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Article

Population dependency ratios and economic growth in SAARC nations: Insights on aging and youth dynamics

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Abstract: This study aims to evaluate the influence of population dependency ratio on the economic growth of Bangladesh, India, and Pakistan, the three members of the South Asian Association for Regional Cooperation (SAARC). The study covers the time from 1960 to 2021. It also analyses in detail how population aging and the youth dependency ratio affects the development of certain sectors, including industry, services and agriculture. This study uses panel data to determine the influence of population dependency ratios on economic growth. To estimate this effect, we use the Pooled Mean Group/Autoregressive Distributed Lag (PMG/ARDL) technique. Based on the results obtained from the ARDL analysis indicate the presence of a long-term relationship among these variables. These discoveries align with prior empirical research conducted by Lee and Shin, Mamun et al., and Rostiana and Rodesbi. Furthermore, the findings suggest that an increase in the old age population dependency ratio positively influences economic growth within these nations. The long-term relationship findings pertaining to the old and young dependency ratio and economic growth corroborate the conclusions of Bawazir et al., who proposed that the old population dependency ratio exerts a favorable impact, while the young population has an adverse effect on economic growth. **Originality:** This research focused on the population dependency ratio, a pivotal demographic metric that gauges the proportion of individuals relying on support (including children and the elderly) compared to those of working age. This investigation particularly explores the interconnection between the population dependency ratio and sectoral development, an essential aspect given that various sectors make distinct contributions to economic advancement. Examining how population dynamics affect sectoral development yields valuable insights into the overall economic performance of Pakistan, India, and Bangladesh.

Keywords: economic growth; population decomposition; old age policy; sectoral change SAARC
JEL Classification: O4; J10; J180; Q1; O140; O150; J13; J14; J24; J140

1. Introduction

The age dependency ratio has a profound impact on both economic growth and performance of different sectors. When the number of dependent individuals surpasses that of those in the working-age group, it leads to a deceleration in economic growth. The effect of this ratio on different sectors varies based on factors such as population demographics, sector characteristics, and the level of economic development in a country. Typically, industries and service-oriented sectors derive greater advantages from having a larger working-age population, as they depend heavily on skilled labor. In contrast, agriculture is less susceptible to fluctuations in the age dependency ratio, mainly because it relies predominantly on unskilled labor and is significantly influenced by natural resources and climatic conditions.

According to **Figure 1**, Pakistan, India, and Bangladesh have economies that rely on a combination of agriculture, industry, and services. However, there exist notable disparities in the makeup of each country's economic structure. In Pakistan, the industrial sector contributes 18.8% to the GDP, while the services sector makes up 52.1%, and the agricultural sector accounts for 22.6%. Pakistan's major industries include textile, food, chemical and cement production, while major service subsectors include wholesale and retail trade, transport and telecommunications. The agricultural sector mainly focuses on the cultivation of cotton, wheat, rice and sugarcane.

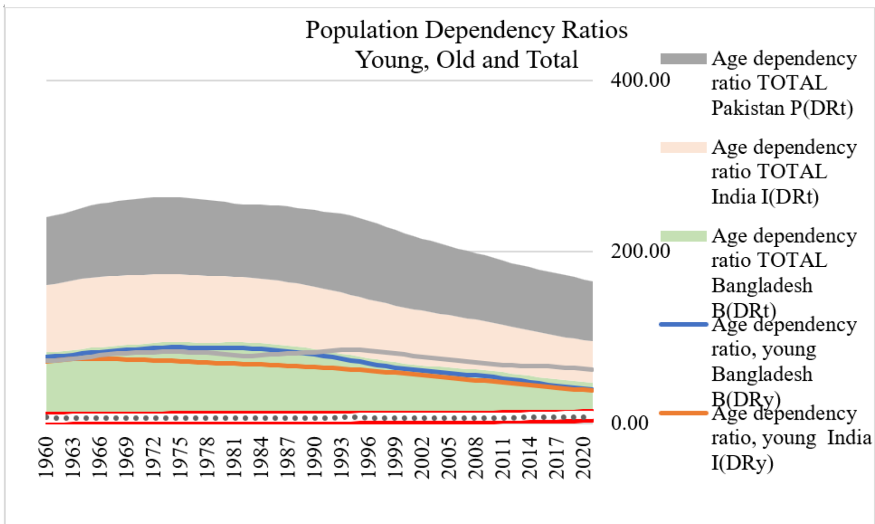

Figure 1. Population dependency ratio (young, old and total) in Bangladesh, India and Pakistan.

Source: The data of all the dependency ratios including young dependency ratios, old dependency ratios and total population dependency ratios of all countries are taken from WDI (World Bank data portal).

In India, the industrial sector contributes 25.8% to the country's GDP, the services sector contributes 47.51% and the agricultural sector contributes 16.8%. India's major industries include textiles, chemicals, pharmaceuticals and automobiles. The major subsectors of the services sector include IT, business process outsourcing (BPO), finance and retail. The main agricultural crops are rice, wheat, sugarcane and cotton.

In Bangladesh, the industrial sector contributes a significant 33.3% to the GDP, while the services sector contributes 51.3% and the agricultural sector contributes 11.6%. The dominant industries in Bangladesh are clothing and textiles, pharmaceuticals and food processing. In the services sector, the most important sub-sectors are wholesale and retail trade, transport and telecommunications. The main agricultural products are rice, jute, tea and sugarcane.

In short, the industrial sector is the biggest participant to GDP in Pakistan and India, while the services sector is the biggest participant to GDP in Bangladesh. In all the three countries, the agriculture sector plays a vital role in the economy, but it is declining in importance as the industrial and services sectors grow.

This study diverges from previous research practices by expanding the exploration of how population affects the dependency ratio in the context of sectoral development across India, Pakistan, and Bangladesh. As population of a country, have major impacts on growth and development. It is important to address the issues and importance of both young and old population dependency and design policies such as labour market policies, pension, health care system and other governmental policies accordingly to boost growth and development in economy. While earlier studies, such as the one conducted by Khan and Tariq (2021), primarily concentrated on the overall population dependency ratio and its influence on economic growth, our study takes a more refined approach. We delve into both the young and old dependency ratios and their impact on three crucial sectors. While prior studies attempted to determine which dependency ratio had a more substantial impact on GDP, our research seeks to build upon this by including more countries and incorporating an increased number of demographic variables into the analysis, as advocated by Bawazir et al. (2020) and Jayawardhana et al. (2023). The purpose of this study is to examine the short- and long-term relationship between population dependency ratio and economic growth within the SAARC region. In addition, we want to analyse the impact of the population dependency ratio on three important economic sectors. The next section provides an overview of relevant theoretical and empirical studies, followed by a section on data and methodology. Finally, we discuss our findings, summarize the results, and examine the policy implications.

Structure of paper

The introduction section provided a detailed overview of the variables, including their past, present, and relationships to one another.

The findings of previous studies that employed these factors in different nations and periods are discussed in the second section of the literature review.

Third section describes variables, models, and methodology. The model, econometric technique, and tests utilised in this investigation are explained in the methodology section. This section contains a description of the variables' sources and measurements in a table format.

The study's empirical results, such as descriptive statistics, a correlation matrix, unit root test results, lag selection model results, and PMG/ARDL model short- and long-term results, are presented in the fourth section.

The last section contains conclusion, research gap, limitations, policy recommendations, and other aspects.

2. Literature review

This research is based on demographic transition theory, which examines how population dynamics, particularly aging, affect economic development. According to this theory, a country goes through four different phases of demographic change as it modernizes and industrializes. Increasing birth and death rates in the first stage, called as the transition stage, result to a relatively stabilized population size. This pattern is often seen in societies with an agricultural economy and limited access to modern healthcare. In the second phase, called the transition phase, health care improves, leading to lower mortality rates and significant population growth. In the third stage, termed the post-transition phase, birth rates decline due to societal changes, increased availability of contraception, and economic advancements, resulting in a slower population growth rate. Finally, in the post-industrial stage, both birth and death rates are low, leading to a stable or declining population.

The demographic transition's initial stages witness the highest population dependency ratio, a measure that assesses the ratio of dependents to the working-age populace. This exerts significant stress on both social welfare systems and economic productivity. Meanwhile, phenomenon of population aging, signifying a rise in the elderly population segment, introduces challenges like heightened demands on healthcare and pension systems, potentially influencing productivity and economic expansion.

Numerous research endeavours have delved into the subject of population dependency ratios and their implications for economic growth. For instance, Khan and Tariq (2021) employed an autoregressive distributed lag (ARDL) model to analyse data spanning from 1872 to 2018. Their findings indicated that a mere 1% uptick in the dependency ratio could precipitate a staggering 14.9% reduction in economic growth within Pakistan. On a different note, Bawazir et al. (2019) unearthed that the young population dependency ratio has a detrimental influence on economic growth in the Middle East, while elderly population dependency yields a positive impact. Lee and Shin (2019), in their extensive panel data analysis encompassing 142 countries from 1960 to 2014, brought to light that the elderly population dependency adversely influence economic growth as it surpasses a critical threshold. Nevertheless, their study also revealed an expanding working-age population, rendering the elderly population benign in terms of its impact on economic growth.

Bloom et al. (2010) revealed that share of aging population will increase during 2005 to 2050 in OECD nations. However, the negative impact of aging population on economic growth will be mitigated by the women participation into labor force and increase the retirement age. The increasing older population will lead to declines the savings in these nations. Lukyanets et al. (2021) revealed that if the issue of popuation aging is ignored it influence the staibility and economic growth adversly.

In 2020, Mamun and his colleagues delved into the considerable and beneficial influence of an aging population on economic growth in Bangladesh. This phenomenon holds true as long as the per capita aging population remains lower than the per capita capital formation. The augmentation of capital formation stands as a potential means to enhance the productivity of the aging workforce and counteract the negative repercussions of an aging demographic.

Moreover, in the context of the Indonesian economy, Rostiana and Rodesbi (2020) uncovered that a one percent rise in the elderly population correlates with a 0.188% upswing in GDP. This is attributable to the declines in the youthful, dependent population and concurrent expansion of the working-age segment.

In contrast, Abeywardhana's 2019 research delved into the link between population aging and economic growth in South Asia. The research findings suggested that a dwindling working-age population, coupled with a rising elderly population, exerts a harmful influence on economic growth. Although, the research posited that if specific employment targets are met by 2050, the adverse effects of population growth could be mitigated. Meanwhile, in 2021, Mohd and colleagues employed an ARDL model to assess the link between population aging and economic growth within the Malaysian economy. Their investigation unveiled a negative impact of an aging population on economic growth, indicating that a 1% increase in the population dependency ratio correlates with a substantial 6.60% decrease in economic growth. Maity and Sinha (2020) supported these findings of negative impact of aging population on economic growth.

Calvo-Sotomayor et al. (2019) explore the connection between working age population and labor productivity in 24 European economies, showing that a 1% increase in the aged population participating in the labor force reduces the ratio of increasing productivity by −0.106% to −0.479%. Puspitowati and Iskandar (2020) studied the impact of demographic changes on structural transformation in ASEAN, finding that population dependency ratio affects industrial value added and services value added. The research suggests that the old population still works to meet their requirements, leading to a positive impact on the services sector.

En Ma and Cheong Tang (2023) estimated the correlation between population aging and inflation rate in 125 countries, finding that elderly population is deflationary while young population increases the inflation rate. Furthermore, Miri et al. (2019) found that the young population dependency has an insignificant influence in the short run but a significant positive impact in the long-run on economic growth in Iran. Goh et al. (2020) explained the impact of population aging on variables such as real GDP, current account balance, fiscal balance, domestic savings, investments, and inflation, finding that an increase in one standard deviation at the old population leads to a decrease of gross private savings by 5 percentage points.

Lastly, Zhang et al. (2023) showed the link between old population and economic growth in China, finding that the aging population directly affects economic growth and inhibits consumption, thus affecting economic growth. De Albuquerque et al. (2020) investigated the impact of population aging on inflation, finding that population group aged from 20 to 34 is predicted to consume more to start a family, buy a house, and other goods.

Remarks of the past studies

In previous studies, conflicting findings have been reported regarding the impact of total population dependency, which includes both old and young dependency ratios. Some researchers have found a negative correlation between total population dependency ratio and economic growth. Specifically, they have identified a beneficial effect of the old population on economic growth, while indicating a negative impact of young dependents on GDP. However, certain research gaps have been identified in the existing literature. For instance, Khan and Tariq (2021) highlighted the limitation of not estimating the complex population dependency ratio that incorporates both the young and old populations. Additionally, there is a need to investigate the differential effects of old and young population dependency ratio on economic growth, to determine which factor has a greater influence on GDP. Another research gap, suggested by Bawazir et al. (2019), is the need to expand the sample size or consider separate samples based on income levels. Furthermore, Mamun et al. (2020) proposed extending the endogenous growth model by incorporating human capital formation to better understand the impact in low-income countries.

3. Methodology

3.1. Data source

The data of all variables such as GDP, IND, SRV, AGRI, DRO, DRY and DRT collected from World Bank data portal World Development Indicator (WDI). The data collected from the period of 1960 to 2021. The data of all these variables is available at World Bank data portal. Bangladesh become independent in 1972 but the data of East Pakistan used and renamed as Bangladesh from 1960 to 1972.

3.2. Methodology

This study seeks to evaluate the correlation between population dependency ratio and economic growth using the pooled mean group (PMG) and autoregressive distributed lag (ARDL) models. The ARDL approach, specifically designed for analysing panel data that incorporate both cross-sectional and time-series dimensions, extends the traditional ARDL model. It enables the examination of the long-term relationship between variables while accounting for short-term dynamics (Pesaran et al., 1999). Previous studies such as Islam et al. (2021) used ARDL model in their estimation.

To assess the stationarity of the dependent and independent variables, panel unit root tests such as the Augmented Dicky-Fuller (ADF) and Phillips-Peron (PP) tests are implemented.

To address the inherent limitations of traditional modelling in empirical analysis, the inclusion of unit root and cointegration tests has become crucial (Ilori and Akeju, 2022). In this regard, the present study utilizes the Augmented Dickey-Fuller (ADF) model to assess the stationarity of the employed dataset. The equations for the ADF model tests are provided below:

Model 1: $\Delta\Pi = \vartheta_0 + \vartheta_1\Pi_{t-1} + \sum_{i=t}^{m}\lambda_i\,\Delta\Pi_{t-1} + \partial_t$

Model 2: $\Delta\Pi = \vartheta_0 + \vartheta_1\Pi_{t-1} + \vartheta_1 t + \sum_{i=t}^{m}\lambda_i\,\Delta\Pi_{t-1} + \partial_t$

where in the context of Time series, the variable being observed over time is denoted by Π_t, and t represents the specific time point or period while ∂ is known as residual. When a time series exhibits stationarity without requiring any differencing, it is referred to as I(0) or integrated of order zero. On the other hand, if the first difference of the series results in stationarity, it is classified as I(1) or integrated of order one.

Data extracted from the World Development Indicators (WDI) a data portal of World Bank. It contains national, regional, and global estimates and provides the most up-to-date and reliable global development data.

3.3. General specification

Model 1: $\mathrm{GDP}_{it} = D\mathrm{RO}, \mathrm{DRY}, \mathrm{DRT}$

Model 2: $\mathrm{GDP}_{\mathrm{INDS}_{it}} = \mathrm{DRO}, \mathrm{DRY}, \mathrm{DRT}$

Model 3: $\mathrm{GDP}_{\mathrm{SRV}_{it}} = \mathrm{DRO}, \mathrm{DRY}, \mathrm{DRT}$

Model 4: $\mathrm{GDP}_{\mathrm{AGRI}_{it}} = \mathrm{DRO}, \mathrm{DRY}, \mathrm{DRT}$

where,

GDP = Gross Domestic Product in current US$
IND = Industrial Sector (percentage of GDP)
SRV = Services Sector (Percentage of GDP)
AGRI = Agriculture Sector (Percentage of GDP)
DRY = Dependency Ratio of Young Population
DRO = Dependency Ratio of Old Population
DRT = Dependency Ratio of Total Population (young + old)

To achieve the goals of research, a multiple regression model is employed to estimate association between several factors, including economic growth, old, young and total dependency ratio. The specific multiple regression model used for this purpose is as follows:

Model 1: $\mathrm{GDP}_{it} = \alpha_0 + \beta_1 \mathrm{DRO}_{it} + \beta_2 \mathrm{DRY}_{it} + \beta_3 \mathrm{DRT}_{it} + \varepsilon_{it}$
Model 2: $\mathrm{GDP}_{\mathrm{INDS}_{it}} = \alpha_0 + \beta_1 \mathrm{DRO}_{it} + \beta_2 \mathrm{DRY}_{it} + \beta_3 \mathrm{DRT}_{it} + \varepsilon_{it}$
Model 3: $\mathrm{GDP}_{\mathrm{SRV}_{it}} = \alpha_0 + \beta_1 \mathrm{DRO}_{it} + \beta_2 \mathrm{DRY}_{it} + \beta_3 \mathrm{DRT}_{it} + \varepsilon_{it}$
Model 4: $\mathrm{GDP}_{\mathrm{AGRI}_{it}} = \alpha_0 + \beta_1 \mathrm{DRO}_{it} + \beta_2 \mathrm{DRY}_{it} + \beta_3 \mathrm{DRT}_{it} + \varepsilon_{it}$

3.4. Empirical model

Model 1 examines the relationship between Gross Domestic Product (GDP) at time (*t*) as the dependent variable. It considers population dependency ratios, namely the young dependency ratio (DRY), old dependency ratio (DRO), and total dependency ratio (DRT). Here, *i* represents the country and *t* represents the time. Models 2, 3, and 4 are derived from Model 1, aiming to estimate and decompose the impact of independent variables, such as (DRY), (DRO), and (DRT), on different sectors of the economy. The decomposed dependent variables of Model 2, 3, and 4 are Gross Domestic Product with the Industrial Sector ($\mathrm{GDP}_{\mathrm{ind}}$), Gross Domestic Product with the Services Sector ($\mathrm{GDP}_{\mathrm{srv}}$), and Gross Domestic Product with the Agriculture Sector ($\mathrm{GDP}_{\mathrm{agri}}$), respectively. These four models are employed to decompose the influence of independent variables on various sectors of GDP, in order to analyse how these dependency ratios affect the selected economies' sectors individually and as a whole. Previous studies, including Liu et al. (2023), Kaoje et al. (2022), and Puspitowati and Iskandar (2020), have also utilized multiple models to decompose the impact of independent variables on different dependent variables. Furthermore, the description of all dependent and independent variables is explained in **Table 1**.

Table 1. Variables description.

Variable	Description	Measurement	Variable Type	Source
GDP	Gross Domestic Product	Current US$ in Billions	Dependent	World Development Indicator, World Bank
IND	Industrial Sector	Industry (including construction) and value added (% of GDP)	Dependent	World Development Indicator, World Bank
SRV	Services Sector	Services, value added (% of GDP)	Dependent	World Development Indicator, World Bank
AGR	Agriculture Sector	Agriculture, forestry, and fishing, value added (% of GDP)	Dependent	World Development Indicator, World Bank

Table 1. (*Continued*).

Variable	Description	Measurement	Variable Type	Source
DRY	Young Dependency Ratio	Age dependency ratio, young (% of working-age population)	Independent	World Development Indicator, World Bank
DRO	Old Dependency Ratio	Age dependency ratio, old (% of working-age population)	Independent	World Development Indicator, World Bank
DRT	Total Dependency Ratio	The age dependency ratio (% of working-age population)	Independent	World Development Indicator, World Bank

Note: Data of all the variables collected from the WDI (World Development Indicators) data portal of World Bank.

4. Results and discussion

Table 2 presented bellow summary statistics for all variables. The mean GDP value is 287.0 billion, and the mean DRY (Dependency Ratio of Young Population) value is 70.01208. The mean values for DRO, DRT, IND, SRV, and AGRI are 6.817169, 76.82925, 21.81672, 43.22537, and 29.39733, respectively. The median DRO is 6.600947, and the DRT has a maximum value of 94.70240 and a minimum of 47.66707. The standard deviation for IND is 5.493689. The remaining variables, both dependent and explanatory, have their own median, minimum, and maximum values, as well as standard deviations. The estimate includes 186 observations.

Table 2. Descriptive statistics.

	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
GDP	287	62.7	3180	3.8	583	186
DRY	70.01	73.03	88.58	38.05	13.56	186
DRO	6.82	6.60	10.08	5.50	0.77	186
DRT	76.83	79.59	94.70	47.67	12.94	186
IND	21.82	21.69	33.32	6.06	5.49	186
SRV	43.23	44.03	53.71	26.43	6.75	186
AGRI	29.40	26.64	61.95	11.63	11.69	186

Note: values of GDP such as mean, median, maximum, minimum and std. Dev. Are in billion USD.
Source: Author's Calculations.

4.1. Correlation matrix

A tabulated presentation of the correlation coefficients between many variables in a dataset is known a correlation matrix. The linear connection between two variables' direction and strength is determined by these coefficients. The values of correlation coefficient range from −1 to +1. A positive correlation coefficient indicates that as one variable rises, the other variable is also tending to rise. On the other hand, a negative sign indicates a negative correlation, suggesting that the tendency for one variable to decline as the other rises.

Based on **Table 3**, the dependent variables GDP, SRV, IND, and AGRI exhibit correlations with independent variables such as DRY, DRO, and DRT. Our results indicate that GDP, SRV, and IND negatively correlated with DRO and DRT. However, all three of these independent variables positively correlated with DRO. On the other hand, the remaining explained variable AGRI positively correlated with DRO and DRT. While, negatively correlated with DRY.

Table 3. Correlation matrix.

	GDP	**SRV**	**IND**	**AGRI**	**DRY**	**DRO**	**DRT**
GDP	1.00	-	-	-	-	-	-
SRV	0.22	1.00	-	-	-	-	-
IND	0.43	0.32	1.00	-	-	-	-
AGRI	−0.42	−0.79	−0.80	1.00	-	-	-
DRY	−0.69	−0.49	−0.71	0.68	1.00	-	-
DRO	0.86	0.34	0.71	−0.64	−0.83	1.00	-
DRT	−0.67	−0.49	−0.71	0.68	1.00	−0.81	1.00

Source: Author's calculations.

The stationarity test results in **Table 4** reveal that, at the given level, the variables of (GDP), (IND), (SRV), (AGRI), (DRY), (DRO), and (DRT) are non-stationary, as their probabilities exceed 0.05. This implies that the null hypothesis, which suggests that these variables are non-stationary, should be rejected. To address the issue of non-stationarity, we conducted an additional Augmented Dickey-Fuller (Fisher Chi-Square) and Phillips and Peron (Fisher Chi-Square) Test, this time focusing on the first difference of the variables.

Table 4. Unit root test.

Dependent Variables with (intercept and trend)				
	PP (Fisher Chi-Square) *t*-statistics	**Prob.**	**ADF (Fisher Chi-Square) *t*-statistics**	**Prob.**
Level				
GDP	0.01	1.00	0.01	1.00
IND	7.66	0.26	7.03	0.32
SRV	7.97	0.24	7.91	0.25
AGRI	6.01	0.42	6.13	0.41
DRY	0.10	1.00	0.57	1.00
DRO	0.09	1.00	0.16	1.00
DRT	0.12	1.00	1.49	0.96
1st Difference				
GDP	63.41*	0.00	78.24*	0.00
IND	110.92*	0.00	79.02*	0.00
SRV	91.98*	0.00	87.71*	0.00
AGRI	112.35*	0.00	99.01*	0.00
DRY	18.16**	0.01	30.02*	0.00
DRO	13.99**	0.03	13.78**	0.03
DRT	16.99**	0.01	37.80*	0.00

Note: All the variables are estimated with individual intercept. And *, ** signify 1%, and 5% level of significance respectively.
Source: Author's calculations.

The findings indicate that GDP, IND, SRV, and AGRI achieved stationarity after undergoing the first difference with intercept and trend. On the other hand, DRY, DRO and DRT remained stationary in the first difference from the interceptor. All these variables showed a probability of lower than 0.05, indicating that the null hypothesis indicating the presence of a unit root or stationarity should be accepted.

The optimal number of delays was determined by performing several tests and criteria, including the LR test statistic, the final prediction error (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SC), and the Hannan-Quinn (HQ) Information criterion. The results of these tests are shown in **Table 5**. Interestingly, all delay selection criteria produced similar results. In particular, LR, FPE, AIC, and SC consistently stated that delay order 2 was optimal. Therefore, the delay length was selected based on the combined results of the LR, FPE, AIC and SC criteria, which converged to 2 as the best delay order. Consequently, the analysis continued with a lag length of 2 according to the definition of the SC criterion.

Table 5. Optimal lag selection using VAR.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−5832.05	NA	2.88×10^{24}	64.83387	64.89	64.86
1	−4587.16	2434.443	3.13×10^{18}	51.10181	51.31	51.19
2	−4198.65	746.8165*	4.62×10^{16}*	46.88495*	47.25746*	47.03599*

Source: Author's calculations.

In summary, the determination of the optimal lag sequence was based on consistent results from multiple tests and criteria, all of which identified 2 as the most appropriate lag length. Therefore, the subsequent analysis was performed with a delay length of order 2 according to the SC criterion.

4.2. Empirical results

As displayed in **Table 6**, long-run ARDL results determine that the coefficient value for the old dependency ratio (DRO) is 2.20×10^{11}, suggesting that a 1% increase in DRO is associated with a 2.20×10^{11} (220.0 billion USD) increase in gross domestic product (GDP). Conversely, the coefficient value for the young dependency ratio (DRY) is -1.05×10^{10}, indicating that a 1% increase in DRY is associated with a -1.05×10^{10} (−10.5 billion USD) decrease in GDP. Additionally, both variables have a *p*-value of 0.0000, implying that these coefficient estimates are highly statistically significant and not likely to occur by chance.

A *p*-value of 0.0000 typically signifies a strong level of statistical significance, supporting the notion that there is a real and meaningful correlation between the explanatory variables (DRO and DRY) and the explained variable (GDP). These findings align with previous studies including Bawazir et al. (2019), Mamun et al. (2020), Rostiana and Rodesbi (2020) and Lee and Shin (2019), which also reported that GDP has positive correlation with DRO and negative correlation with DRY. According to Bawazir et al. (2019), these results are due to the old dependency ratio being lower than 10%, which eliminates the negative impact of DRO on GDP. When considering the industrial sector (IND) as the explained variable, there is a positive relationship between IND and DRO and DRY. The research shows that DRY has a substantial and positive influence on IND, as a 1% rise in the young dependents corresponds to a 0.16 percent rise in the growth of the industrial sector. On the other hand, IND and DRO have an insignificant positive correlation, meaning that a 1% rise in the old dependency ratio leads to a 1.73% rise in industrial growth. For the service sector (SRV) as the explained variable, DRO, and DRY as the explanatory variables, both DRO and DRY have a harmful influence on the growth of service sector. Both variables have a significant impact on SRV, as a 1% rise in DRO resulting a −3.82% decline in SRV, while a 1% increase in DRY results in a −0.64% decrease in SRV leads. Considering agricultural sector (AGRI) as the explained variable, DRO has insignificant negative effect on AGRI. A 1% rise in DRO leads to a −4.31% decline in AGRI. while, DRY has a positive and insignificant influence on AGRI, with a 1% rise in DRY resulting in a 0.04% rise in AGRI.

Table 6. Autoregressive Distributed Lag (ARDL) long run relationship results.

Variable	**Coefficient**	**Std. Error**	***t*-Statistic**	**Prob.***
Dependent Variable: Gross Domestic Product				
DRO	2.20×10^{11}	4.97×10^{11}	4.42	0.00
DRY	-1.05×10^{11}	2.08×10^{9}	−5.05	0.00
Dependent Variable: Industrial Sector				
DRO	1.73	1.46	1.19	0.24
DRY	0.16	0.05	3.40	0.00
Dependent Variable: Services Sector				
DRO	−3.82	1.06	−3.60	0.00
DRY	−0.64	0.07	−8.57	0.00
Dependent Variable: Agriculture Sector				
DRO	−4.31	5.10	−0.84	0.40
DRY	0.04	0.22	0.18	0.86

Note: The coefficient of GDP 2.20×10^{11} and 1.05×10^{11} are equal to 220.0 billion USD and 10.5 billion USD.
Source: Author's calculations.

The results table of PMG/ARDL (**Table 7**) indicates a harmful influence on economic growth (GDP) in the short run due to (DRY) and (DRO). According to the findings, a 1% rise in DRY resulting in a GDP decline of -2.81×10^{10} (−28.1 billion USD), and a 1% increase in DRO led to a GDP decrease of -1.88×10^{10} (−18.8 billion USD). Moving to the second section of the table, which focuses on the industrial sector (IND) as the dependent variable, DRY showed a positive impact with a 1% increase leading to a 0.58% rise in IND. However, DRO had a negative impact, as a 1% increase in DRO was associated with a −1.14% decline in IND. It is worth noting that both variables insignificantly affected the IND in the short run. Shifting to the section where the services sector (SRV) is the dependent variable, DRO exhibited a positive effect, whereas DRY negatively influenced the SRV. Specifically, a 1% increase in DRO resulted in a 0.20% increase in SRV, while a 1% rise in DRY led to a −0.12% decrease in SRV. Finally, in the last part of the table, where the agriculture sector (AGRI) is the dependent variable, DRO negatively influenced AGRI, whereas DRY had a positive effect. A 1% rise in DRO led to a −2.72% reduction in AGRI, while a 1% rise in DRY resulted in a 0.78% rise in AGRI.

Table 7. Autoregressive Distributed Lag (ARDL) short run relationship results.

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.*
Dependent Variable: Gross Domestic Product				
COINTEQ01	−0.03	0.08	−0.35	0.73
D (GDP (−1))	0.14	0.23	0.59	0.55
D (DRO)	-2.81×10^{10}	5.45×10^{10}	−0.52	0.61
D (DRY)	-1.88×10^{10}	1.82×10^{10}	−1.03	0.30
C	-7.38×10^{9}	4.82×10^{10}	−0.15	0.88
Dependent Variable: Industrial Sector				
COINTEQ01	−0.22	0.15	−1.46	0.14
D (DRO)	−1.14	11.19	−0.10	0.92
D (DRO (−1))	3.71	10.69	0.35	0.73
D (DRY)	0.58	0.51	1.15	0.25
D (DRY (−1))	−0.78	0.37	−2.10	0.04
C	−0.70	0.66	−1.05	0.30
Dependent Variable: Services Sector				
COINTEQ01	−0.17	0.11	−1.54	0.13
D (DRO)	0.20	2.74	0.07	0.94
D (DRY)	−0.12	0.04	−3.16	0.00
C	18.69	11.53	1.62	0.11
Dependent Variable: Agriculture Sector				
COINTEQ01	−0.10	0.03	−2.80	0.01
D (DRO)	−2.72	2.88	−0.94	0.35
D (DRY)	0.78	0.63	1.24	0.22
C	5.49	2.43	2.26	0.03

Note: The coefficient of GDP 2.81×10^{10} and 1.88×10^{10} are equal to 28.1 billion USD and 18.8 billion USD.
Source: Author's calculations.

In **Table 8**, we assessed the influence of the total dependency ratio of the population (DRT) on the gross domestic product (GDP) of each country individually. Our findings show a positive link between GDP and DRT in Bangladesh. The results demonstrate that a 1% rise in DRT resulting a decline of 6.43×10^{8} (0.643 billion USD) in GDP of Bangladesh. In contrast, for Pakistan, the relationship between total dependency ratio (TDR) and gross domestic product (GDP) is negative. This implies that a 1% rise in DRT will reduce Pakistan's GDP by -1.67×10^{9} (−1.67 billion USD). These findings support the results of the studies conducted by Khan and Tariq (2021) and Chishti (2023), which suggest that population dependency ratio has a harmful influence on economic growth in Pakistan. Similarly, in India, the total dependency ratio (DRT) exerts a bad influence on (GDP). The research indicates that a 1% rise in DRT resulting to a decline in India's GDP by -3.77×10^{10} (−37.7 billion USD). As we see in the previous studies such as Khan and Tariq (2021) revealed that population dependency ratio negatively influences economic growth in Pakistan. Our findings confirm that (DRT) has negative influence on GDP of Pakistan and India. While the research by Lee and Shin (2019) shows that aging population less than threshold level has positive impact on economic growth. According to Mamun et al. (2020) unless the per capita aging population is greater than the per capita capital formation, there is no negative effect of the aging population on the economy of Bangladesh.

Table 8. Autoregressive Distributed Lag (ARDL) individual country results.

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.*
Dependent Variable: Gross Domestic Product (Bangladesh)				
COINTEQ01	0.08	0.00	129.48	0.00
D (GDP (−1))	0.11	0.02	5.64	0.01
D (DRT)	6.43×10^{8}	1.50×10^{18}	4.28×10^{-10}	1.00
C	1.29×10^{10}	1.22×10^{20}	1.06×10^{-10}	1.00
Dependent Variable: Gross Domestic Product (Pakistan)				
COINTEQ01	0.03	0.00	107.77	0.00
D (GDP (−1))	0.22	0.02	10.92	0.00
D (DRT)	-1.67×10^{9}	4.08×10^{18}	-4.10×10^{-10}	1.00
C	6.21×10^{9}	2.15×10^{19}	2.88×10^{-10}	1.00
Dependent Variable: Gross Domestic Product (India)				
COINTEQ01	0.07	0.00	264.79	0.00
D (GDP (−1))	−0.31	0.02	−13.34	0.00
D (DRT)	-3.77×10^{10}	9.16×10^{20}	-4.12×10^{-11}	1.00
C	8.04×10^{9}	4.29×10^{20}	1.87×10^{-11}	1.00

Note: The coefficient of GDP such as 6.43×10^{8} is equal to (0.643) billion USD and 1.67×10^{9} and 3.77×10^{10} are equal to 1.67 billion USD and 37.7 billion USD respectively.
Source: Author's calculations.

5. Conclusion

The study utilized the PMG/ARDL model to examine the influence of the population dependency ratios on the economic growth of SAARC economies. Panel data for the period 1960 to 2021 used for three SAARC countries, namely Pakistan, Bangladesh and India. In addition, the research explored the influence of the dependency ratio of the young and old population (DRY and DRO) on sectoral development, including the industrial, service and agricultural sectors (IND, SRV and AGRI). The results showed that DRY had a negative long-term impact, while DRO had a positive effect on the GDP of these countries. Moreover, in the industrial sector (IND), both the youth and old age ratios (DRY and DRO) had a positive effect. Likewise, the dependency ratio of young and older people (DRY and DRO) in the service sector (SRV) negatively affected. Finally, DRY had a positive effect in the agricultural sector (AGRI), while DRO had a negative effect. According to the short-term estimate that (DRO) negatively influence (GDP), the industrial sector (IND) and the agricultural sector (AGRI). On the contrary, DRO positively affects (SRV). If we consider the effect of total population dependency ratio (DRT) separately, the results suggest a positive effect on Bangladesh's GDP. However, the Total Dependency Ratio (DRT) also has a negative impact on the GDP of Pakistan and India.

It is critical for policymakers in these countries to understand the impact of population dependency rates on these sectors. They must develop strategies that can address the challenges of the population's high dependency rates. This could include investing in education and health to reduce the number of dependents or raising the retirement age to keep more people in work. Promote policies that promote higher labor force participation: Because high dependency rates (the proportion of people who are too young or too old to work) can hinder economic growth, policymakers should focus on initiatives that promote higher labor force participation. These countries should prioritize the implementation of policies for employment generation and rise investment in support systems for older dependents. By promoting self-reliance and reducing the economic burden of aging, they can effectively reduce the costs associated with elderly relatives. This approach leads to an increase in the workforce and ultimately economic growth.

5.1. Limitations

There are a few limitations on the study. Firstly, data for the country Bangladesh found on the World Bank data portal. The fact that the data is available from 1960 even though Bangladesh achieved independence in 1972 is confusing. The reason is that Bangladesh was recognized as East Pakistan when it was a part of Pakistan. Thus, Bangladeshi data was obtained from East Pakistani data. Secondly, those 65 years of age and older make up the old dependence ratio. However, in some cases, those over 65 who are in good health can still work. In certain situations, people also drop out from the workforce for other reasons, such as seasonal unemployment. In addition, the people become jobless and depend on labor force. Finally, data on dependency and labor participation based on gender is not included in the research. This is a limitation, as it does not truly represent the rate of dependence. These limitations can be overcome in the future by improving data quality and developing methods.

5.2. Future scope

Future studies can break down the impact on economic growth in these nations and include gender-based dependency ratios, such as male and female dependents. Furthermore, by increasing the sample size, researchers may compare the countries to identify which is more affected by the dependency ratio. Additionally, to evaluate if there are enough jobs for the workforce, future research can incorporate further demographic variables, including birth and death rates, educational levels, and employment. Moreover, the total dependency ratio includes both old and young populations, leading to the problem of multicollinearity. To overcome this issue and obtain more reliable outcomes, future researchers can perform post-diagnostic tests, including multicollinearity checking. There are other variables that influence economic growth, which can be used as control variables for more accurate results. Consequently, the impact of dependency ratios on economic growth becomes more accurate and understandable.

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Availability of data and material: The data of all variables used in the study are publicly available on the data portal of World Bank.

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