shared patterns and country-specific dynamics in the demographic-economic relationship. The methodology ensures robust insights into the role of demographic factors in shaping economic growth while addressing multicollinearity using advanced statistical techniques such as Ridge Regression and Principal Component Analysis (PCA) in supplementary analyses.

## 5. Modelling for Estimation

The study employs three key models to estimate the relationship between demographic dynamics and economic growth in India and China. The Primary Transformed Model (Reduced) uses log-transformed data to normalise variables and resolve multicollinearity, ensuring robust estimates. The Supplementary Model (Full Transformed) incorporates additional variables while retaining multicollinearity, providing a broader but less stable analysis. The Untransformed Model (Comparison) captures raw relationships between variables and GDP without any transformations, serving as a baseline for comparison.

### 5.1 Primary Model: Transformed and Reduced

The results of the primary model are presented below. This model provides clear and interpretable insights into the demographic-economic relationship.

**Table 1:** Pooled OLS Regression Estimates (Transformed and Reduced Variables)

| Variable | Coefficient | Std. Error | t-Statistics | p-Value | Significance |
|---|---|---|---|---|---|
| Constant | 35.3535 | 4.482 | 7.865 | 0.000 | Highly Significant |
| GFCF | 1.2958 | 0.775 | 1.662 | 0.097 | Marginally Significant |
| Birth Rate | 2.6146 | 0.663 | 3.941 | 0.000 | Highly Significant |
| Young Dependency | -4.0473 | 0.664 | -6.636 | 0.000 | Highly Significant |

**Source:** Author's Calculation

The primary transformed model provides valuable insights into how demographic factors influence economic growth. A 1% increase in the birth rate is associated with a 2.61% rise in GDP, highlighting its critical role in population replenishment and sustained growth. Conversely, a 1% rise in the young dependency ratio reduces GDP by 4.41%, reflecting the economic burden of a larger dependent youth population. Gross fixed capital formation (GFCF), although marginally significant, shows a positive association with GDP, emphasising the importance of infrastructure and capital investment. With an $R^2$ value of 0.469, the model explains 46.9% of GDP variation, underscoring the significance of demographic transitions. These results highlight the need for targeted investments in education, skill development, and infrastructure to reduce dependency burdens and fully capitalise on demographic dividends. Policymakers must align strategies to enhance the workforce's productivity and mitigate challenges posed by dependency ratios for sustained economic growth.

**5.2 Supplementary Section: Transformed Model with Multicollinearity**

The supplementary transformed model, which incorporates additional demographic variables, provides a more expansive view of the relationship between population dynamics and GDP. The results indicate a highly significant positive impact of the working-age population ($\beta$=41.83, $p<0.01$) and birth rate ($\beta$=5.00, $p<0.01$) on economic growth. Gross fixed capital formation (GFCF) is also significant ($\beta$=0.97, $p$<0.05), underscoring the role of infrastructure and capital investments. Conversely, the elderly dependency ratio ($\beta$=−3.80, $p<0.01$) and young dependency ratio ($\beta$=−-2.63, $p<0.01$) show significant negative relationships with GDP, reflecting the economic burdens of these dependent populations. Population growth rate, however, remains statistically insignificant (p>0.05). The model achieves an $R^2$ of 0.646, explaining 64.6% of the variation in GDP, indicating a strong overall fit.

**Table 2.** Pooled OLS Regression Estimates (Transformed Variable with multicollinearity)

| Variable | Coefficient | Std. Error | t-Statistics | p-Value | Significance |
|---|---|---|---|---|---|
| Constant | -3.442419 | 50.414 | -6.828 | 0.000 | Highly Significant |
| GFCF | 0.9714 | 0.713 | 1.362 | 0.0176 | Significant |
| Birth Rate | 5.0027 | 0.856 | 5.845 | 0.000 | Highly Significant |
| Young Dependency | -2.6290 | 0.664 | -3.959 | 0.000 | Highly Significant |
| Working Age Population | 41.8288 | 8.443 | 4.9601 | 0.001 | Highly Significant |
| Elderly Dependency | -3.7966 | 1.819 | -2.0871 | 0.003 | Highly Significant |
| Population growth rate | -2.037 | 0.894 | -2.278 | 0.370 | Insignificant |

**Source:** Author's Calculation

Although the model provides a high R-Square, the presence of multicollinearity (as evidenced by high VIF values) severely undermines the reliability of its coefficient estimates. Multicollinearity inflates standard errors and destabilises coefficient values, making it challenging to attribute specific impacts to individual variables accurately.

To address multicollinearity and provide deeper insights into the demographic-economic relationship, this section presents the results of Ridge Regression and Principal Component Analysis (PCA). These methodologies complement the primary analysis by stabilising coefficient estimates (Ridge Regression) and reducing dimensionality to focus on uncorrelated components (PCA). Ridge Regression introduces a penalty term (α) to address multicollinearity by shrinking coefficients. This method retains all variables, ensuring interpretability while mitigating inflated standard errors caused by highly correlated predictors

**Table 3:** Ridge Regression

| Variable | Coefficient |
|---|---|
| GFCF | 0.43 |
| Birth Rate | 5.00 |
| Young Dependency | -1.63 |
| Working Age Population | 18.89 |
| Elderly Dependency | -3.10 |
| Population growth rate | -0.80 |

**Source:** Author's Calculation

The Ridge Regression results demonstrate that the working-age population and birth rate positively contribute to GDP, while the elderly dependency and young dependency ratios have negative impacts, reflecting the economic burden of dependents. GFCF, while positive, has a reduced effect due to its marginal significance.

**Principal Component Analysis:**

PCA transforms the dataset into uncorrelated components that explain the majority of the variance. For this analysis, the first three components account for 95% of the total variance.

**Table 4:** PCA with Explained Variance

| Principal Component | Explained Variance (%) |
|---|---|
| PC1 | 47.82 |
| PC2 | 28.12 |
| PC3 | 19.06 |

**Source:** Author's Calculation

The first principal component (PC1) captures 47.82% of the variance, primarily reflecting the combined effects of demographic factors. Together with PC2 and PC3, these components effectively summarise the data while addressing multicollinearity.

**PCA Regression Results:**

The transformed principal components were used as predictors in a regression model to evaluate their relationship with GDP.

**Table 5:** PCA Regression Result

| Variable | Coefficient | Std. Error | t-Statistics | p-Value | Significance |
|---|---|---|---|---|---|
| Constant | 0.4855 | 0.0283 | 17.15 | 0.001 | Highly Significant |
| PC1(Birth rate, working age population, young dependency) | 0.0045 | 0.0244 | 0.18 | 0.085 | Significant |
| PC2(Elderly dependency, Population growth rate) | 0.0275 | 0.0265 | 1.04 | 0.302 | Not Significant |
| PC3(GFCF and remaining) | -0.0018 | 0.0279 | -0.07 | 0.948 | Not Significant |

**Source:** Author's Calculation

While PCA successfully reduces multicollinearity, the regression results indicate that none of the principal components are statistically significant. This suggests that the combined effects of demographic factors require further exploration, or the variance captured by these components does not strongly correlate with GDP growth. The Ridge Regression results provide stabilised coefficients for individual variables, retaining their interpretability while mitigating multicollinearity. PCA, on the other hand, reduces dimensionality and highlights the aggregate effects of demographic factors, but its regression results reveal limited direct associations with GDP. These methods serve as complementary analyses to the primary model, offering robustness checks and additional perspectives on the demographic-economic relationship.

### 5.3 Untransformed Model using raw data

The untransformed model explains 48.9% of the variation in GDP (R-square=0.489) and is statistically significant overall (F-statistic $p<0.0001$). Key findings include a significant negative relationship between GDP and both the working-age population ($p<0.001$) and the young dependency ratio ($p<0.001$), suggesting inefficiencies in labour utilisation and the economic burden of youth dependency. The elderly dependency ratio shows a marginally significant negative impact ($p=0.078$), highlighting challenges from an ageing population.

**Table 6:** Pooled OLS Estimates with Untransformed Variable

| Variable | Coefficient | Std. Error | t-Statistics | p-Value | Significance |
|---|---|---|---|---|---|
| Constant | 28.0123 | 6.37 | 4.40 | 0.000 | Highly Significant |
| GFCF | -9.74 | 9.69 | -1.01 | 0.317 | Not Significant |
| Birth Rate | 11.03 | 9.62 | 1.15 | 0.254 | Not Significant |
| Young Dependency | -13.68 | 2.93 | -4.67 | 0.000 | Highly Significant |
| Working Age Population | -31.75 | 7.55 | -4.21 | 0.076 | Significant |
| Elderly Dependency | -5.3166 | 2.98 | -1.76 | 0.003 | Highly Significant |
| Population growth rate | -6.123 | 11.50 | -0.53 | 0.596 | Not significant |

**Source:** Author's Calculation

Variables like GFCF, birth rate, and population growth rate are not significant, indicating minimal direct effects on GDP. While the model provides useful insights, unexpected negative coefficients and insignificant variables suggest potential issues such as multicollinearity, limiting its reliability compared to transformed models. The results reveal that demographic factors significantly influence GDP, with theoretical underpinnings aligning closely. The positive impact of birth rates reflects population replenishment's role in sustaining economic growth, consistent with demographic transition theory. Conversely, the negative effects of young and elderly dependency ratios align with the economic burden of dependents, as highlighted in dependency ratio literature. The marginal significance of GFCF suggests that investments in infrastructure, while important, may not directly translate to GDP growth without supportive policy frameworks. These findings underscore the need for targeted interventions in education, skill development, and workforce productivity to maximise demographic dividends and mitigate dependency challenges.

## 6. Recommendations

To fully harness the potential of demographic transitions, policymakers in India and China must implement targeted strategies. India should focus on maximising its demographic dividend by investing in education, healthcare, and skill development to enhance workforce productivity and reduce regional disparities. Additionally, creating more employment opportunities, particularly in high-growth sectors, is essential to absorb its growing working-age population. For China, addressing the challenges of an aging population is critical, requiring policies that promote elder participation in the workforce and strengthen social security systems. Both countries should prioritize investments in infrastructure and innovation to support long-term economic resilience. Furthermore, fostering inclusive growth through gender equity in education and labor force participation will amplify the benefits of demographic shifts. By aligning these strategies with sustainable economic policies, both nations can navigate their demographic transitions effectively and maintain robust growth trajectories.

## 7. CONCLUSION

This study underscores the central role of demographic dynamics in shaping long-term economic growth in India and China. By examining key indicators such as birth rates, age dependency ratios, working-age population shares, and the rising proportion of elderly citizens, the analysis demonstrates that population structure is a powerful determinant of macroeconomic performance. A larger working-age population, when effectively educated and productively employed, can significantly accelerate GDP growth through increased labor supply, higher productivity, and expanded consumption. India, which is still in the midst of its demographic transition, continues to benefit from a sizeable youth population and a growing labor force. However, realizing this demographic dividend requires strategic investments in quality education, skill development, technological readiness, and employment generation. Without these, the demographic advantage could convert into a "demographic burden."

In contrast, China has already moved beyond the peak of its demographic dividend due to its historically low fertility rates and prolonged one-child policy. The resulting rapid rise in the elderly population poses challenges such as a shrinking labour supply, rising healthcare costs, pension pressures, and slowing economic momentum. China's experience illustrates the long-term economic consequences of accelerated population ageing and highlights the importance of balancing population control policies with economic sustainability. The comparative findings reveal that both nations must design policies aligned with their unique demographic trajectories. India needs to focus on maximising labour productivity, improving human capital, expanding job opportunities, and strengthening healthcare infrastructure. China, on the other hand, must address the constraints of an ageing society through technological innovation, labour-saving automation, pension reforms, and policies encouraging healthy ageing. Overall, this study concludes that demographic trends are not merely statistical occurrences but strategic determinants of national competitiveness. Policymakers in both countries must integrate demographic insights into long-term development planning to ensure sustainable, resilient, and inclusive economic growth.

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