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Research Article

Demographic Transition and Human Capital in Developing Countries: An Empirical Analysis

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ABSTRACT

This paper provides empirical evidence that supports the bi-directional relationship between demographic transition and human capital in accordance with the demographic transition model (DTM). The study uses the panel data analysis, which consists of 31 developing countries in total from 2010 to 2020. The results expose that fertility rate and mortality rate have negative effects on demographic transition while economic growth and labor force have positive effects on the human capital index. The results suggest that appropriate measures ought to be taken by the government to improve education policies and health insurance programs.

Keywords: Demographic Transition, Human Capital Index, Developing Countries.

INTRODUCTION

Following the Second World War, many states gained independence, leading to unprecedented population growth in developing economies. Population is a critical factor in economic development. Between 1995 and 2000, approximately sixty percent of the world's population increase occurred in nine developing economies. During this period, countries like Pakistan had total fertility rates ranging from 3.1 to 5.0. The population momentum accumulated over decades will take considerable time to counteract. Future world population size will largely depend on the speed of fertility decline, which is closely linked to educational improvements in countries with currently low educational achievements.

Throughout human history, continuous population increases have accelerated economic forces. Traditional societies experienced high mortality and fertility rates, whereas modern societies have lower rates for both. Most developing economies, including Pakistan, started with high fertility and mortality rates. Pakistan's rapid population growth has resulted in a significant youth dependency burden. Additionally, the relationship between population and human capital has become a critical issue in recent years.

Research by Temel (2013) and Vogel (2015) identified fertility as a key determinant of human capital formation. Asia is aging rapidly, with the number of people aged 65 and over expected to more than double by 2050. The workforce will also undergo significant changes, with declines in working-age populations in economies like Armenia, Georgia, and Japan. As the average age of workers increases, they are expected to be healthier, better educated, more skilled, and retire later. Lower fertility rates and higher investments per child have led to increased average years of schooling. In the past two decades, life expectancy has improved by 11 years. New technologies will enable more people to be

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productive, regardless of age. Warren Thompson (1929) introduced the demographic transition model (DTM), which comprises four or possibly five stages. The first stage features high birth and death rates, known as the Malthusian stage. The second stage, the transition stage, is marked by declining mortality rates due to significant improvements in per capita income and technological progress. The third stage sees lower birth and death rates due to social and behavioral changes. This stage occurs in modernized societies with higher per capita incomes and lower fertility and mortality rates (Galor and Weil, 1999). The fourth stage indicates the cessation of population growth.

Emerging economies differ from developed ones in various ways, including health, education, and women's roles in national income. Industrialized economies benefit from better education and healthcare, contributing to more productive choices. While most countries continue to experience population growth, some, like China, are adopting policies to slow population growth to conserve resources for future generations.

Developing economies often lack proper sanitation, healthcare facilities, and state-level incentives to enhance educational facilities. Female labor force participation is crucial for economic growth, but the value and contribution of women's work are often undervalued compared to developed economies (Rahman & Islam, 2013). In many economies, birth rates have dropped significantly, even where population growth remains high. This study highlights the importance of human capital as a crucial factor in mitigating the macroeconomic impacts of demographic changes. Olniyani and Okemakinde (2008) emphasized the importance of human capital development for production activities. Investments in human capital are associated with increased economic productivity. This study aims to analyze the bi-directional relationship between demographic transition and human capital.

LITERATURE REVIEW

Population growth is a significant variable in macroeconomic dynamics. The term "demographic transition" refers to the secular shift in mortality and fertility from high and volatile levels to lower and more stable ones. During this transition, increased dependency ratios can drive growth in per capita consumption or income (Mason, Lee, & Lee, 2010). While there is an extensive body of literature analyzing the association between demographic transition and human capital, there is a notable lack of studies exploring the direct relationship between these demographic transitions and human capital.

Sarel (1995) employed the Pooled OLS regression technique using data from 121 countries covering the period from 1960 to 1985. The results indicated a positive and significant relationship between demographic transition and economic growth. Ahmad and Khan (2018), using panel data covering the period from 1960 to 2014, investigated the relationship between human capital and age structure. Their study suggested that reducing fertility rates could enhance economic expansion. Bloom and Finlay (2009), using the fixed-effect technique, revealed that population growth has a small or negligible effect on economic growth, suggesting that demographic change has a catalytic impact on economic growth.

Ludwig, Schelkle, and Vogel (2012) showed that demographic changes in the U.S. will reduce the share of the working-age population. Frini and Muller (2012) highlighted that education drives fertility transition both in the short and long run, finding a positive relationship between fertility and education. Vogel, Ludwig, and Supan (2017) examined the consequences of demographic change for the welfare of generations in industrialized countries. Their study found that labor market policies focusing on broad margins and educational adjustments are crucial in mitigating the adverse effects of demographic change.

Cuaresma and Lutz (2014) analyzed the impact of changes in age structure on economic growth, finding strong evidence of a positive connection between economic growth and average years of schooling. Foong (2015) revealed both short- and long-term relationships between economic growth and human capital, finding strong indications of a positive relationship between economic growth and foreign direct investment. Fernihough (2017) explored the child quantity–quality tradeoff using unified growth theory, reporting a negative relationship between literacy and school attendance.

Sahu, Srivastava, Kumar, and Singh (2018) found that more than half of the population suffers significantly in terms of nutritional status and morbidity. Lutz et al. (2018) unveiled the significant impact of technology adoption on education, with returns in terms of increased economic growth. This study reported positive effects on human capital stocks and the working-age population.

Frini and Muller (2012) investigated the speculative relationship between demographic transition, education, and economic growth in Tunisia. Using time-series data from 1963 to 2007, they reported a positive association between income, schooling, and fertility rates in Tunisia. Bairoliya and Miller (2021) examined the short- and long-term impacts of fertility rates in China. Using data from the China Family Panel Study (2011 to 2013), they found that higher fertility levels reduce human capital in the long run. Ciutiene and Railaite (2015) analyzed the relationship between human capital and population aging, based on theoretical analysis. They found that the appreciation of human capital promotes education and life expectancy.

Most studies have focused on the role of demographic transition in economic growth, highlighting human capital as an intervening variable. However, the current study aims to bridge the gap in the literature by exploring the bi-directional relationship between demographic transition and human capital, specifically examining its significant input in scholarly discourse.

THEORETICAL FRAMEWORK

In the 19th century, the significance of age-structural transition and human capital for economic development gained recognition. The theoretical concept of demographic transition is widely accepted as a historical shift from high birth and death rates in societies with minimal technology, healthcare, education, and economic development to lower birth and death rates. Improvements in health can lead to increased life expectancy, which is associated with longer investment payback periods.

However, an examination of the scientific literature reveals that human capital development within the context of population aging focuses not only on the elderly but also highlights the potential of younger individuals.

Economic development has evolved through three main stages: the Malthusian stage, characterized by underdevelopment, high mortality, and high fertility rates; the transition stage, marked by significant technological progress and increases in per capita income; and the modernized stage, featuring high per capita income and low fertility and mortality rates (Galor& Weil, 1999).

According to Malthusian Theory, population pressure undermines the adequacy of food supply. It has been widely accepted that rapid population growth poses challenges to a population's standard of living. Frank W. Notestein's theory of demographic transition, which measures the negative relationship between fertility and technological advancement, has become one of the most widely acknowledged findings in social science.

This section provides the theoretical framework for assessing the impact of demographic change on the human capital index. Data is primarily sourced from the World Development Indicators and the Penn World Table. Following the methodologies of Azarnert et al. (2006) and Ahmad and Khan (2018), the following model is constructed to examine the relationships among the variables.

$WPR=\alpha_1+\alpha_2 LX+\alpha_3 FR+\alpha 4\, MR+\alpha_5 HCI+\alpha 6\, GDPG+\mu i$

$HCI=\alpha_1+\alpha_2 WPOP+\alpha_3 GDPG+\alpha_4 FDI+\alpha 5\, URB+\alpha 6 LF+\alpha 7 GFCF+\mu i$

Table 1. Variable Description

Abbreviation	Variable Name	Measurement
WPR	working age population ratio	Population ages 15-64 (% of total population)
HCI	Human capital index	Year of schooling and returns to education
GDPD	Gross domestic product growth	GDP growth (Annual %)
MR	Mortality Rate	Infant (Per 1,000 Live Birth)
FR	Fertility Rate	Total (Birth Per Women)
Lx	Life Expectancy	Birth, Total (Year)
GFCF	Gross fixed capital formation	(% of GDP)
FDI	Foreign direct investment	Net inflow (% of GDP)
URB	Urbanization	Total population
LF	Labor force	Labor force, total

To consider the association between demographic transition and human capital, study uses data from 31 developing countries covering a period of eleven years commencing from 2010 to 2020. With the association of STATA, particularly shows parameter estimation. The model structure test results show that: comparing the random effects regression model and fixed effect regression model. The Selection of these models-based p esteems of the chi-square within the Breusch-Pagan Lagrange Multiplier LM tests. The corresponding p-value of chi-square in the LM test is significantly less than 0.05, so the study selected a random effects regression model.

RESULTS AND DISCUSSION

The study conducted a descriptive characteristic of all explanatory variables and explained variables. Whole statistical analysis based on statistical sample size, mean, standard deviation, minimum and maximum value. Two models are analyzed in this paper or panel used of economies throughout 2010 to 2020.

Table 2. Descriptive Statistics

Variable	Mean	std. Dev.	Min	Max	Observations
WPR	60.81054	9.380629		18.39164	N = 279
Overall	74.204				n = 31
Between		9.48197		19.03043	T = 9
Within	73.66478				
		82202158		.32663	
	.78752				
LX	66.98495	7.156903		45.1	N = 279
Overall	77.85122				n = 31
Between		7.139353		9.66955	T = 9
Within	77.21653				
		1.310604		0.32384	
	71.0204				
FR	3.065369	1.137391		1.259	N = 279
Overall	5.839				n = 31
		1.146506		1.266667	T = 9
Between	5.635889				
Within		.1304224		2.656258	
	3.533258				
MR	35.19391	19.24698		6.4	N = 279
Overall	84.6				n = 31
		19.23214		8.1	T = 9
Between	80.3				
Within		3.348837		25.13835	
	49.13835				
HCI	2.202063	.6576514		.0000248	N = 279
Overall	3.514184			0	n = 31
	.661631	.0000373	3.323056		T = 9
Between		.0857153		1.975439	
Within	2.776404				
LF	3.05e+07	8.28e+07		315281	N = 279
Overall	4.88e+08				n = 31
		8.40e+07		338743.7	T = 9
Between	4.73e+08				
Within		2154584		1.91e+07	
	4.54e+07				
FDI	3.05e+07	8.28e+07		315281	N = 279
Overall	4.88e+08				n = 31
		8.40e+07		338743.7	T = 9
Between	4.73e+08				
Within		2154584		1.91e+07	
	4.54e+07				

URB	84.98496	22.20979	1.289129	N = 279
Overall	100			n = 31
		22.75689	1.289431	T = 9
Between	100			
Within		3.69913	65.34638	
	98.14048			
GDPG	84.98496	22.20979	1.289129	N = 279
Overall	100			n = 31
		22.75689	1.289431	T = 9
Between	100			
Within		3.69913	65.34638	
	98.14048			

Table 2 presents data from developing countries. Descriptive statistics, including standard deviation, mean, minimum, and maximum values, are provided for all variables. The table categorizes the data into three types: overall, between, and within. The overall standard deviation is used for the entire panel data, the within data for time series components, and the between data for cross-sectional components. The statistics presented in the table appear to be standard, with no major discrepancies observed. For variables such as demographic transition, human capital, fertility rate, life expectancy, economic indicators, mortality rate, and urbanization, the within variation is lower than the between variation. Conversely, for foreign direct investment (FDI) and labor force variables, the within variation is higher than the between variation. This suggests that the most appropriate analysis in this context should focus on cross-sectional data rather than time series analyses, such as stationary tests and co-integration.

Table 3. Breusch and Pagan Lagrangian multiplier test for random effects

Test: Var(u) = 0	
chibar2 (01) = 1056.05	Prob> chibar2 = 0.0000

Tabl3 04. Hausman Test

Test: Ho: difference in coefficients is not systematic	
chi2 (5) = (b-B)'[(V_b-V_B) ^ (-1)] (b-B)	
= 6.07	Prob>chi2 = 0.2993

Based on the findings from the Hausman test and the Breusch-Pagan LM test, the random effects model is determined to be the most suitable for the sample of developing countries. The model specification test results indicate the following:

When comparing the mixed regression model with the random effects regression model, the chi-square P-value from the LM test is significantly less than 0.05. This result suggests that the random effects regression model is preferable. Further, when comparing the random effects model to the fixed effects model, the chi-square P-value from the Hausman test is significantly greater than 0.05, indicating that the random effects model is more appropriate for the panel data in question.

The dependent variable in the analysis is the demographic transition, measured by the working-age population. The analysis examines the impact of various independent variables, including the fertility rate, mortality rate, human capital index, life expectancy, and gross domestic product (GDP) growth, on the demographic transition.

Table 5. Results of Random Effect Estimates of Model with Dependent Variable of Demographic Transition

Variables	Coefficient	Std Error	Z-Value	P>|z|	[95% Conf. Interval]	
Mortality Rate	-.0520252	019835	2.62	0.009	--.0909011	-.0131492
Fertility Rate	-4.74456	.417074	-11.38	0.000	-5.56201	-3.92711
Life Expectancy	-.091698	.0557792	-1.64	0.100	-.2010233	.0176272
Human Capital Index	-2.444418	.5837803	-4.19	0.000	-3.588606	-1.300229
GDP Growth	.0273447	.0167884	1.63	0.103	-.0055599	.0602493
Constant	88.57745	5.320548	16.65	0.000	78.14937	99.00553

p<0.01 specifies significance at the 1% level, p<0.05 specifies significance at the 5% level and p<0.1 specifies significance at the 10% level

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The results presented in Table 5 indicate that fertility rate, mortality rate, human capital, and life expectancy have a negative and significant impact on the working-age population ratio. To address the impact of the fertility rate on the working-age population, it is important to consider the different stages of the demographic transition model (DTM).

During the early stages of the DTM, fertility rates were generally increasing. The data shows that an increase in the fertility rate leads to a 4.74456 decrease in the working-age population at a 1% level of significance. This relationship is logical within the DTM framework, as high fertility rates adversely affect developing economies. Large family sizes reduce educational opportunities and negatively impact the health of both mothers and children. This finding aligns with the empirical evidence provided by Foong (2015), which documented that high fertility rates reduce the working-age population ratio.

The current analysis also shows that the growth rate positively and significantly impacts the working-age population rate, whereas life expectancy, mortality rate, and human capital have a negative but significant impact. Specifically, a 1% increase in human capital leads to a 2.444418% decrease in the working-age population at a 1% level of significance.

In the early stages of the DTM, living standards were very low compared to the high population growth rates. Malthusian theory explains that relative changes in mortality and fertility rates result in the observed inverted U-shaped trajectory of population growth. Much of the human capital in developing countries is wasted due to the unavailability of educational facilities, traditional agricultural methods, and low parental status, as explained in the first and second stages of Malthusian theory.

Results of the Human Capital Model

The second model uses the human capital index as the dependent variable and includes gross fixed capital formation, labor force, working-age population ratio, gross domestic product growth, foreign direct investment, and urbanization as independent variables. The results of the Lagrangian Multiplier (LM) Test and the Hausman Test, discussed below, indicate that the panel data in this model is best suited to a random effects framework.

Specifically, the probability value in the LM Test is less than 0.05, and the probability value in the Hausman Test is greater than 0.05. Consequently, the LM Test demonstrates that the random effects model is preferable to the pooled regression model. Additionally, the Hausman Test confirms that the random effects model is more appropriate compared to the fixed effects panel model.

Table 6. Breusch and Pagan Lagrangian multiplier test for random

Test: Var (u) = 0	
Chibar2(01)=1053.44	Prob>chibar2= 0.0000

Table 7. Hausman Test

Test: Ho: difference in coefficients not systematic		
chi2 (5)=(b-B)'[(V_b-V_B) ^ (-1)] (b-B)		
	= 10.61	Prob>chi2= 0.0597

The results of the random effects model, discussed below, align with the existing economic literature, as the variables are statistically significant and the signs correspond with established theories. Statistical significance indicates the consistency of the tested theories. A significance level of one percent means there is a one percent chance of the theory being violated in a hundred experiments based on theoretical justification.

The results of the second model reveal that the coefficients for gross fixed capital formation, working-age population ratio, labor force, and urbanization have a positive and significant impact on the human capital index. The random effects model indicates that foreign direct investment and gross domestic product growth have a negative but significant impact on the working-age population ratio. Specifically, an increase in gross fixed capital formation enhances human capital accumulation by 0.0036115 percentage points at a 1% level of significance. The coefficient for economic growth suggests that a one percent increase in GDP growth reduces human capital by 0.0054069 percentage points at a 1% level of significance.

The labor force also has a significant and positive effect on human capital. As the economies grow faster, the demand for labor increases, leading to higher wages and a larger labor force. The working-age population contributes to a 0.0106078 percentage point increase in human capital at a 5% level of significance. The working-age population is a crucial factor in fostering economic growth. Therefore, during the transition in age structure, the benefits can be maximized by leveraging the economically active population.

Table 8: Random Effect Estimates of the Model with Human Capital as Dependent Variable

Variables	Coefficient	Std Error	Z-Value	P>|z|	[95% Conf. Interval]	
GFCF	0036115	.0014408	2.51	. 0.012	.0007876	.0064353
Life Expectancy	1.38e-09	1.28e-09	1.08	0.281	1.13e-09	3.89e-09
Working-Age Population	.0106078	.0060957	1.74	0.082	-.0013396	.0225552
FDI	-.0028887	.0012976	-2.23	0.026	-.0054319	-.0003455
Urbanization	.0043275	.0014384	3.01	0.003	.0015084	.0071466
GDP growth	-.0054069	.0020849	-2.59	0.010	-.0094932	-.0013205
Constant	1.09107	.3644609	2.99	0.003	.3767395	1.8054

$p<0.01$ specifies significance at the 1% level $p<0.05$ specifies significance at the 5% level $p<0.1$ specifies significance at the 10% level

CONCLUSION AND POLICY IMPLICATION

This study analyzes the bi-directional relationship between demographic change and the human capital index in developing countries using the Demographic Transition Model (DTM). To achieve this, the impact of demographic transition and human capital index variables on economic development is empirically estimated. The analysis uses panel data from 31 selected countries over the years 2010-2020, providing nine time periods. A random effects technique is employed to analyze the dynamic panel data. The relationship between demographic variables and human capital variables has been dynamic and differs from historical stages (Ji, 2014). These findings align with the arguments of Chu (2013) and Vogel (2015). In developing countries, the working-age population rate and human capital have shown a positive contribution, while the fertility rate has shown a negative impact on demographic transition.

A decline in fertility implies that younger cohorts entering the working-age population create development opportunities for the economy. Similarly, the coefficient for GDP growth is positive and significant, suggesting that GDP growth is important for the working-age population. The coefficient for the human capital index (HCI) also positively influences the working-age population rate. All control variables, including FDI, urbanization, and GDP growth, have significant and positive coefficients, aligning with theoretical expectations. Certain developing economies are characterized by a scarcity of resources for development. Effective policy should focus on promoting factors that can simultaneously address multiple tasks.

Ultimately, demographic change and human capital play a key role in determining economic development. Various aspects and avenues exist for further research to explore the role of demographic transition and human capital in developing economies. Public policy should aim to improve productivity, emphasizing education and building human capital early in life, investing in malnutrition reduction, and reducing child mortality. This paper suggests policies to keep girls in school, boost female education, and reduce child marriage. It also addresses social norms on fertility and aims to improve access to sexual and reproductive healthcare, including family planning programs. The study supports gender equity and female empowerment, along with enhancing the ability to work later in life. Future research could extend this work by using detailed age, sex, and distribution data on age structure and human capital, as younger cohorts are generally more productive than older ones in most economies.

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