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Demographic Changes and Economic Growth in Pakistan: The Role of Capital Stock

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Pakistan has experienced a decrease in population growth since the early 1990s leading to an increase in the ratio of working age population, known as demographic dividend. The demographic dividend may lead to higher savings and investments, which spurs economic growth. Given this postulation, the study is the first of its kind to analyse the impact of demographic variables on economic growth through physical capital for Pakistan from 1960 to 2014. In this regard, the demographic change is captured by taking four alternate measures, namely population growth, young age dependency ratio, old age dependency ratio and working age population ratio. In order to examine the channel effect, first the direct impact of demographic changes on physical capital is estimated. Later, the impact of demographically induced capital stock on economic growth is estimated. By using the FMOLS technique, the study concludes that the total negative impact is highest in the case of old age dependency, which means that higher old age dependency is the most threatening demographic change for economic growth. The least harmful demographic change is young age dependency. Moreover, the empirical findings highlight the importance of capital stock as the mediating channel in the demographic change and economic growth relationship. The study recommends effective long-term policies to increase youth employment and to enhance savings for maximising the benefits of demographic dividend.

JEL Classification: J11; O47
Keywords: Direct and Indirect Impact, Demographic Transition, Demographic Age Structure, Capital Stock, FMOLS

1. INTRODUCTION

Demographic changes are a component vital in explaining the economic growth of a country. Over the course of time, researchers have debated on the probable impact of demographic changes on economic/income growth being either negative, positive or neutral, as explained by the pessimistic, optimistic and neutralism schools, respectively, with particular emphasis on population change and birth rates as indicators of demographic change.

The pessimistic view focuses on the *capital dilution effect*, the *dependency effect*, and the *savings effect* being plausible explanations for the negative relationship between population growth and income growth. The *capital dilution effect*, also known as the *solow effect*, suggests that increase in population increases the number of labourers and

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consequently reduces the capital per worker. Similarly, the *dependency effect* and the *savings effect* encompass a larger number of dependents and lower savings resulting from increasing birth rates respectively (Malthus, 1798; Coale and Hoover, 1958; Kelley, 1988; Barro, 1991; Brandner and Dowrick, 1994; Todaro and Smith, 1994; Ahituv, 2001; Lee and Mason 2010). However, according to Ashraf et al. (2013), the *dependency effect* is dominant in the initial decades while the *capital dilution effect* becomes important in later years.

In contrast, the optimistic view documents the positive impact of population growth on economic performance, underlining the importance of economies of scale and human capital stock due to an increase in population, (Boserup, 1965; Srinivasan, 1988; Kuznets, 1960; Simon, 1981). According to the optimists' view, increasing population can also help reduce the diminishing returns arising from an aging population (Coale and Hoover, 1958; Meier, 1995). Furthermore, Boserup (1965) suggests that population growth creates incentives for innovations in technology and institutions.

Finally, the third and most recent view is neutralism, which concludes that population growth has little or no significant impact on economic growth in the presence of other control variables (Bloom and Freeman, 1986; Kelley, 2001; Bloom and Williamson, 1998).

However, the aforementioned literature on the relationship between population growth and economic growth has ignored an important aspect of the relationship, which is the changing age structure of the population. Different age structures within similar population figures can have varying impacts on economic growth (Bloom et al. 2001). Countries with relatively higher young and old age populations may experience lower economic growth. The requirement of huge expenditures on this population in the areas of education and health is a contributing factor. In contrast, countries with a high proportion of a working age population have better economic performance.

The varying population age structure is a result of changing fertility and mortality rates over time, which can be linked to the demographic transition of countries. In the current phase of the demographic transition globally, most developing countries are experiencing declining mortality and fertility rates that may result in increasing the working age population as a percentage of the total population (Batini et al. 2006). This offers an opportunity for demographic dividend, provided these countries focus on the education and health needs of the younger population, keeping in mind that the labour market should have the capacity to absorb this population productively (Bloom et al. 2001; Bloom and Finlay, 2009).

Demographic dividends affect the economic performance of a country through increased labour supply, higher savings, and investments in human capital. All these factors have a positive impact on economic growth. For example, it is worth noting that these demographic dividend factors have substantially contributed to the East Asian growth phenomenon. (Bloom and Williamson, 1998).

As mentioned above, a considerable amount of literature focuses on the direct impact of various indicators of demographic changes on economic growth. However, the impact of demographic changes on economic growth is direct, but also conditional on various channels such as physical capital, employment and human capital. It is important to analyse how, and to what extent, the impact of demographic changes on economic growth varies through these channels.

Extensive literature on economic growth shows that the various factors necessary for economic growth. Some of them are physical capital, human capital, inflation rate, government consumption ratio, trade openness, institutional quality, democracy, and life expectancy etc. (Sala-i-Martin, 1997; Sala-i-Martin et al. 2004). The Harrod-Domar and Solow models of economic growth consider physical capital one of the most important determinants of economic growth for any country. Mankiw et al. (1992) and Barro and Sala-i-Martin (2004) in their famous studies on empirics of economic growth have underscored the significance of physical capital for economic growth. Therefore, we have selected physical capital stock as the mediating factor in the relationship of demographic change and economic growth.

Interestingly, scholars have pondered on the mechanics of the impact of demographic variables on physical capital. To begin with, the life cycle model of savings and investments asserts that household decisions about savings and investments depend on their age along with their income (Modigliani and Brumberg, 1954). Goyal (2004) is of the view that decisions about portfolio investment are also a function of age. Bakshi and Chen (1994) contributed life cycle investment hypothesis, and life cycle risk aversion hypothesis illustrating the relationship between investments and age. The former explains that as people get older their equity investment increases; while the latter documents that an increase in average age results in an increase in risk premium.

A study by Batini et al. (2006) concluded that an increase in population and labour force results in an increase in investment through changes in marginal product of capital and consumption, and saving decisions. Using the overlapping generation model (OLG), d'Albis (2007) corroborated a non-monotonic relationship between demographic changes and capital accumulation owing to the opposite signs of capital dilution and savings effects.

Presently Pakistan is going through a demographic transition with an increase in the ratio of working age population and a decline in dependency ratios (see Figure 1). Crude birth rates (CBR) were high in the 1970s and early 1980s, but decreased to 30 births per 1000 population by 2006, and 29 births per 1000 population by 2015. Similarly, the total fertility rate was 6.6 births per woman in 1960, and 5 births per woman in 1997, declining to 3.5 births per woman in 2015 (World Bank, 2017). The crude death rate was 15 in 1970 and dropped to 7 in 2015. As a result, the age dependency ratio as a percentage of working age population has declined from 88 in the 1980s and 1990s, to 65 in 2015 (World Bank, 2017). The annual population growth rate in Pakistan has been approximately 2 percent for the last decade.

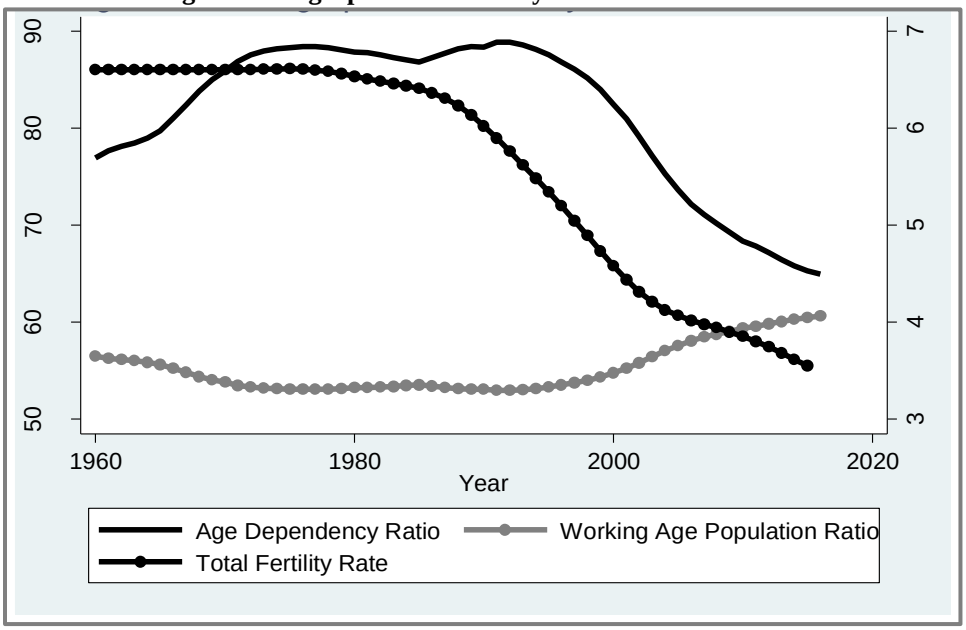
Figure 1 depicts a smoother decline in fertility rate as compared to the age dependency ratio. The latter, after declining in the early 1980s, started increasing again but eventually showed a consistent decline from the 1990s onwards. At the same time, the working age population ratio has shown a continuous increase. Moreover, since the beginning of the 1980s, the fertility rate has shown a sharp decline. Figure 1 shows the 1990s as the start of the demographic dividend period for Pakistan. According to Nayab (2008), the duration of demographic dividend in Pakistan is from 1990 to 2045 with its peak around the year 2000.

It is imperative to mention here the findings of the recent population census conducted in 2017 that reported a surprisingly high annual average population growth of 2.40 percent over the period 1998-2017 for Pakistan, given the previously reported

population growth rate of around 2 percent for this period (Pakistan Bureau of Statistics, 2018). According to the world development indicators, this percentage of population growth is parallel to the one in 1998. The age dependency ratios and working age population ratio may be different and thus lead to a lower demographic dividend then expected according to Figure 1. Therefore, it is important to study the implications of demographic changes in Pakistan.

This study aims to analyse the impact of demographic indicators on the economic growth of Pakistan. Some earlier studies have analysed the issue for Pakistan, (e.g. Hussain, et al. 2009, Choudhry and Elhorst, 2010 and Iqbal et al. 2015). However, the present study is unique in its attempt to estimate the direct and indirect impact of demographic variables on economic growth through the channel of physical capital, given the importance of physical capital in explaining economic growth. The study utilises the time-series data of Pakistan over the period 1960-2015 and applies FMOLS technique to estimate various models for measuring the direct and the indirect impact. Our empirical analysis is comprised of three steps.

Fig. 1. Demographic and Fertility Transition in Pakistan



In the first step, the direct impact of demographic changes on economic growth uses four indictors: (i) population growth; (ii) old age dependency ratio; (iii) working age population ratio; and (iv) young age dependency ratio, for estimations.

The second step computes indirect impact. This involves (a) estimating the direct impact of each demographic indicator on capital stock separately; (b) estimating the impact of demographically induced capital stock on economic growth; (c) computing the indirect impact by multiplying the coefficient of demographic change indicator (from a) with the respective capital stock coefficient (from b). Finally, the total impact is the sum of the direct and indirect impacts.

2. LITERATURE REVIEW

Numerous studies have underlined the significance of demographic variables, i.e. working age ratio, young age dependency ratio, and old age dependency ratio, in explaining economic growth and development (see Table A-1 for summary of literature review). Malmberg (1994) analysed the economic growth effects of changing age structures for the Swedish economy over the period 1950-89 and concluded that there were significant effects. Barro (1991) and Asian Development Bank (1997) in their cross-country growth regressions included the growth rate of an economically active population as an explanatory variable and concluded that it had a positive impact.

Later, Bloom and Williamson (1998) extended the analysis by also analysing the impact of growth rates of populations of under age 15, and over age 64, together with the growth rate of the dependent population on GDP per capita growth in separate regressions. Results have shown that populations under 15 years of age have a negative and significant impact on income growth; however, the coefficient of populations of over 64 years of age is insignificant. In a study specifically focusing on Asian countries, Bloom et al. (2001) ascribed most of the East Asian economic miracle to demographic transition and declining youth dependency ratios in these countries.

In a further study, Kelley and Schmidt (2005) reported a positive impact of a working age population on growth rates of output per capita and output per worker for a sample of 86 developing countries over the period 1960-95. Authors have also included age dependency ratio, and population size and density, as alternative demographic regressors, and have established that demographic change accounts for 20 percent change in per capita income growth. In a recent study on implications of age structures for economic growth, Prskawetz et al. (2007) have corroborated the negative impact of youth age dependency ratio on economic growth for a large panel of countries spanning the years 1960-95.

Similarly, Lindh and Malmberg (2009) analysed the relationship between different age structures and economic growth for EU-15 countries and concluded a hump-shaped relationship between age groups and GDP growth. In a related study, Choudhry and Elhorst (2010) concluded that child and old age dependency ratios negatively affected the per capita income growth, for the period 1961-2003 for seventy countries. Further, per capita income growth is also a positive function of the difference between the working age population growth and total population growth.

In studies related to Pakistan, Hussain et al. (2009) have analysed the impact of demographic variables on economic growth for the period 1972-2006. Both the infant mortality rate and total fertility rate have negatively affected the GDP growth of the country, while the growth rate of the labour force had an insignificant impact on economic growth. In another study, Choudhry and Elhorst (2010) concluded that population dynamics explain 25 percent of the changes in per capita GDP growth in Pakistan. Finally, Iqbal et al. (2015) have analysed the impact of demographic transition on economic growth of Pakistan over the period 1974-2011 and have reported a positive impact of demographic transition on economic growth in the long run but a negative impact in the short-run.

Focusing on the relationship between population growth and savings, Park and Shin (2011) have supported a positive relationship between population and savings and

argued that an increase in population implies more workforce and hence more savings. This positive effect of population on savings is termed the *growth effect* illustrating that higher population growth means a higher percentage of young population initially converting to a higher percentage of working age population later, thus leading to more savings.

The opposite effect is the *dependency effect* that showed a negative relationship between population growth and savings owing to an increased number of dependents (Prskawetz, 2007). Finally, Asongu (2011) is of the view that an increase in population may increase production through increases in consumption and labour supply. The opposite effect may also take place owing to an increase in unemployment creating a burden on the economy. In this situation, investors decrease their investments thus reducing economic growth.

Addressing the empirical evidence on the relationship between demographic changes and physical capital, Malmberg (1994) has analysed the macroeconomic effects of changing age structure for the Swedish economy over the period 1950-89 and produced a hump shaped relationship between age group and savings.

Recently, evidence on the relationship between demographic variables and physical capital was postulated by Goyal (2004), Bosworth and Chodorow-Reich (2006) and Batini et al. (2006) and Asongu (2011). Goyal (2004) analysed data from the U.S. and concluded that demographic variables have an important role in explaining aggregate investment and savings. Forecasting the effect of demographic transition over the next 80 years for USA, Japan and other developing countries, Batini et al. (2006) corroborated that a strong effect of demographic variables on savings, investment, and capital flows existed. Using panel data of 85 countries over the period 1960-2005, Bosworth and Chodorow-Reich (2006) have documented a hump shaped relationship between age groups and savings. Finally, Asongu (2011) has estimated a significant long-run relationship between population growth and investments for 38 African countries over the period 1977-2007. However, the size of the impact varies between public and private investments for various countries.

3. METHODOLOGY AND DATA

This study empirically examines the mediating role of physical capital stock in the relationship between demographic changes and economic growth. Alternatively, we intend to estimate the direct and indirect effects of demographic changes on economic growth by using the channel of physical capital stock. The empirical analysis, therefore, involves multiple steps. Firstly, for direct impact, we estimate the effect of demographic changes on economic growth in the following model.

$$GDP_t = \alpha_0 + \alpha_1 K_t + \alpha_2 HK_t + \alpha_3 TO_t + \alpha_4 FDI_t + \alpha_5 CPI_t + \alpha_6 DV_t + \varepsilon_t \quad \ldots \quad (1)$$

where t = 1960 to 2015

Here, GDP_t is log of real gross domestic product. K_t is physical capital stock measured as log of real gross fixed capital formation. HK_t is human capital index based on years of schooling and returns to education. TO_t is trade openness measured as trade as percentage of GDP. FDI_t is foreign direct investment (net inflows) as percentage of GDP. CPI_t is log of consumer price index. DV_t is the particular demographic variable i.e.

PG_t, population growth (annual percentage), working age population as a percentage of total population i.e. WAPOP, $OADR_t$, old age dependency ratio as percentage of working-age population and $YADR_t$, young age dependency ratio as percentage of working age population. The model is applied four times for each of the four different focused demographic variables.

The dependency ratio is expected to have an adverse impact on economic growth. Higher population growth puts pressure on economic and financial resources. As a result, resources are diverted from investment towards consumption (Kogel, 2003). The impact of population growth on economic growth is viewed as positive by population optimists while negative by population pessimists. According to pessimists, higher population growth creates pressure on economic resources, which hampers accumulation of capital, in turn decreasing economic growth.

On the other hand, optimists posit that higher population growth generates more labour force, which leads to economies of scale and innovation, and thus contributes towards economic growth. The working age population accelerates economic growth (An and Jeon, 2006; Nguyen, 2008; Bloom and Finlay, 2009; Choudhry and Elhorst, 2010) because it provides labour, reducing the dependency ratio, ultimately contributing to economic growth (Choudhry and Elhorst, 2010).

Following Halkos and Paizanos (2014), the indirect impact is analysed in two further steps: Initially, the impact of demographic change on capital stock is estimated through the model in Equation (2). The estimated value of capital stock from the latter is labeled "demographic-change-induced capital stock". Later, the impact of demographically induced capital stock on economic growth is estimated through the model given in Equation (3).

$$K_t = \delta_0 = \delta_1 K_{t-1} + \delta_2 GDP_t + \delta_3 HK_t + \delta_4 r_t + \delta_5 FD_t + \delta_6 FDI_t + \delta_7 RER_t + \delta_8 G_t + \delta_9 DV_t + \xi_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

$$GDP_t = \gamma_0 = \gamma_1 K_t^{DV} + \gamma_2 HK_t + \gamma_3 TO_t + \gamma_4 FDI_t + \gamma_5 CPI_t + \gamma_6 FDI_t + \varsigma_t \quad \ldots \quad (3)$$

Where FD_t is financial development measured through domestic credit to private sector as percentage of GDP. RER_t is log of real exchange rate. G_t is government consumption expenditures as percentage of GDP, and K_t^{DV} is demographic-change-induced capital stock estimated through Equation (2).

Demographic variables affect physical capital directly through investment, and indirectly through the savings channel. In this regard, life cycle theory supports the idea that saving decisions vary with age. Savings of young and old people are relatively lower when compared to the working age population. Moreover, a lower dependency ratio generally leads to higher savings by the working age group (Kogel, 2003). Therefore, the dependency ratio imposes an adverse impact on savings and investment (Hyung, 2013). Moreover, as explained by the Solow and endogenous growth models, high population growth has an adverse impact on economic growth (McMahon, 2001). High population growth leads to higher consumption, which reduces savings and investment (Park and Shin, 2011).

Human capital refers to a higher level of education and skills. Therefore, it ensures higher returns from investment and economies of scale, helping in accumulation of physical capital stock. Moreover, human capital stock not only helps in generating new

capital stock but also improves the absorptive capacity of the economy for new technology (Lopez-Bazo and Moreno, 2008). The impact of exchange rate changes can be explained both as favourable as well as harmful. For instance, exchange rate affects domestic investment and capital accumulation through cost of capital location. Depreciation in exchange rate accelerates domestic investment as it increases the gains from exports. In contrast, imports become more expensive, which may hamper domestic investment due to higher cost of imported raw material. Therefore, the impact of exchange rate on domestic investment is conditional on the strength of export and import channels.

Finally, we take the product of the coefficients of demographic change indicators from Equation (2) and coefficient of estimated capital stock from Equation (3) to identify the indirect impact of demographic change on economic growth (i.e. $\delta_8 * \gamma_1$). The computation of indirect and total effect is given as follows:

$$\frac{dG_t}{dDV_t} = \frac{dG_t}{dDV_t} + \frac{dG_{it}}{d K_t^{DV}} * \frac{dK_t}{dDV_t} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

The study covers 1960-2015. All the data is extracted from World Development Indicators by the World Bank and Penn World Tables (PWT) 9.0. Before carrying out the empirical analysis for the times series data, it is important to test the selected series for the stationarity properties. Among various available tests, Augmented Dickey Fuller test (ADF) developed by Dickey and Fuller (1979) is most widely recommended by existing literature. Therefore, the ADF test is used to examine the stationarity properties of the data.

For estimation, the present study employs Fully Modified Ordinary Least Squares (FMOLS) technique to estimate the impact of demographic change on the economic growth of Pakistan through the channel of physical capital. The FMOLS technique, proposed by Phillip and Hansen (1990), is a semi-parametric approach to co-integration. It is used to estimate the single equation co-integration relationship with the combination of variables that are integrated of order one. FMOLS modifies the conventional least squares to account for the serial correlation and test for endogeneity among the regressors that may arise due to the existence of co-integrating relationships (Rukhsana and Shahbaz, 2008).

4. RESULTS AND DISCUSSIONS

The descriptive statistics are presented in Table 1. The statistics show that the average population growth is 2.6 percent with a minimum value of 2 percent and maximum of 3.3 percent during the sample period. Among the dependency ratios, average young age dependency remains significantly higher than old age dependency which may be due to high population growth in the country. The average working age population is 54.67 percent of the total population. The highest variation is exhibited by YADR while lowest is observed in OADR. Among macroeconomic variables, GDP shows large variations as compared to investment. Notably, HK in the country is very low as observed from the mean value of HK. The average value of interest rate is 7 percent with a minimum of 2 percent while a maximum of 12 percent. TO and FDI both are considered an important source of technology diffusion and openness. By looking at the average values, we can observe that TO, on average, remains higher than FDI in Pakistan.

Table 1

Descriptive Statistics

Variable	No. of Obs.	Mean	Std.Dev.	Min	Max
GSP	54	28.754	0.8029	27.283	29.949
K	54	27.223	0.589	25.757	28.076
GEGDP	55	11.071	1.773	7.781	16.78
HK	54	1.496	0.271	1.166	2.029
PER	54	4.038	0.448	3.312	4.729
TO	47	32.484	4.287	19.932	38.909
FDI	44	0.757	0.832	-0.063	3.668
DC	54	23.559	4.000	11.148	29.786
PG	54	2.616	0.425	2.028	3.344
OADR	54	7.198	0.133	7.075	7.777
YADR	54	76.101	8.179	54.738	83.048
WAPOP	54	54.668	2.592	52.539	61.794
r	55	7.909	2.732	2.140	12.470

Before estimating the final model, the unit root properties are examined and their results are reported in Table A-2 in Appendix. These estimates identify that all the variables are stationary at the first difference and, therefore, are integrated of order one.

4.1. Direct Impact of Demographic Changes on Economic Growth

The first step of our empirical analysis is to estimate the impact of selected demographic change indicators on economic growth. In this regard, we estimated Equation (1) four times with four different demographic variables. The results of this step are reported in column 2-5 of Table 2.

According to empirical findings, the impact of demographic change indicators shows that two of the three indicators, namely old age dependency ratio (OADR) and young age dependency ratio (YADR), affect GDP growth adversely. Notably, the size of OADR is much higher than YADR. This finding suggests that the old age population is more burdensome for the economic growth of Pakistan. These findings are appealing as expenditures on young age populations are mainly on education and help increase the level of human capital stock, ultimately augmenting the development process of a country.

Although the increase in young age dependency reduces financial savings, it increases the spending on human capital. Since younger people spend more on human capital, the adverse impact of YADR is less as compared to the OADR (Park and Shin, 2011). Prskawetz et al. (2007) support this finding, explaining the negative impact of young age dependency ratio on economic growth. Similarly, Lindh and Malmberg (2009) report a negative impact of age group 65 years and above on GDP growth.

The third indicator of demographic change, population growth, however, has a positive effect. This finding explains the fact that higher population growth leads to a larger labour force, which in turn leads to higher GDP growth. Notably, this positive impact of population growth is less than the negative impact of other two indicators.

Table 2

Direct Impact of Demographic Changes on Economic Growth

Variable	Model 1 Coefficient (S.E)	Model II Coefficient (S.E)	Model III Coefficient (S.E)	Model IV Coefficient (S.E)
K_t	0.247***	0.207***	0.223***	0.192***
	(0.019)	(0.028	(0.014)	(0.054)
$OADR_t$	–0.084***	–	–	
	(0.026)			
$YADR_t$	–	–0.002**	–	
		(0.001)		
PG_t	–	–	0.017***	
			(0.003)	
WAPOP				0.013*
				(0.006)
TO_t	0.078***	0.068***	0.066***	0.079***
	(0.011)	(0.015)	(0.007)	(0.029)
FDI_t	–0.016***	0.004	–0.003*	0.001
	(0.002)	(0.004)	(0.002)	(0.007)
HK_t	0.519***	–1.23***	–0.611***	–1.715***
	(0.079)	(0.235)	(0.081)	(0.499)
CPI_t	0.023***	–0.099***	–0.107***	–0.153***
	(0.008)	(0.020)	(0.009)	(0.039)
C	3.289***	12.254***	12.889***	12.052***
	(0.347)	(1.265)	(0.601)	(0.029)
R^2	0.999	0.999	0.999	0.999

Note: Model I, Model II, and Model III, respectively, display the estimates for the model taking OADR, YADR, PG, and WAPOP as an indicator of demographic change.

***, **, *indicate statistical significance at 1 percent, 5 percent, and 10 percent level of significance, respectively.

The optimistic view endorses a favourable impact of population growth on economic growth. For instance, Boserup (1965) argues that population growth creates incentives for innovation and helps build up human capital, appearing favourable for economic growth. In a similar vein, Gerald and Meier (1995), Kuznets (1960), and Simon (1981) argue that higher population growth builds human capital stock and outweighs the adverse impact of the dependency of an aging population. More recently, Thuku et al. (2013) and Ali et al. (2013) also demonstrated a positive impact of population growth on economic growth. However, Ali et al. (2013) state that higher population growth generates a larger workforce that may be challenging for countries. Trimborn (2012), on the other hand, reports that the accelerating impact of demographic changes on technological progress and economic growth helps in the medium term, whereas in the long term, countries experience slower growth.

Finally, the fourth indicator of demographic changes, working age population, accelerates economic growth (An and Jeon, 2006; Nguyen, 2008; Bloom and Finlay, 2009; Choudhry and Elhorst, 2010) since it provides a labour force while reducing the dependency ratio, ultimately contributing to economic growth (Choudhry and Elhorst, 2010). Additionally, an increased working age population results in higher productivity growth. Furthermore, higher growth in the working age population is referred to as the "large-country" effect, which implies more people involved in productive work (Isaksson, 2007).

Turning towards the impact of other variables, we observe a statistically significant impact of all variables on economic growth. In particular, estimates reveal that trade openness has a significant impact on growth. Trade theories document a positive impact of trade openness on the economic growth of a country. The Endogenous Growth Theory developed by Frankel and Romer (1999), and Lucas (1998) implies that trade leads to competition, technology transfer and efficient allocation of resources ultimately fostering economic growth. Din et al. (2003) and Umer (2014) document that trade is an important policy instrument and has a positive and significant impact on output growth of Pakistan.

In contrast, our findings exhibit a statistically adverse impact of FDI on economic growth. Literature from Borensztein et al. (1998); Mencinger (2003); Omran and Bolbol (2003), also provides evidence for the negative impact of FDI on growth. Human capital signifies a positive impact on economic growth. Empirical studies such as Lucas (1998), Romer (1990), Barro (1991), Barro and Lee (1993) have considered human capital an important factor in explaining economic growth. Moreover, inflation rates also exert a favourable impact on economic growth.

Literature reports both negative and positive impact of inflation on economic growth. This finding supports the argument that inflation generates profit-earning opportunities for producers, which increases output level. Hussain and Malik (2011) also support this finding. However, Ayyoub et al. (2011) document that inflation is favourable to economic growth only below a certain threshold level and otherwise hurts economic growth.

4.2. Indirect Impact of Demographic Changes on Economic Growth

In order to estimate the indirect impact of demographic changes on economic growth, we proceed as follows: (i) estimate the impact of each indicator of demographic change on capital stock separately, and obtain the series of estimated capital stock. (ii) Use these estimated capital stock series, from the first step, to estimate its impact on growth. This exercise enables us to estimate the impact of each indicator of demographic change variable on economic growth through the channel of physical capital stock. In the following paragraphs, we discuss the findings of both of these steps.

The estimates for the direct impact of each demographic change indicator on capital stock are presented in Table 3. The selected set of regressors show theoretically expected signs in relation to the capital stock. In particular, for the demographic change indicators, Table 3 reports a negative impact of all the indicators of demographic change on investment. Particularly, the dependency impact measured through OADR and YADR decreases investment by 0.17 percent and 0.045 percent respectively. Once again, the adverse impact of OADR is more dominant than YADR.

Table 3

Direct Impact of Demographic Change on Capital Stock

Variable	Model V Coefficient (S. E)	Model VI Coefficient (S.E)	Model VII Coefficient (S.E)	Model VIII Coefficient (S.E)
K_{t-1}	0.552***	1.567***	0.398***	0.035***
	(0.026)	(0.044)	(0.032)	(0.014)
GDP_t	1.505***	2.436***	1.782***	0.509*
	(0.056)	(0.103)	(0.076)	(0.033)
HK_t	0.011	1.244***	1.598***	–1.106***
	(0.143)	(0.369)	(0.231)	(0.074)
r_t	–0.003***	–0.024***	–0.001	–0.006***
	(0.001)	(0.001)	(0.001)	(0.0005)
G_t	–0.014***	–0.032***	–0.011***	0.003***
	(0.001)	(0.002)	(0.001)	(0.0006)
FD_t	0.0004	–0.027***	0.013***	0.001***
	(0.0007)	(0.001)	(0.001)	(0.0004)
FDI_t	0.007**	–0.026***	–0.072***	0.053***
	(0.003)	(0.006)	(0.005)	(0.002)
RER_t	–0.147***	1.025***	–0.099***	–0.0005***
	(0.012)	(0.024)	(0.018)	(0.0001)
$OADR_t$	–0.171***			
	(0.045)			
$YADR_t$		–0.045***		
		(0.002)		
PG_t			–0.031**	
			(0.011)	
WAPOP				0.006*
				(0.003)
R^2	0.990	0.747	0.979	0.992

Note: Model VII, Model VIII, and Model IX, respectively, display the estimates for the impact of OADR, YADR, PG, and WAPOP on capital stock. The time-period for the study is 1960-2015.

***, **, * indicates statistical significance at 1 percent, 5 percent, and 10 percent level of significance, respectively.

The life cycle theory states that savings and investment decisions vary with age. For instance, young and old age groups, generally, save less in comparison to the working age group. Therefore, OADR and YADR exhibit a negative impact on investment level. Moreover, an increase in the overall dependency ratio decreases the savings of the working age group (Kogel, 2003). The empirical literature from Hyung (2013), and Kelly and Schmidt (2005), among others, also supports the negative impact of dependency ratios on investment. Moreover, Bakshi and Chen (1994) have formulated two hypotheses relating age structures and investment, namely the life cycle investment hypothesis, and the life cycle risk aversion hypothesis. The first explains that older people invest more in equities while the latter states that older people are more risk averse therefore they invest more in equities. Park and Shin (2011) considered that there is a direct relationship between age structure of population and investment.

The adverse impact of population growth on investment is the lowest (–0.03 percent) amongst three of the demographic change indicators. Theories based on the Solow growth model, and endogenous growth models, document an inverse impact of population growth on savings in an economy (McMahon, 2001). These theories argue that with an increase in population, a larger proportion of income is devoted to consumption and less is saved, which lowers the rate of investment since less funds are available. Our finding is in line with these theories and supported by Park and Shin (2011).

Similarly, the investment-diversion effect explains that public private expenditures are diverted from growth-oriented investment to social security projects because of high population growth in a country (Kelly and Schmidt, 2005). Finally, the impact of working age population on investment is observed as favourable. The working age population boosts savings and thus investment levels in the country. According to Bloom and Williamson (1998), a rising growth rate of the working age population leads to a decrease in the dependency ratio, which increases savings, and thus investment level in the country.

Focusing on the impact of other variables, GDP growth positively and significantly affects capital stock. The accelerator theory of investment confirms that an increase in overall output in a country is an indicator of a better economic performance of that country, which also attracts more investment (Anwer and Sampath, 1999). Moreover, human capital signifies a positive impact on physical capital stock. It shows that a higher level of skill and education of workers allows higher returns from investment. In addition, stock of human capital helps in generating more stock of physical capital as well as higher returns from investment and increased absorption of technology (Lopez-Bazo and Moreno, 2008).

Similarly, FDI helps to increase domestic investment. This implies that foreign investment provides a competitive environment to domestic investors leading to higher domestic investments. We also take interest rates as an indicator of the cost of borrowing to estimate its impact on physical capital stock. The IS-LM framework explains an inverse relationship between interest rates and investment. Our study suggests that a higher cost of borrowing leads to lower investment. This finding is supported by Joshua and Delano (1990) who also explain the adverse impact of interest rates on investment.

Interestingly, our report finds that government expenditures crowd out private investment. Pakistan, being a developing country, faces serious resource constraints. As such, high government expenditures put upward pressure on demand for loanable funds, which makes them expensive, thus lowering private investment by increasing the cost of borrowing. On the other hand, financial development appears to improve the channels through which funds are utilised in an economy. A developed financial system provides better financing and hedging opportunities, which helps in increasing the investment level. Reports on Pakistan suggest that financial development has a favourable impact on investment level. This finding is in line with King and Levine (1993) and Salahuddin et al. (2009).

In order to estimate the impact of demographically induced capital stock on economic growth, we re-estimate the economic growth model given in Equation (1) by

replacing capital stock with the estimated capital stock while the other regressors are the same. These estimates are presented in Table 4. The empirical findings for all the selected regressors are robust, as discussed above. Focusing on the impact of demographically induced capital stock on growth, the estimated capital stock, in all the models, shows a statistically significant and positive impact on GDP growth. Particularly, the magnitude of the impact of capital stock induced by OADR is the highest followed by population growth, YADR, and WAPOP respectively.

Table 4

Impact of Demographically Induced Capital Stock on Economic Growth

Variable	Model IX Coefficient (S.E)	Model X Coefficient (S.E)	Model XI Coefficient (S.E)	Model XII Coefficient (S.E)
GDP_{t-1}	0.321**	0.481***	0.302*	0.351***
	(0.157)	(0.032)	(0.171)	(0.113)
K_t^{OADR}	0.178***			
	(0.065)			
K_t^{YADR}		0.063***		
		(0.014)		
K_t^{PG}			0.151**	
			(0.067)	
K_t^{WAPOP}				0.013*
				(0.007)
TO_t	0.085**	0.108***	0.109**	0.079**
	(0.037)	(0.032)	(0.043)	(0.029)
FDI_t	0.008	0.013**	0.009	0.0009
	(0.005)	(0.006)	(0.006)	(0.007)
HK_t	–0.968**	–0.807**	1.077***	–1.715***
	(0.313)	(0.259)	(0.364)	(0.499)
CPI_t	–0.188***	–0.106**	0.138***	–0.253***
	(0.028)	(0.039)	(0.046)	(0.039)
C	13.882***	12.371***	14.506***	12.053***
	(3.165)	(2.193)	(3.543)	(2.597)
R^2	0.995	0.999	0.996	0.999

Note: Model IV, Model V, and Model VI, respectively, display the estimates for the impact of capital stock induced by the OADR, YADR, PG, and WAPOP on Economic Growth. The time-period for the study is 1960-2015.

***, **, * indicates statistical significance at 1 percent, 5 percent, and 10 percent level of significance, respectively.

Finally, we compute the indirect impact of demographic change on economic growth. As explained above, we take a product of the coefficient of the impact of each measure of demographic change indicator (δ_8) on capital stock with the coefficient of the estimated capital stock on economic growth (γ_1). These findings are displayed in column 3 of Table 5. This exercise reveals that the indirect impact of demographic change on GDP growth appears negative in all cases.

Interestingly, in accordance with the direct impact, the magnitude of the impact is highest for OADR while lowest for YADR. These findings suggest that young age dependency is the least harmful demographic change in Pakistan. Although population growth appears favourable for investment, it still has an adverse impact on GDP growth. Notably, the working age population maintains a favourable impact, both direct and indirect, on economic growth. This indicates that the working age population promotes economic growth through both direct and indirect channels.

Table 5

Total Impact of Demographic Change on Economic Growth

Variable	Direct Impact	Indirect Impact	Total Impact
OADR	–0.084	0.178 * (–0.171)	(–0.084) + (–0.030) = –0.114
YADR	–0.002	0.063 * (–0.045)	(–0.002)+ (–0.003) = –0.005
PG	0.017	0.151 * (–0.031)	(0.017) + (–0.004) = –0.013
WAPOP	0.013	0.381 *(0.006)	(0.013) + (0.002) = 0.015

Having dealt with direct and indirect impacts separately, we now compute the total impact of demographic change on economic growth in Pakistan. In doing so, we take the sum of the above two effects i.e. the direct and indirect impact. These estimates are given in column 4 of Table 5. We observe that the total impact of all the indicators of demographic change appear negative. The total negative impact is highest in case of old age dependency, which means that old age dependency is the most threatening demographic change for economic growth. The least harmful demographic change is the young age dependency.

By comparing direct and total impacts of demographic change indicators on economic growth, we may also conclude that the total impact, while considering the channel of capital stock, is different from simple direct impact. For instance, in the case of population growth and OADR, while the overall impact is lower than direct impact, it remains negative. Surprisingly, the overall impact of YADR is slightly higher than simple direct impact. Finally, the impact of working age population remains positive and the size of overall impact is substantially higher than direct impact. These findings provide a cautious conclusion that while discussing the impact of demographic changes on economic growth, it is important to consider the transmission channels through which demographic changes affect economic growth. Hence, simple direct impact may be understated or overstated and may lead to misleading conclusions.

5. CONCLUSIONS AND POLICY IMPLICATIONS

Many studies have established that demographic changes influence the economic performance of a country, particularly its economic growth. Theoretically, the optimistic, pessimistic and neutralist views project positive, negative and no-impact effects of population growth on economic growth respectively. Researchers have also studied implications of changing age structures for economic development, and linked these changing age structures with the transition of fertility and mortality rates and hence to demographic transition. According to these studies, changes in the age composition of a

country's population cause demographic transitions, which ultimately stimulate or impede economic growth.

During the first two stages of demographic transition, birth rates increase while death rates decline slowly. The third stage of demographic transition is specifically important for developing countries because the declining fertility and mortality rates offer an opportunity of demographic dividend in the form of an increasing ratio of working age population. Pakistan, like many other developing countries, is currently experiencing an increase in working age population and has the opportunity to use it to achieve broader development goals.

Demographic dividend affects the economic performance of a country through increased labour supply, higher savings, and investment in human capital, all of which have a positive impact on economic growth. Therefore, economic growth is affected directly and indirectly by demographic changes. Existing empirical literature mainly discusses the direct impact of demographic changes on economic growth but few studies has empirically investigated the indirect effect on it.

This study empirically examines the role of physical capital stock in the relationship between demographic changes and economic growth for Pakistan over the period 1960-2015, an indirect effect of demographic changes. Four indicators of demographic change namely, population growth, old age dependency ratio, working age population ratio and young age dependency ratio are used.

Our empirical analysis is comprised of four steps:

(i) Direct impact of demographic changes on economic growth is estimated,
(ii) Indirect impact computed by estimating the direct impact of each demographic indicator on capital stock, and analysing the impact of demographically induced capital stock on economic growth,
(iii) Computing the indirect impact by multiplying the former and the later coefficients.
(iv) Total impact is computed by summing the direct and the indirect impacts.
(v) The analysis is based on Fully Modified OLS technique.

Results have shown that the direct impact of each indicator of demographic change is different from its indirect effect. Among the focused demographic indicators, young age and old age dependency have an adverse impact on economic growth through the direct and indirect channels both. It is worth noting that old age dependency has a larger direct and indirect effect on economic growth. Interestingly, the direct impact of population growth on economic growth is positive but the indirect impact is negative, implying that population growth reduces physical capital through a decrease in savings. However, the working-age population ratio increases economic growth through both the direct and indirect impacts.

The total impact is higher, compared to direct impact, pointing towards the importance of studying the mediating role of physical capital in determining the impact of demographic changes on economic growth, without which the results may be misleading. The previous works tend to downplay the effect of population growth on economic development, which does not describe the urgency of the situation in Pakistan.

Firstly, the direct impact of old age dependency is more pronounced when compared with other indicators of demographic change. This highlights the insufficiency of publicly provided safety nets for the elderly, putting the burden of their care squarely on the shoulders of the working age population. As a result, we see that the impact of old aged dependency is rather high while the coefficient of working age population ratio is quite small. Further, the time cost of caring for the elderly may render a significant portion of the working age population unable to participate in the labour market, leading to reduced impact on economic growth. This signifies the need for government assistance in the form of pensions and subsidized healthcare provisions. In addition, subsidised at-home care facilities would enable labour force participation, contributing to economic growth.

The comparison of direct and indirect impact of population growth signifies that the direct impact in itself may be misleading, but once assessed through its negative influence on capital stock, the problem becomes more pronounced. This signifies the need to cater for the population explosion and its adverse impact through reducing birth rates. Policies to encourage family planning and birth control should be put in place. Increasing the opportunity cost of bearing children, instituting compulsory universal education, facilitating female labour force participation, penalising negligent parenthood and child marriages are additional methods to discourage large families. Most of these are already part of the current policy framework of the country but our results demonstrate a gross implementation gap.

Finally, Pakistan has the opportunity to capitalise on a bulging working age population that is being squandered for various reasons. Only by allotting due priority to the issue will the government be able to derive the potential benefits from a fortuitous situation. Given the results of the study and the 2017 census, the government should devise effective policies to reduce population growth, which will reduce young age dependency ratios. Moreover, to reap the benefits of the increasing working age population ratio in the form of higher economic growth, more employment opportunities should be created.

Table A-1

Summary of the Literature Review

Authors	Study Objective	Sample/Period	Results
Malmberg (1994)	Analyse the impact of age structures on economic growth and sources of growth	Sweden/ 1950-89	Shifts in age structure explain Swedish economic growth and there exists hump shaped relationship between age groups and savings
Barro (1991)	Analyse the impact of economically active population on income growth	98 countries/ 1960-85	Growth rate of economically active population has positive impact on real GDP per capita growth
ADB (1997)	Analyse the impact of economically active population on income growth	East and South East Asian Countries/ 1965-92	Growth rate of economically active population has positive impact on income growth
Bloom and Williamson (1998)	Study the impact of demographic variables on economic growth through accounting effect and behavioural effect	78 countries/ 1965-90	Growth rates of population and working age population has respective negative and positive impacts on GDP per capita growth. While population under 15 is also having negative impacts on income growth
Bloom et al. (2001)	Study the relationship between the economic growth and the demographic transition by focusing on various regions	Case studies of population change and growth for East Asia, Japan, North America and Western Europe, South-central and Southeast Asia	East Asian miracle can be explained by the demographic transition of East Asian countries
Kelley and Schmidt (2005)	Focuses on population's role in economic growth by developing a model for output per worker growth	1960-95, 86 countries	Declining births and declining deaths have contributed to rise in per capita income growth across the World, specifically, in Asia and Europe.
Prskawetz et al. (2007)	Impact of working age population ratio and youth dependency ratio on growth rate of output per worker	1965-90, 97 countries	Changes in age structures have important effects on economic growth
Lindh and Malmberg (2009)	Relationship between age structures and economic growth in EU15 countries	EU 15 countries, 1950-2004	Variations in the age distribution of the population has significant effect on economic growth and a hump shaped relationship exist between the two variables

Continued—

Table A-1—(*Continued*)

Choudhry and Elhorst (2010)	Analyse the impact of age dependency ratios on per capita income growth	70 countries/1961-2003 and Pakistan	negative impact of old and child age dependency ratios on per capita income growth in cross-country analysis, while, population dynamics explain 25% of changes in per capita GDP growth in Pakistan
Hussain et al. (2009)	Impact of demographic variables on economic growth	Pakistan/1972-2006	infant mortality rate and total fertility rate are having a negative impact on GDP growth
Iqbal et al. (2015)	Relationship between demographic transition and economic growth in the short and long run	Pakistan/1974-2011	positive impact of demographic transition on economic growth in the long-run but negative impact in the short-run
Park and Shin (2011)	relationship between population ageing on savings, capital accumu-lation, labour force participation and total factor productivity	12 Asian economies/1981-2010	Positive relationship between population growth and savings and in future population ageing will have adverse impact on economic performance
Asongu (2011)	Relationship between population growth and investment dynamics	Individual time-series analysis of African countries and for 38 African countries/1977-2007	In the long-run population growth has significant and sizeable effects on different types of investments: it can sometimes decrease or increase foreign, public, private and domestic investments in different countries.
Goyal (2004)	Relationship between population age structure and net outflows from the stock market and stock market returns	US/1926-198	Outflows are positively related with proportion of old age people and changes in proportion of middle age population negatively affect the outflows.
Batini et al. (2006)	Impact of demographic transition over the next 80 years	US, Japan and other industrial and developing countries	In advanced countries, population ageing will reduce per capita income growth while, in developing countries increase in working population can increase per capita income growth. Demographic variables have strong effect on savings, investment and capital flows
Bosworth and Chodorow-Reich (2006)	Relationship between population ageing and savings and investment	85 countries/1960-2005	Significant impact of population ageing on national rates of saving and investment but impact is different for different countries

Table A-2

Estimates of Unit Root Test

Variable	Level	1st Diff	Decision
GDP	–0.700	–6.260	
	(–3.497)	(–3.498)	I(1)
	–1.938	–4.494	
GFCF	(–3.498)	(–3.500)	I(1)
	0.626	–7.526	
LEMP	(–2.921)	(–2.922)	I(1)
	–2.456	–7.736	
TO	(–2.926)	(–2.928)	I(1)
	2.527	–5.309	
FDI	(–2.951)	(–2.945)	I(1)
	–1.125	–6.462	
LRER	(–2.917)	(–2.919)	I(1)
GFCF_OADR	–2.500	–4.158	I(1)
	(–2.945)	(–2.935)	
GFCF_PG	–2.524	–4.521	I(1)
	(–2.935)	(–2.935)	
GFCF_YADR	–2.103	–3.983	I(1)
	(–2.935)	(–2.935)	
IR	–2.547	–7.218	I(1)
	(–2.916)	(–2.917)	
LCPI	0.069	–3.348	I(1)
	(–2.919)	(–2.919)	
GEGDP	–1.989	7.118	I(1)
	(–2.916)	(–2.917)	
POPG	–1.595	–1.697	I(1)
	(–2.919)	(–1.948)	
OADR	–2.188	–3.781	I(1)
	(–3.498)	(–3.500)	
YADR	–0.555	–2.391	I(1)
	(–1.947)	(–1.948)	
WAPOP	–2.279	–2.941	I(1)
	(–2.924)	(–2.925)	
DC	–2.541	–6.098	I(1)
	(–3.508)	(–3.499)	

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