



The impact of economic, social, and political globalization and democracy on life expectancy in low-income countries: are sustainable development goals contradictory?

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Abstract

The 17 Sustainable Development Goals announced by the United Nations are important guides for the development processes of developing countries. However, achieving all of these goals is only possible if the goals are consistent with each other. It has been observed in the literature that possible contradictions between these goals are ignored. Therefore, the main purpose of this study is to investigate whether two sustainable development goals (SDGs) of the UN are contradictory or supporting each other in low-income countries. These SDGs are “Good Health and Well-Being” (SDG3) and “Partnerships for the Goals” (SDG17). For this purpose, the role of globalization and democracy in life expectancy is empirically investigated in 16 low-income countries over the period 1970–2017. While globalization has been used as an indicator of the partnership between countries, democracy has been used as an indicator of accountability and cooperation between governments and societies. According to estimations of the continuous-updated fully modified (CUP-FM) and bias-adjusted ordinary least squares (BA-OLS), globalization and its subcomponents such as economic, social, and political globalization affect life expectancy positively. Democracy also increases life expectancy in those countries. The GDP per capita is also used as a control variable. Our results show that a higher level of per capita income is positively associated with higher levels of life expectancy. In conclusion, no contradiction was found between SDG3 and SDG17 in those countries. Achieving a healthier society requires economic, social, and political integration between governments and societies.

Keywords Life expectancy · Democracy · Globalization · Low-income countries · Sustainable development

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1 Introduction

The main problem of economics is to increase economic development and social welfare. Increasing the social welfare level is a complex process that depends on economic and non-economic factors. Achieving economic development or increasing the level of welfare depends on achieving and sustaining the main objectives in political, economic, and social areas. Today, development is no longer a process that can be realized through policies implemented by governments alone. It requires cooperation between governments and societies. While cooperation between different countries requires globalization in the economic, social, and political fields, democracy is the way to ensure cooperation between governments and societies.

Health is one of the most important indicators of social welfare. Besides being one of the indicators of development, it is one of the determinants of human capital formation which is necessary for economic development. Individuals living in developed countries live a healthier life compared to those living in less developed countries. While the differences between the levels of development of countries determine the health conditions, at the same time, improvement of public health paves the way for economic development. Healthy people have higher opportunities to earn a higher income than unhealthy people. Individuals with higher incomes can benefit from better nutrition and access to health services. Therefore, economic development and improvement of health conditions represent a two-way process. In this context, the determination of the variables that will enable the achievement of the goal of a healthier society is especially important in explaining the economic differences between developing countries and developed countries. Because of its importance, health-related goals have an important place both among the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) announced by the United Nations.

The world leaders with the support of international funding organizations announced the Millennium Declaration in September 2000 at the United Nations Headquarters in New York. They committed their nations to a new international partnership to achieve some development targets having with the final deadline of 2015. The Millennium Development Goals (MDGs) consist of 8 goals, 21 targets, and 60 related indicators covering a wide spectrum of development areas such as “End Poverty and Hunger (MDG 1),” “Universal Education (MDG 2),” “Gender Equality (MDG 3),” “Child Health (MDG 4),” “Maternal Health (MDG 5),” “Combat HIV/AIDS (MDG 6),” “Environmental Sustainability (MDG 7),” and “Global Partnership (MDG 8).” As we see, three of the goals are directly associated with the health status of the people. In the deadline of 2015, according to “Health in 2015: From MDGs to SDGs” report of the World Health Organization (WHO), there are improvements in health-related targets such as child health, maternal health, and combat with HIV/AIDS. Globally, HIV, tuberculosis, and malaria targets have been met. Also, the child mortality rate was reduced by 53% and maternal mortality by 43% (WHO 2016). On a global view, although health-related problems are largely resolved, the situation is not as good for low-income countries. As shown in Fig. 1, significant differences exist between developing countries and developed countries in achieving health-related goals.

According to MDGs, indexes in the context of health status show that the goals desired in terms of health are not attained in low-income countries compared to other income groups. After the deadline of MDGs, the United Nations has announced 17 SDGs, and “Good Health and Well-Being” takes its place as the third goal. Since achieving these goals requires the cooperation of countries and societies, “Partnership for the Goals” is

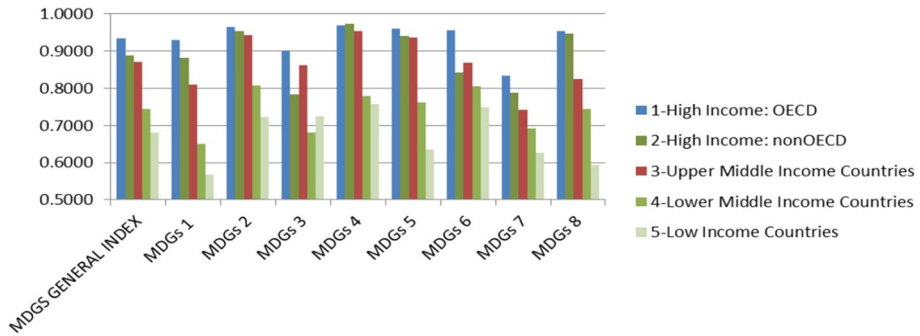


Fig. 1 World Bank Income Groups' MDGs Index Values in 2015. *Source* Halisçelik and Soytaş (2015)

determined as the seventeenth SDG. According to the United Nations (2019), the main indicators of global partnerships are trade, foreign direct investments, remittances, financial integration technology transfers, data monitoring and accountability, internet usage, and political integration among countries. In our study, while globalization is used as a proxy indicator of global cooperation, democracy is an indicator of cooperation between societies and governments. Democracy also refers to accountability levels of governments.

Globalization can simply be defined as the process of international integration which has economic, social, and political dimensions (Dreher 2006). Many countries have adapted to this process and have enjoyed the welfare effects of globalization by implementing necessary economic and institutional transformation. However, some countries still suffer from poor adaptation to global markets. According to the KOF Globalization Index published by the Swiss Economic Institute (2020), low-income countries have the lowest globalization level compared to other income groups. They also suffer from bad health conditions such as low life expectancy, communicable diseases, and high mortality rates according to MDG indexes given above. At this point, the literature is divided into two parts. The first one blames globalization and argues that poverty and as a result of this, low life expectancy derives from the inequality created by globalization itself (Buss 2002). The second group mostly focuses on the benefits of free trade, capital mobility, and technology transfers (Rao and Vadlamannati 2011). The low-income countries also suffer from low institutional quality in the context of democracy and political rights. According to Freedom House's list of electoral democracies, the countries without electoral democracy are mostly the low-income countries in the Middle East, North Africa, Sub-Saharan Africa, and Southeast Asia (Freedom House 2019).

The main question of our study is to determine whether the problem of low life expectancy in low-income countries is due to the low levels of globalization and weak political institutions in these countries. To answer this question, the role of economic, social, and political globalization and democracy in life expectancy in those countries is empirically investigated. This study provides several contributions to previous literature. First, we provide a new perspective in the context of sustainable development goals. Previous studies mostly focused on how to achieve SDGs, while possible conflicts between the goals were mostly ignored especially in the context of health. Such conflicts between sustainable development goals in the literature have mostly focused on the impact of economic growth and globalization on the sustainable environment (Ulucak and Bilgili 2018; Zafar et al. 2019a). Those studies are mostly addressed the relationship between SDG7, SDG8,

SDG13, and SDG17 (Zafar et al. 2019b). To the best of our knowledge, it is the first study that investigates the relationship between SDG3 and SDG17. It is also important to examine this relationship in low-income countries since they still suffer from low levels of life expectancy, less adaptation to globalization, and poor democratic institutions compared to other income groups. Previous works mostly provide global evidence, while only a few studies focus on less developed countries. Achieving these 17 goals put forward by the United Nations at the same time is possible only if these goals do not conflict with each other. Second, empirical works in previous literature consist of traditional estimation methods called first-generation tests. In the analysis of panel data, the estimators considering cross-sectional dependence are called the second-generation estimators. Cross-sectional dependency simply refers to the situation when the shock that occurs in one country affects other countries as well. The source of this problem encountered in panel data analysis is the economic, financial, and political integration among countries (Menyah et al. 2014). The ignorance of cross-sectional dependence results in biased and inconsistent estimates and wrong inferences (De Hoyos and Sarafidis 2006; Chudik and Pesaran 2013). Low-income countries are mostly African countries where there is a rising trend in terms of integration to global markets and institutions (Beck et al. 2011). Using estimation techniques that consider cross-sectional dependence in those countries prevents misleading results. As the literature is divided into two parts about the effects of globalization on human well-being, fresh evidence via robust estimation methods is required in order to provide proper policy implications. To fill this gap, our work provides second-generation estimations.

2 Literature review

To improve the health conditions of a country, the welfare of the poor should be improved as well. Poverty is detrimental to access to health services. Therefore, the positive impact of globalization on health first emerged with its positive effects on economic growth (Labonté et al. 2009: 10). The effects of globalization on growth were mostly driven by free trade, international specialization, technology transfers, knowledge spillovers, and competitive markets. It also offers broader opportunities for entrepreneurs and paves the way for innovation (Grossman and Helpman 2015: 101). As expected, poverty rates significantly reduced in the last two decades because of the integration of developing economies to global markets (Harrison 2006). When trade liberalization and income increases are considered together, people's access to treatments and medications can be easier and life expectancy may be prolonged. However, we should consider other possibilities in the context of spreading communicable diseases. As Deaton (2004) mentioned before, access to cheap and easy travel can increase the rate of spread of communicable diseases. Migration is also another fact to take into account. Particularly rising sexual tourism and migrant sex workers increase the spread of sexually transmitted diseases such as HIV/AIDS. But today there are improved treatment methods to solve these problems. Even HIV-infected people can survive with antiretroviral therapy, and it also reduces sexual transmission of the infection (Dollar 2001; Cohen et al. 2011). Due to the high cost of advanced drugs as in the case of antiretroviral therapy, it should be accepted that people in low-income countries will have trouble accessing the drugs (Buss 2002). There are approaches known as the unequal exchange that globalization increases inequality among countries and that developed countries are more profitable from the globalization process (Love, 1980). It may also increase

domestic income inequality. There are a few studies that came with the conclusion that globalization rises inequality (Dreher and Gaston 2008; Ha 2012), but Bergh and Nilsson (2010) suggested a different perspective. Due to extensive R&D investments and scientific activities, developed countries can find new treatment methods and supply advanced drugs. The only way to access that knowledge and these drugs are trade and integration between developed and underdeveloped countries. Globalization can play an important role in improving the health conditions of low-income countries to the extent that it can provide these linkages. One should also notice that wider markets and higher returns are important factors that motivate entrepreneurs. Buss (2002) claimed that the intellectual property rights of advanced drugs belong to private firms in developed countries, and because of the strong protection of property rights, less developed countries have trouble accessing them. However, rising global human rights became an important step to advance public health issues against economic concerns in the trade of pharmaceutical products.

The human rights approach focuses on how globalization affected disadvantaged people worldwide (Chapman 2009). It is an important instrument in the suppression of the inequality created by economic globalization. Because of the pressure on the government about human rights, disadvantaged people are becoming able to meet their basic human needs. The role of political globalization on this point is forcing governments to adopt global institutions. It increases the number of international organizations in which a country is a member. This makes governments more accountable in the global area and forcing them to pay attention to protect human rights. Gelleny and McCoy (2001) also claimed that integration among countries leads to political stability. Therefore, governments' tendency to violate human rights in order to maintain their power becomes lesser. Moreover, as social dimensions of globalization expand and communication opportunities among people in different countries increase, the possibility of human rights violations being discovered by other people increases (Dreher et al. 2012). Governments that know the international sanctions required by these violations have to be more cautious against human rights violations. Social globalization also provides cultural integration among the world's people, and it changes lifestyles and consumption patterns worldwide. The consequences of this change can have positive and negative effects. First, increased urban population and sedentary lifestyles may enhance prepared food consumption and reduce daily movements which result in rising obesity and diabetes (Hu 2011). Second, although rapidly increasing consumption options and diversity are known as welfare indicators, they also can cause stress which is known as an important determinant of many diseases both psychological and physical (Cutler et al. 2006). Third, due to knowledge spillovers and communication technology, people can learn about healthy nutrition and protection from communicable diseases. Thus, unhealthy but traditional consumption patterns and lifestyles may change. These days we experience the coronavirus epidemic and we see once again the importance of globalization. Countries are aware of infectious diseases in different parts of the world in a very short time and can take measures to stop the spread of the virus. The changes created by social and political globalization play a major role in this emergence. Social globalization enables people in very remote areas of the world to communicate with each other, while political globalization forces governments to be transparent about infectious diseases.

With economic globalization, increased economic activity may lead to urbanization. One may think about unhealthy conditions of an urban area such as environmental degradation, air and water pollution, higher crime rates, and stress which reduce life expectancy. However, according to Kabir (2008), people living in an urban area can benefit from improved medical care, easy access to pharmacy, and to the hospitals that use higher

technology. They can also get a better education and can enjoy better socioeconomic conditions.

Democracy can be considered as another determinant of life expectancy. In order to solve the health problems of the poor, people should draw the attention of the government. Sen (1999) claimed that the instrumental role of democracy in solving problems is enabling people to express and support their claims. Thus, the attention of politicians can be attracted to the problems of the poor. Politicians who have never tasted poverty do not have the urge to take action against the problems of the poor at the right time. Another linkage can be established through accountability (Besley and Kudamatsu 2006). In democracies, governments have an obligation to account to citizens for what purposes the resources were used. Thus, resources can be allocated to solve important public issues such as quality of life, communicable diseases, and mortality.

Compared to theoretical discussions, previous literature provides a lack of empirical evidence. Barlow and Vissandjee (1999) examined the determinants of life expectancy with cross-sectional data available in 1990 for 77 developed and developing countries. According to regression results, per capita income, literacy rate, and lower fertility are important determinants of life expectancy while living in a tropical area decreasing it. Another finding in this study shows that health expenditures in those countries failed to increase life expectancy. Following this study, Or (2000) analyzed the determinants of health outcomes in 21 industrialized OECD countries covering the period 1970–1992. This study presents gender-specific estimates separately for men and women. Fixed effects estimation results reveal a significant negative relationship between public health expenditure and women's premature death. The relationship also occurs for men, while GDP per capita dropped from the regression model due to high collinearity. Furthermore, GDP per capita and the proportion of white-collar workers reduce premature death for both men and women, while alcohol consumption increases it.

Franco et al. (2004) analyzed the impact of democracy on health utilizing political rights data of 170 countries. Empirical results show that people living in democracies enjoy better health conditions such as longer life expectancy, better maternal health, and lower child mortality. Following this, Besley and Kudamatsu (2006) investigated the nexus between democracy and health outcomes utilizing panel data from the 1960s to the 2000s. In their study, they used life expectancy at birth and child mortality variables for 146 countries as indicators of health outcomes. According to results, democracy has a positive and significant effect on life expectancy at birth and it also reduces child mortality. Safaei (2006) also investigated the impact of democracy on life expectancy and adult and child mortality rates with the data of 32 autocratic, 13 incoherent, and 72 democratic countries. According to the OLS estimation results, improving democratic institutions increases life expectancy and reduces child and adult mortality rates. Another finding of the study is that socioeconomic factors such as income, education, and access to health care services are important determinants of health status.

Owen and Wu (2007) found a positive relationship between trade openness and health outcomes using a panel of 219 countries. Health outcome measures of this study are infant mortality and life expectancy. Trade openness is one of the most important dimensions of globalization.

Kabir (2008) analyzed the determinants of life expectancy in 91 developing countries. Empirical results obtained are the opposite of the expected. According to results, per capita income, literacy rate, per capita health expenditure, and urbanization have no significant impact on life expectancy. On the other hand, the number of physicians has a positive and significant impact on life expectancy, while malnutrition reduces it.

As a dummy variable, living in Sub-Saharan Africa is another factor that reduces life expectancy due to communicable diseases like HIV, malaria, etc.

Bergh and Nilsson (2010) used a panel of 92 countries in the period 1970–2005 to investigate the relationship between globalization and life expectancy. They used social, political, and economic globalization data separately, and the results show a significant positive effect of economic globalization on life expectancy at birth. But no significant relationship was found between social globalization, political globalization, and life expectancy. They also used average years of education, urban population, the number of physicians, and nutrition as control variables and the effect of economic globalization was still positive and significant.

Welander et al. (2015) examined the effects of globalization and democracy on child health in their panel data analysis for 70 developing countries covering the period 1970–2009. According to the results, globalization significantly reduces child mortality. In addition, democracy improves child health and it also increases the beneficial effects of globalization on child health. Following this study, Tausch (2015) analyzed the role of globalization in life expectancy in 99 countries. The results of OLS estimates show that globalization leads to inequality, and therefore, it reduces health performance in terms of life expectancy and infant mortality. These results are contradictory to positive views on the role of globalization in public health. However, in 19 of 99 countries, globalization increases public health performance. Ali and Audi (2016) also analyzed the role of globalization in life expectancy in Pakistan. According to ARDL estimation results, life expectancy is positively associated with higher levels of globalization. Another study on the Pakistan case proposed by Alam et al. (2016) concluded that foreign direct investment and trade openness which are important indicators of economic globalization affects life expectancy positively.

Patterson and Veenstra (2016) concluded that electoral democracies provide better health conditions compared to other countries. Their analysis includes annual data from 168 countries covering the period 1960–2010. Empirical results show democracy has a significant positive impact on life expectancy and it reduces infant mortality.

In their recent study, Shahbaz et al. (2019) investigated the impact of globalization, financial development, and economic growth on life expectancy. The authors used nonlinear time series analysis methods utilizing the data of 16 Sub-Saharan African countries over the period 1970–2012. Their results show that globalization, financial development, and economic growth affect life expectancy positively in 14 of 16 Sub-Saharan African countries.

The previous literature provides a lack of evidence in the context of globalization, democracy, and life expectancy relationship. There are also methodological weaknesses in previous empirical studies. First, it can be observed that previous studies are mostly based on traditional estimation methods. Second, the panel data analyses are based on the first-generation estimators that assume cross-sectional independence. This assumption is hard to satisfy due to integration among countries. In addition, ignoring the cross-sectional dependence results in inconsistent estimations. Particularly in empirical work in the context of globalization which refers to economic, political, and cultural integration among countries, considering the cross-sectional dependence becomes more important. Therefore, in order to make a methodological contribution to previous literature, we used second-generation panel time series methods considering cross-sectional dependence.

3 Methodology and data

According to the United Nations, achieving sustainable development goals requires global cooperation and partnership. Therefore, “partnerships for goals” has taken its place as the 17th sustainable development target. However, it was emphasized that some sub-goals should be realized in order to reach this goal. These include improving international resource mobility, helping developing countries to attain debt sustainability, promoting the transfer of information and technology between developed and developing countries, an open and rule-based free trade system, encouraging public–private and civil society partnerships, increasing transparency and accountability, and high quality and reliable data (United Nations 2019). In our empirical work, economic, social, and political globalization and democracy variables were used as proxies of the subcomponents of SDG17. In addition, the life expectancy at birth variable that mostly used in related literature as a proxy of health status and well-being, it is used in our study as a proxy of SDG3. In this study, we investigated the role of globalization and democracy in life expectancy in 16 low-income countries.¹ Following Barlow and Vissandjee (1999) and (2000), GDP per capita is used as a control variable in order to mitigate omitted variable bias. Our dataset is covering the period 1970–2017. Following the related literature, we present our model as follows:

$$lex_{it} = \beta_{1i} + \beta_2 X_{it} + \beta_5 dem_{it} + \beta_6 gdp_{it} + \varepsilon_{it} \quad (1)$$

where *lex* is life expectancy at birth which refers to the average number of years a newborn is expected to live. Life expectancy at birth data is provided by World Bank (2019) World Development Indicators. Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. The dataset is consisting of a weighted average of collected data from several co-founders. In Eq. 1, *X* refers to the KOF Globalization Index developed by Dreher (2006). This index has been used in previous literature as a proxy of SDG17 (Saint Akadiri et al. 2020). The current version of the data published by the Swiss Economic Institute is revised by Gygli et al. (2019). The globalization variables are between 0–100, and 100 refers to the highest globalization level. In our analysis, we used subcomponents of globalization index such as economic (EC), social (SOS), and political (POL) globalization in addition to overall globalization (GLB). Due to high collinearity, the effects of different types of globalization are analyzed separately. Models 1, 2, 3, and 4 represent the estimations with overall, economic, social, and political globalization indexes, respectively. The democracy variable (*dem*) is provided from the Polity IV project dataset (Marshall and Jaggers 2002). While the increases in this indicator represent a more democratic regime, the decreases represent a more autocratic regime. Finally, *gdp* is real GDP per capita (constant 2010 \$) and it is provided from World Bank World Development Indicators. All variables transformed to the logarithmic form except democracy due to negative values. In the estimation of the model, the panel data analysis methods are used.

¹ Those countries are Benin, Burkina Faso, Burundi, Central African Republic, Chad, Democratic Republic of Congo, The Gambia, Haiti, Madagascar, Malawi, Mali, Nepal, Niger, Rwanda, Sierra Leone, and Togo.

3.1 Cross-sectional dependence

Traditional panel data methods are based on the assumption that no cross-sectional dependence exists among cross section units. However, this assumption is hard to satisfy due to rising economic, social, and political integration between countries. The estimations do not take this process into account may cause inconsistent results. Such results may also lead to incorrect inferences (Chudik and Pesaran, 2013). The existence of cross-sectional dependence in variables and the error term is obtained from the model analyzed with Pesaran (2004) CD_{LM} and Pesaran et al. (2008) bias-adjusted LM test. These techniques are robust whether $N > T$ and $T > N$. Therefore, CD_{LM} and bias-adjusted LM (LM_{adj}) tests are found to be appropriate and their test statistics can be calculated as follows:

$$CD_{LM} = \left(\frac{1}{N(N-1)} \right)^{\frac{1}{2}} \sum_{i=1}^{N-1} \sum_{j=i+1}^N (T\hat{\rho}_{ij}^2 - 1) \tag{2}$$

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^N \frac{(T-k)\hat{\rho}_{ij}^2 - \mu_{Tij}}{V_{Tij}} \tag{3}$$

Equation 2 shows the calculation of Pesaran (2004) CD_{LM} , and Eq. 3 is Pesaran et al. (2008) bias-adjusted LM test statistic. V_{Tij} , μ_{Tij} , and $\hat{\rho}_{ij}$, respectively, represent variance, mean, and the correlation between cross section units. The null and alternative hypothesis for both test statistics; H_0 : No cross-sectional dependence exist; H_1 : Cross-sectional dependence exist.

In the selection of stationarity tests and long-run estimators, the existence of cross-sectional dependence will be decisive. If the null of no cross-sectional dependence is rejected, second-generation methods that assume cross-sectional dependence should be used in order to provide unbiased and consistent estimation results.

3.2 Slope homogeneity

Pesaran and Yamagata (2008) proposed a method to examine slope heterogeneity in panel data analysis based on the Swamy (1970)'s random coefficient model.

The calculation of the test statistic of Swamy's model is given in Eq. 4.

$$\hat{S} = \sum_{i=1}^N \left(\underbrace{\tilde{\beta}_i}_{\beta} - \underbrace{\beta}_{WFE} \right) \frac{x_i' M_T x_i}{\tilde{\sigma}_i^2} \left(\underbrace{\tilde{\beta}_i}_{\beta} - \underbrace{\beta}_{WFE} \right) \tag{4}$$

In Eq. 4, $\tilde{\beta}_i$ and β_{WFE} , respectively, indicate the parameters obtained from pooled OLS and weighted fixed effects estimation, while M_T is the identity matrix. The test statistic obtained from Swamy's model is improved by Pesaran et al. (2008) as follows:

$$\tilde{\Delta} = \sqrt{N} \left(\frac{N^{-1} \tilde{S} - k}{\sqrt{2k}} \right) \tag{5}$$

$$\tilde{\Delta}_{adj} = \sqrt{N} \left(\frac{N^{-1} \tilde{S} - E(\tilde{Z}_{it})}{\sqrt{Var(\tilde{Z}_{it})}} \right) \tag{6}$$

where \tilde{S} is the Swamy test statistic and k is a number of explanatory variables. $\tilde{\Delta}_{adj}$ is a bias-adjusted version of $\tilde{\Delta}$. $\tilde{Z}_{it}=k$ and $Var(\tilde{Z}_{it}) = 2k(T - k - 1)/T + 1$. The null and alternative hypothesis for both test statistics is given below.

$$H_0 : \beta_i = \beta$$

$$H_1 : \beta_i \neq \beta$$

The rejection of the null hypothesis shows that slope coefficients of Eq. 1 are heterogeneous. In the selection of panel data estimation methods, the results of those preliminary analysis are taken into account.

3.3 Unit root test

Pesaran (2006) suggested a factor modeling approach to solve the cross-sectional dependency problem. This approach is simply based on adding cross-sectional averages to the models as proxies of unobserved common factors. The Cross-sectionally Augmented Dickey–Fuller (CADF) unit root test developed by Pesaran (2007) is based on that factor modelling approach. This method is an augmented form of Augmented Dickey–Fuller (ADF) regression with lagged cross-sectional average and its first difference to deal with cross-sectional dependence (Baltagi, 2008: 249). This method considers the cross-sectional dependence and can be used, while $N > T$ and $T > N$. The CADF regression is:

$$\Delta y_{it} = \alpha_i + \rho_i^* y_{i,t-1} + d_0 \bar{y}_{t-1} + d_1 \Delta \bar{y}_t + \epsilon_{it} \tag{7}$$

\bar{y}_t is the average of all N observations. To prevent serial correlation, the regression must be augmented with lagged first differences of both y_{it} and y_t as follows:

$$\Delta y_{it} = \alpha_i + \rho_i^* y_{i,t-1} + d_0 \bar{y}_{t-1} + \sum_{j=0}^p d_{j+1} \Delta \bar{y}_{t-j} + \sum_{k=1}^p c_k \Delta y_{i,t-k} + \epsilon_{it} \tag{8}$$

After the calculation of CADF statistics for each cross section ($CADF_i$), Pesaran (2007) calculates the CIPS statistic as average of CADF statistics.

$$CIPS = \frac{1}{N} \sum_{i=1}^N CADF_i \tag{9}$$

If the calculated CIPS statistic exceeds the critical value, it means that the unit root hypothesis is rejected. After the preliminary analysis of unit root, the existence of a long-run relationship between the variables in our model will be investigated via Westerlund and Edgerton (2007) cointegration test. After this, the long-run coefficients will be estimated using the continuous-updated fully modified (CUP-FM) estimator developed by Bai and Kao (2006) and Bias-adjusted OLS estimator developed by Westerlund (2007).

3.4 Cointegration test and long-run relationship

In this study, the cointegration relationship was investigated by Westerlund and Edgerton (2007) LM bootstrap test. This method considers cross-sectional dependence and provides robust results in small samples (Westerlund and Edgerton, 2007). This method is based on the following equation

$$y_{it} = \alpha_i + x'_{it}\beta_i + z_{it} \tag{10}$$

$$z_{it} = u_{it} + v_{it}, v_{it} = \sum_{j=1}^t n_{ij} \tag{11}$$

where n_{ij} is an independent and identically distributed process with zero mean and $\text{var}(n_{ij}) = \sigma_i^2$. Westerlund and Edgerton (2007) suggested following LM test in order to test the null of cointegration

$$LM_N^+ = \frac{1}{NT^2} \sum_{i=1}^N \sum_{t=1}^T \widehat{w}_i^{-2} S_{it}^2 \tag{12}$$

where S_{it} is partial sum process of the fully modified estimate of z_{it} and \widehat{w}_i^{-2} is the estimated long-run variance of u_{it} conditional on $\Delta x'_{it}$. If the calculated LM statistic is below the critical value, the null of cointegration will be accepted. The critical values will be provided using the bootstrap method in order to prevent cross-sectional dependence.

In the estimation of long-run coefficients, the CUP-FM estimator was used and this method is based on the following regression

$$\widehat{\beta}_{CUP} = \left[\sum_{i=1}^N \left(\sum_{t=1}^T \widehat{y}_{i,t}^+ \left(\widehat{\beta}_{CUP} \right) \left(x_{i,t} - \widetilde{x}_i \right)' - T \left(\widehat{\lambda}_i \left(\widehat{\beta}_{CUP} \right) \widehat{\Delta}_{F\epsilon i}^+ \left(\widehat{\beta}_{CUP} \right) + \widehat{\Delta}_{\mu\epsilon i}^+ \left(\widehat{\beta}_{CUP} \right) \right) \right) \right] \left[\sum_{i=1}^n \sum_{t=1}^T \left(x_{i,t} - \widetilde{x}_i \right) \left(x_{i,t} - \widetilde{x}_i \right)' \right]^{-1} \tag{13}$$

where $\widehat{\lambda}_i$ refers to the estimated factor loadings and $\widehat{y}_{i,t}^+ = y_{i,t} - \left(\lambda_i' \widehat{\Omega}_{F\epsilon i} + \widehat{\Omega}_{\mu\epsilon i} \right) \widehat{\Omega}_{\epsilon i}^{-1} \Delta x_{i,t}$ indicates the transformation of the dependent variable for endogeneity correction. According to Bai and Kao (2006), CUP-FM estimator is robust under cross-sectional dependence. However, the assumption that the number of common factors (k) is known cannot be satisfied in practice (Westerlund, 2007). Therefore, Westerlund (2007) suggested a bias-adjusted estimator (BA-OLS) following the methodology of Bai and Kao (2006) except in the context of determining the number of common factors. The author suggested the estimation of k using an information criterion as

$$\widehat{k} = \min(IC(k)), 1 < k < k_{max} \tag{14}$$

where $IC(k)$ is the information criterion. In this study, we determined the number of common factors via the Bayesian information criterion (BIC) as follows.

Table 1 Cross-sectional dependence

	CD _{LM} (Pesaran 2004)		LM _{adj} (Pesaran et al. 2008)	
	Statistic	P value	Statistic	P value
LEX	245.62	0.000	245.44	0.000
GLB	321.23	0.000	321.06	0.000
EC	141.20	0.000	141.03	0.000
SOS	329.40	0.000	329.23	0.000
POL	294.58	0.000	294.41	0.000
DEM	182.75	0.000	182.58	0.000
GDP	129.12	0.000	128.95	0.000
Model 1	9.099	0.000	180.2	0.000
Model 2	13.30	0.000	139.4	0.000
Model 3	22.90	0.000	272.10	0.000
Model 4	10.66	0.000	146.5	0.000

Table 2 Slope homogeneity

	Tests	Statistics	P value
Model 1	$\tilde{\Delta}$	0.909	0.363
	$\tilde{\Delta}_{adj}$	0.927	0.354
Model 2	$\tilde{\Delta}$	0.983	0.326
	$\tilde{\Delta}_{adj}$	1.009	0.313
Model 3	$\tilde{\Delta}$	0.925	0.355
	$\tilde{\Delta}_{adj}$	0.957	0.339
Model 4	$\tilde{\Delta}$	1.329	0.184
	$\tilde{\Delta}_{adj}$	1.384	0.166

$$BIC(k) = V(k) + kV(k_{max}) \left(\frac{(N + T - k)\ln(NT)}{NT} \right) \tag{15}$$

In the equation above, V(k) is the estimated variance of \hat{u}_{it} based on k factors. By minimizing the BIC, we obtain \hat{k} . Westerlund (2007) showed that the estimation of k provides better results compared to CUP-FM estimator assuming k is known. Both of the estimators require cointegrated variables in the long run.

3.5 Empirical results and discussion

The results of Pesaran (2004) CD_{LM} and Pesaran et al. (2008) bias-adjusted LM tests are given in Table 1.

The results given in Table 1 show that the null of no cross-sectional dependence is rejected at 1% according to both CD_{LM} and LM_{adj} test statistics in all variables. In addition, in the error terms obtained from models 1, 2, 3, and 4 the null of no cross-sectional dependence is rejected at 1%. These results show that the methods to be used in the

analysis of the stationarity of the variables and the determination of the long-run relationship should consider the cross-sectional dependence.

The results of homogeneity tests developed by Pesaran and Yamagata (2008) are given in Table 2. According to the results, the null of homogeneity is accepted at %1 in all models. Therefore, estimators assume parameter homogeneity are used in our analysis.

After the preliminary analysis of cross-sectional dependence, the CADF unit root test developed by Pesaran (2007) is found to be appropriate for our model because of its robustness under cross-sectional dependence. The results of the CADF unit root test are given in Table 3.

In the analysis of unit root, constant and trend terms are both considered at level, while only constant term is added at first difference. Maximum lag level is determined as 3, while optimum lag level is determined by F joint test from general to particular. According to results, the null of unit root is accepted for all variables, while calculated CIPS statistics of first-differenced variables exceed 1% critical value. All variables have a unit root, and their first differences are stationary (I_1). Therefore, in order to determine the existence of a long-run relationship, we applied Westerlund and Edgerton (2007) panel cointegration test. This method considers cross-sectional dependence and can be used, while the series are integrated in the same order. The results are shown in Table 4.

Constant and trend are both considered in the analysis of cointegration, and critical values are obtained from 5000 bootstrap replications. The results show that the null of cointegration is accepted for all models. There is a long-run relationship between life expectancy, globalization, democracy, and GDP per capita. After determining the cointegration relationship, we estimated long-run coefficients utilizing CUP-FM and BA-OLS estimators proposed by Bai and Kao (2006) and Westerlund (2007), respectively.

Table 3 CADF unit root test results

	CIPS Statistics		
	Level	1st difference	Results
LEX	-1.883	-2.414***	I_1
GLB	-2.508	-3.399***	I_1
EC	-2.534	-6.152***	I_1
SOS	-2.425	-2.768***	I_1
POL	-2.245	-3.328***	I_1
DEM	-2.407	-3.110***	I_1
GDP	-1.180	-5.558***	I_1

***, **, and * indicate significance at 1%, 5%, and 10% level, respectively. The critical values at those significance levels for the model with constant and trend terms are -2.76, -2.62, and -2.54, respectively. For the model with constant only, the critical values are -2.25, -2.11, and -2.03, respectively

Table 4 LM bootstrap cointegration test

	1	2	3	4
LM statistics	3.528 (0.955)	4.137 (0.968)	5.994 (0.561)	2.773 (0.984)

P values are given in parenthesis

The long-run estimation results given in Table 5 show that overall, economic, social, and political globalization are positively associated with life expectancy at 1% significance level according to both CUP-FM and BA-OLS estimators. The results show that a 1% increase in globalization index increases life expectancy %0.014 and %0.015 according to CUP-FM and BA-OLS estimators, respectively. The impact of economic, social and political globalization indexes is 0.013%, 0.011%, and 0.015% according to CUP-FM estimation results while 0.014%, 0.012%, and 0.017% according to both estimators, respectively.

Our results confirms the findings of Owen and Wu (2007), Ali and Audi (2016), and Shahbaz et al. (2019) who found a positive relationship between globalization and life expectancy. Our empirical work also supports the evidence of Bergh and Nilsson (2010) in terms of positive effect of economic globalization on life expectancy. While the authors found no significant impact of social and political globalization on life expectancy, our results show that life expectancy is positively associated with both social and political globalization. The results we found contradict Tausch (2015)'s evidences in 80 of 99 countries. However, according to his results, in 19 of 99 countries, globalization affects health positively. When these countries are examined, it is seen that 14 of them are countries in the low and lower-middle income groups. In this sense, it can be said that the evidence we found for low-income countries is in line with the author's evidence. As Dreher (2006) mentioned, despite its possible inequality effects, the net effect of globalization on development is mostly positive and our empirical work supports that idea. The effect of democracy on life expectancy is also positive and significant at 1% which confirms the findings of Franco et al. (2004) and Besley and Kudamatsu (2006). In electoral democracies, people living in poverty and suffering from health problems can easily attract the attention of policymakers compared to autocracies. This leads to the reallocation of resources to solve the primary problems of the society. In the context of sustainable development goals, our results show that there is no conflict between SDG3 (good health and well-being) and SDG17 (partnerships for the goals). The improvement of the health conditions of the poor countries depends on global partnership and economic, social, and political integration among countries. In addition, democracy is an important tool in achieving the goal of a healthy society, as it fosters accountability, transparency, and partnership between governments and the societies they rule. As stated in the introduction section, low-income countries show low performance in terms of health-related sustainable development goals, and their connections with global markets are weak compared to other countries. At the same time, democratic institutions are not developed. Our work supports the idea that in order to achieve SDG3, global partnership and democracy are required.

The GDP per capita that used as a control variable has a positive impact on life expectancy at a 1% level. These results support the evidence of Barlow and Vissandjee (1999), Or (2000), and Shahbaz et al. (2019). Individuals living in countries with high per capita income are expected to have higher welfare and have a longer life expectancy (Judge, 1995). In low-income countries where people still suffer from having difficulty in meeting basic human needs, increasing per capita income may lead to better nutritional status, easier access to advanced treatment methods and technology.

Table 5 CUP-FM and BA-OLS estimation results

	CUP-FM	BA-OLS
GLB	0.014 (7.39) ***	0.015 (8.37) ***
EC	0.013 (7.48) ***	0.014 (7.47) ***
SOS	0.011 (7.31) ***	0.012 (8.23) ***
POL	0.015 (9.31) ***	0.015 (7.65) ***
DEM	0.016 (9.85) ***	0.016 (9.77) ***
GDP	0.023 (5.97) ***	0.025 (6.19) ***
		0.017 (10.6) ***
		0.018 (11.2) ***
		0.026 (6.78) ***
		0.027 (6.70) ***
		0.025 (7.57) ***
		0.017 (8.65) ***
		0.018 (11.1) ***
		0.028 (7.01) ***

*** indicates statistical significance at 1% level, and t statistics are given in parenthesis

4 Conclusion

In this study, the effects of globalization and democracy on life expectancy are empirically investigated in low-income countries. While globalization and democracy indexes are used as proxy indicators of “Partnerships for the Goals (SDG 17),” life expectancy used a proxy of “Good Health and Well-Being (SDG 3).” With this, it is aimed to examine the existence of contradiction between those SDGs. In the estimation of the long-run relationship between the variables, second-generation panel data analysis methods that consider cross-sectional dependency are used. According to the results, the globalization index and its subcomponents such as economic, social, and political globalization are important instruments to achieve a healthier society. In addition, higher levels of democracy lead to higher levels of life expectancy. Finally, GDP per capita growth improves health status of countries.

The findings obtained from our study show that economic, social, and political integration of countries and democracy accelerate the process of achieving a healthier society. Therefore, it is seen that SDG3 and SDG17 targets are compatible with each other. In order to achieve SDG3, economic, social, and political integration between countries should be encouraged and democratic institutions should be improved. Policy makers should remove the barriers on globalization, and they should promote participation on international organizations and public–private and civil society partnerships.

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