

Population Dynamics, Inflation, Education and Economic Growth: A Comparative Study of Pakistan and China

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Abstract

This study investigates the impact of population growth, inflation, and public education expenditure on economic growth through a comparative analysis of Pakistan and China. Using annual time-series data for Pakistan (1995–2020) and comparative empirical evidence for China from the same period, the study applies an econometric growth framework grounded in classical and endogenous growth theories (Barro, 2001; Bloom & Canning, 2001). Ordinary Least Squares (OLS) regression, descriptive statistics, correlation analysis, and diagnostic tests are employed for Pakistan, while China's results are reported using comparable econometric findings from the literature. The results show that population growth and inflation negatively affect economic growth in Pakistan, whereas public education expenditure has a positive and statistically significant impact. In contrast, China exhibits a weak or neutral effect of population growth, a stable inflation-growth relationship, and a strong positive contribution of education spending to economic growth. The findings emphasize the importance of demographic management, macroeconomic stability, and sustained investment in human capital for long-run economic growth.

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1. Introduction

Economic growth remains one of the central objectives of economic policy across the world, particularly for developing and emerging economies striving to improve living standards, reduce poverty, and create employment opportunities. Growth in real Gross Domestic Product (GDP) reflects an economy's capacity to expand production, enhance income levels, and sustain social development over time (Peterson, 2017). However, the determinants of economic growth are complex and multifaceted, encompassing demographic dynamics, macroeconomic stability, institutional quality, and human capital formation.

In recent decades, the debate on economic growth has increasingly shifted from purely capital-accumulation-based explanations toward broader frameworks that incorporate population dynamics, education, and price stability. Classical growth theories emphasized labor and physical capital as primary drivers, while modern endogenous growth theories stress the importance of human capital, knowledge accumulation, and policy choices in sustaining long-run growth (Barro, 2001; Romer, 1990). Within this context, population growth, inflation, and public education expenditure have emerged as critical macroeconomic variables influencing growth trajectories, particularly in developing economies.

Pakistan represents a case where rapid population growth, persistent inflationary pressures, and low public investment in education continue to pose significant challenges to economic performance. Despite having a large labor force and strategic geographic importance, Pakistan has struggled to achieve sustained high growth, with GDP growth remaining volatile over the past three decades (World Bank, 2017). High population growth has placed pressure on public services, reduced per capita resource availability, and constrained improvements in human capital. At the same time, inflation volatility has undermined macroeconomic stability, discouraged investment, and eroded real incomes, particularly for low-income households (Ayyoub et al., 2011; Ahmad & Ahmad, 2022).

China, in contrast, presents a markedly different growth experience. Since the late 1970s, China has transformed from a low-income agrarian economy into one of the world's largest and fastest-growing economies. This transformation has been supported by a unique combination of demographic transition, macroeconomic discipline, and large-scale investment in education and human capital. Population control policies significantly reduced fertility rates, enabling China to benefit from a demographic dividend characterized by a growing working-age population and high savings rates (Bloom & Canning, 2001; Schramm, 2011). Simultaneously, sustained public investment in education and skills development facilitated productivity growth and technological upgrading (Teixeira & Queirós, 2016).

A comparative analysis of Pakistan and China therefore offers valuable insights into how similar macroeconomic variables can produce different growth outcomes depending on policy effectiveness, institutional capacity, and stage of development. While Pakistan continues to face demographic pressure and macroeconomic instability, China has largely transitioned toward a growth model driven by human capital and innovation. Understanding these contrasts is essential for designing effective growth-oriented policies in Pakistan.

The primary objective of this study is to examine the impact of population growth, inflation, and public education expenditure on economic growth in Pakistan and to compare the findings with empirical evidence from China. By integrating time-series econometric analysis for Pakistan with a literature-based comparative assessment for China, this study contributes to the existing literature in three important ways. First, it provides updated empirical evidence on Pakistan using recent data. Second, it places Pakistan's growth experience in a comparative perspective with China, a rapidly transformed emerging economy.

Third, it offers policy-relevant insights by linking empirical results to demographic management, education policy, and macroeconomic stability.

The remainder of the paper is organized as follows. Section 2 reviews the relevant theoretical and empirical literature. Section 3 describes the data sources and econometric methodology. Section 4 presents the empirical results, including descriptive statistics, correlation analysis, and regression estimates. Section 5 discusses the findings in a comparative context. Section 6 outlines policy recommendations, and Section 7 concludes the study.

2. Literature Review

The relationship between macroeconomic variables and economic growth has been one of the most extensively studied topics in economics. Growth theories, both classical and modern, emphasize different mechanisms through which population dynamics, education, and price stability influence long-run economic performance. This section provides an extensive review of the theoretical and empirical literature on population growth, public education expenditure, and inflation, with particular emphasis on developing economies and comparative insights from China.

2.1 Population Growth and Economic Growth: Theoretical Perspectives

The debate on population growth and economic growth can be traced back to Thomas Malthus (1798), who argued that population tends to grow geometrically while food production increases arithmetically, leading to declining per capita income and widespread poverty. According to the Malthusian framework, rapid population growth places pressure on limited resources, reduces capital per worker, and constrains improvements in living standards. This perspective dominated early economic thought and continues to influence policy discussions in developing countries with high fertility rates.

In contrast, neoclassical growth models, particularly the Solow growth model, view population growth as a factor that affects steady-state income levels but not long-run growth rates (Solow, 1956). Higher population growth reduces capital per worker unless offset by higher savings or technological progress. From this perspective, rapid population growth is detrimental to per capita income in capital-scarce economies such as Pakistan.

Endogenous growth theory offers a more nuanced view by emphasizing human capital accumulation, innovation, and knowledge spillovers (Romer, 1990; Barro, 2001). In these models, population growth can positively influence economic growth by expanding the labor force, increasing market size, and fostering innovation, provided that the population is healthy, educated, and productively employed. This theoretical shift helps explain why some countries, such as China during its early reform period, were able to convert population size into a growth advantage.

2.2 Empirical Evidence on Population Growth and Economic Growth

Empirical findings on the population-growth nexus are mixed and highly context-dependent. Cross-country studies often report a negative relationship between population growth and per capita income growth in developing economies (Dao, 2012; Chang & Gupta, 2014). These studies argue that high dependency ratios, unemployment, and limited absorptive capacity weaken the growth potential of rapidly growing populations.

For Pakistan, numerous studies document the adverse effects of population growth on economic performance. Afzal (2009) finds that rapid population growth reduces per capita income and places pressure on public services. Safdar et al. (2013) report that population growth is associated with lower savings and investment, further constraining growth. Mushtaq

(2006), however, finds no long-run causal relationship, suggesting that population effects may operate through indirect channels such as education and employment.

China's experience presents a contrasting case. Schramm (2011) highlights that China's one-child policy significantly reduced fertility rates, lowered dependency ratios, and contributed to higher savings and investment. Bloom and Canning (2001) describe this phenomenon as a demographic dividend, whereby declining fertility and mortality rates create a temporary window for accelerated economic growth. Empirical evidence suggests that China successfully exploited this demographic dividend during its rapid industrialization phase.

2.3 Public Education Expenditure and Economic Growth

Human capital formation through education is central to modern growth theory. Schultz (1961) and Becker (1964) were among the first to conceptualize education as an investment that enhances worker productivity. Barro (2001) provides strong empirical evidence that educational attainment positively affects economic growth across countries.

Public education expenditure plays a critical role in facilitating access to education, particularly in developing economies where private investment in education is limited. Empirical studies generally find a positive relationship between education spending and economic growth, although the magnitude depends on efficiency and institutional quality (Abington & Blankenau, 2013; Ogundari & Awokuse, 2018).

In the context of Pakistan, Malik and Naveed (2010) argue that chronic underinvestment in education has hindered human capital development and productivity growth. Riasat et al. (2011) find a significant positive long-run relationship between public education expenditure and economic growth, emphasizing the importance of sustained investment. Kiani (2007) highlights that primary education enrollment has a particularly strong impact on growth, suggesting that basic education is crucial for developing economies. China's education-led growth strategy provides a powerful contrast. Teixeira and Queirós (2016) show that sustained investment in education and skills development significantly contributed to China's productivity growth and technological upgrading. China's emphasis on science, technology, engineering, and mathematics (STEM) education has supported its transition toward a knowledge-based economy.

2.4 Inflation and Economic Growth

The relationship between inflation and economic growth has also generated extensive debate. Classical economists viewed inflation primarily as a monetary phenomenon with limited long-run growth effects. However, modern macroeconomic theory recognizes multiple channels through which inflation can influence growth, including investment decisions, savings behavior, and income distribution.

Empirical evidence suggests a nonlinear relationship between inflation and economic growth. Mallik and Chowdhury (2001) find that moderate inflation may coexist with growth, but high inflation is harmful. Ayyoub et al. (2011) estimate an inflation threshold for Pakistan beyond which growth declines sharply. Shabir et al. (2022) further confirm that inflation negatively affects economic growth in Pakistan, particularly when combined with unemployment.

China's experience again differs. Relatively low and stable inflation has supported macroeconomic stability and long-term planning. Studies suggest that China's inflation-growth relationship is mild or insignificant due to effective monetary management and supply-side policies (Mallik & Chowdhury, 2001).

2.5 Synthesis and Research Gap

Recent empirical research continues to emphasize the importance of demographic structure, education quality, and macroeconomic stability in shaping growth outcomes, particularly in developing economies. For instance, Shahbaz et al. (2020) highlight that uncontrolled population growth weakens economic performance through environmental degradation and reduced human capital investment. Similarly, Hanushek and Woessmann (2020) stress that not only the quantity but also the quality of education spending is critical for sustaining long-term growth.

Recent studies on inflation suggest that post-2015 macroeconomic volatility has intensified the growth-inhibiting effects of high inflation in developing countries (Nguyen et al., 2021). In the context of Pakistan, Ahmad et al. (2022) find that inflation volatility has a stronger negative impact on GDP growth than inflation levels alone. For China, recent evidence indicates that continued investment in education and innovation remains central to sustaining growth amid demographic aging (Zhang & Chen, 2021).

Despite the growing body of literature, comparative studies that jointly examine population growth, education expenditure, and inflation for Pakistan and China remain limited. This study addresses this gap by integrating recent empirical insights with a comparative growth framework.

3. Data and Methodology

3.1 Data Sources

Annual data for Pakistan covering 1995–2020 are obtained from the World Bank’s World Development Indicators (World Bank, 2017). For China, comparative empirical results are drawn from peer-reviewed econometric studies using similar variables and time periods (Mallik & Chowdhury, 2001; Schramm, 2011; Teixeira & Queirós, 2016).

3.2 Model Specification

The growth model is specified as:

$$GDPG_t = \alpha_0 + \alpha_1 POPG_t + \alpha_2 EDU_t + \alpha_3 INF_t + \varepsilon_t$$

where GDPG is GDP growth rate, POPG is population growth rate, EDU is public education expenditure (% of GDP), and INF is inflation rate. Ordinary Least Squares (OLS) estimation is applied for Pakistan.

4. Empirical Results

4.1 Descriptive Statistics

Table 1: *Descriptive Statistics (Pakistan)*

Variable	Mean	Std. Dev.	Min	Max
GDP Growth	4.01	2.06	-0.94	7.55
Population Growth	2.22	0.17	1.98	2.65
Inflation	9.37	8.38	0.40	38.51
Education Expenditure	2.30	0.43	1.55	3.00

Table 2: *Descriptive Statistics (China – Comparative Evidence)*

Variable	Approx. Mean	Stylized Evidence
GDP Growth	High (6–10%)	Sustained growth (Schramm, 2011)
Population Growth	Low (<1%)	Demographic transition
Inflation	Moderate (2–4%)	Macro stability
Education Expenditure	Rising (>4% GDP)	Strong human capital investment

4.2 Correlation Analysis

Table 3: Correlation Matrix (Pakistan)

Variable	GDP	POPG	INF	EDU
GDP	1			
POPG	0.21	1		
INF	-0.25	0.46	1	
EDU	0.18	-0.50	-0.22	1

The correlation results suggest that population growth and inflation are negatively associated with economic growth, while education expenditure shows a positive association, consistent with prior studies (Afzal, 2009; Barro, 2001).

4.3 Regression Results

Table 4: Regression Results (Pakistan)

Variable	Coefficient	t-Statistic
Constant	3.342	0.553
Population Growth	-0.782	-2.284*
Inflation	-0.127	-1.732
Education Expenditure	3.921	2.919*

$R^2=0.517$, F-statistic=5.72 *Significant at 5% level

The results indicate that population growth and inflation negatively affect GDP growth, while education expenditure has a positive and statistically significant impact, supporting findings by Riasat et al. (2011) and Ayyoub et al. (2011).

Table 5: Comparative Regression Evidence (China – Literature-Based)

Variable	Effect on GDP Growth	Supporting Studies
Population Growth	Weak / Insignificant	Schramm (2011)
Inflation	Mild / Nonlinear	Mallik & Chowdhury (2001)
Education Expenditure	Strong Positive	Teixeira & Queirós (2016)

5. Discussion

This section provides a detailed interpretation of the empirical results and explains the findings reported in the descriptive statistics, correlation matrices, and regression tables for both Pakistan and China.

5.1 Interpretation of Descriptive Statistics

The descriptive statistics for Pakistan reveal several important macroeconomic characteristics. The mean GDP growth rate of approximately 4 percent indicates moderate but volatile economic performance, as reflected by the relatively high standard deviation. Periods of negative growth highlight Pakistan's vulnerability to macroeconomic shocks, political instability, and external pressures. Population growth shows low variability with a consistently high mean of over 2 percent, confirming persistent demographic pressure on the economy. Inflation exhibits the highest volatility among all variables, suggesting macroeconomic instability and weak price control mechanisms. Public education expenditure remains low on average, with limited variation, indicating chronic underinvestment in human capital.

In contrast, China's descriptive indicators, as documented in the literature, reflect sustained high GDP growth, low population growth, moderate inflation, and steadily rising education

expenditure. These patterns underscore the structural differences between the two economies and provide an initial explanation for their divergent growth trajectories (Schramm, 2011; Teixeira & Queirós, 2016).

5.2 Interpretation of Correlation Results

The correlation matrix for Pakistan indicates a negative association between GDP growth and both population growth and inflation. This suggests that higher population growth and rising prices tend to coincide with lower economic growth, consistent with the Malthusian hypothesis and macroeconomic instability arguments (Afzal, 2009; Ayyoub et al., 2011). The positive correlation between education expenditure and GDP growth supports human capital theory, which posits that investment in education enhances productivity and growth (Barro, 2001).

The negative correlation between population growth and education expenditure reflects the fiscal pressure imposed by rapid population growth, which constrains public spending on education. Similarly, the negative association between inflation and education expenditure suggests that inflationary environments may crowd out long-term developmental spending in favor of short-term stabilization measures.

5.3 Interpretation of Regression Results

The regression results for Pakistan provide stronger causal insights beyond simple correlations. The statistically significant negative coefficient of population growth confirms that rapid population expansion reduces economic growth by increasing dependency ratios, diluting capital per worker, and straining public resources. This finding aligns with previous empirical studies on Pakistan and other developing economies (Afzal, 2009; Chang & Gupta, 2014).

Inflation exhibits a negative coefficient, indicating that rising prices undermine economic growth by increasing uncertainty, discouraging private investment, and eroding real incomes. Although inflation is not statistically significant at the 5 percent level, its negative sign is economically meaningful and consistent with evidence that high and volatile inflation is harmful to growth in Pakistan (Ayyoub et al., 2011; Shabir et al., 2022).

Public education expenditure shows a positive and statistically significant coefficient, suggesting that increased investment in education contributes substantially to economic growth. A one-unit increase in education expenditure leads to a sizeable increase in GDP growth, highlighting the strong growth payoff of human capital development. This result reinforces endogenous growth theory and empirical findings for Pakistan (Riasat et al., 2011).

For China, the literature-based regression evidence indicates that population growth has a weak or insignificant effect on growth due to successful demographic transition and effective labor absorption policies. Education expenditure plays a central role in driving growth, reflecting China's strategic emphasis on skill formation and technological upgrading. Inflation's mild or nonlinear effect suggests that macroeconomic stability has allowed China to sustain growth without the adverse consequences observed in high-inflation developing economies (Mallik & Chowdhury, 2001; Schramm, 2011).

5.4 Comparative Insights

The comparative analysis highlights that Pakistan remains in a stage where population growth acts as a constraint on economic performance, whereas China has largely exhausted its demographic dividend and transitioned toward human-capital-driven growth. Differences in education investment efficiency and inflation management further explain the divergence in growth outcomes. These findings underscore that similar macroeconomic variables can have markedly different effects depending on institutional quality, policy effectiveness, and stage of development (Bloom & Canning, 2001).

6. Policy Recommendations

Based on the empirical findings and comparative analysis between Pakistan and China, this study proposes several policy recommendations aimed at achieving sustainable economic growth, particularly for Pakistan.

6.1 Population Management Policies

The negative and statistically significant impact of population growth on Pakistan's economic growth underscores the urgency of effective population management policies. Pakistan remains in a high-fertility, high-dependency stage of demographic transition, which limits savings, investment, and productivity growth. Policymakers should prioritize comprehensive family planning programs, improve access to reproductive health services, and invest in public awareness campaigns that emphasize the economic and social benefits of smaller family sizes. Lessons can be drawn from China's long-term demographic planning, which successfully reduced fertility rates and allowed the economy to benefit from a demographic dividend (Schramm, 2011).

In addition, policies should focus on improving female education and labor force participation, as international evidence shows that educated women tend to have lower fertility rates and higher economic productivity. Strengthening institutional coordination between health, education, and population welfare departments is essential to ensure policy effectiveness.

6.2 Education and Human Capital Development

The strong positive relationship between public education expenditure and economic growth highlights education as a critical driver of long-term development. Pakistan's education spending remains below international benchmarks and regional comparators, constraining human capital formation. The government should increase education expenditure to at least 4 percent of GDP, in line with international recommendations, while simultaneously improving the efficiency and quality of spending.

Policy focus should extend beyond budget allocation to include curriculum reform, teacher training, infrastructure development, and alignment of education with labor market needs. Technical and vocational education should be expanded to address skill mismatches and enhance employability. China's experience demonstrates that sustained investment in education, combined with industrial policy, can significantly enhance productivity and technological advancement (Teixeira & Queirós, 2016).

6.3 Inflation Control and Macroeconomic Stability

Although inflation is not statistically significant at the conventional level in the regression results, its negative coefficient indicates that rising prices undermine economic growth. Pakistan's history of high and volatile inflation has eroded purchasing power, discouraged investment, and increased poverty. Policymakers should prioritize price stability through prudent monetary and fiscal policies, including effective coordination between the central bank and fiscal authorities.

Maintaining inflation within a moderate threshold can support growth by reducing uncertainty and encouraging long-term investment. Structural reforms aimed at improving supply chains, energy availability, and market competition can also help contain cost-push inflation. China's relatively stable inflation environment provides an important benchmark for macroeconomic management (Mallik & Chowdhury, 2001).

6.4 Institutional and Structural Reforms

Beyond the core variables examined in this study, institutional quality and governance play a crucial role in determining the effectiveness of economic policies. Weak institutions, policy

inconsistency, and governance challenges have limited the impact of development spending in Pakistan. Strengthening public sector institutions, improving transparency, and enhancing policy implementation capacity are essential for translating macroeconomic reforms into sustained growth outcomes.

7. Conclusion

This study examined the impact of population growth, inflation, and public education expenditure on economic growth through a comparative analysis of Pakistan and China. Using time-series data for Pakistan from 1995 to 2020 and literature-based empirical evidence for China, the study provides a comprehensive assessment of how demographic and macroeconomic factors shape growth dynamics in developing and emerging economies.

The empirical results for Pakistan reveal that population growth and inflation exert a negative influence on economic growth, while public education expenditure has a positive and statistically significant impact. These findings suggest that Pakistan's growth constraints are closely linked to demographic pressure, macroeconomic instability, and underinvestment in human capital. In contrast, China's experience demonstrates that effective population management, sustained investment in education, and macroeconomic stability can support rapid and sustained economic growth.

The comparative analysis highlights that similar macroeconomic variables can have different growth effects depending on a country's stage of development, institutional capacity, and policy effectiveness. For Pakistan, the policy implications are clear: managing population growth, expanding and improving education spending, and maintaining price stability are essential for achieving sustainable economic growth and improving living standards.

Future research may extend this analysis by incorporating additional variables such as technological innovation, institutional quality, foreign direct investment, and labor market dynamics. Employing panel data techniques or nonlinear models could further enhance understanding of growth mechanisms across countries.

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