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Demographic Transition, Human Capital Dynamics and Economic Growth: An Application of the LSDVC Approach in ECOWAS

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Abstract This paper examines the effect of demographic transition with human capital dynamics on economic growth over the period from 1990 to 2020. We perform a bias corrected least square dummy variable (LSDVC) approach developed by Bruno (2005) for short dynamic panels with fixed effects and extended to accommodate unbalanced data. The empirical results reveal that demographic transition and human capital play an important role on economic growth. Working-age population, population growth rate and youth dependency ratio influence positively economic growth. As for human capital and its variation over time, findings reveal a positive contribution on economic growth as well as the lagged value of human capital in order to take into account the previous qualifications accumulation. The study provides implications for Policymakers to invest in people training in order to grow and accumulate working-age population qualifications and to create a dynamic labor market to insert youth people moving in working-age.

Keywords Demographic transition, Human capital, Economic growth, Dynamic panel data, Bias corrected least square dummy variable (LSDVC) estimator

1. Introduction

This article revisits the debate on the effect of population structure on economic growth. Since many decades, the population structure and demographic dividend became important factors in developing countries economic growth (see Zhu and Zhong, 2017; Cai and Lu, 2013). The debate was conducted by population optimists defending that fast population growth promotes technological and institutional innovation (see Boserup, 1981, Kuznets, 1967), population pessimists who contend that a high population growth is impoverishment (see Coale and Hoover, 1958; Ehrlich, 1968) and the population neutralist (see Bloom and Freeman, 1986; Kelly, 1988) for who, population growth has no positive or negative effects on economic growth.

In the last two decades, the population growth has been decomposed into its fertility and mortality components and examined for their independent effects on economic growth (see Bloom and Williamson, 1998). The downward trend in mortality signal the beginning of all demographic transitions and changes in the age structure are observed. The demographic transition refers to the transition of a region or country from high death and birth rates to lower death and birth rates as the region or country develops from a pre-industrial to an industrialized economy.

That demographic transition theory was firstly developed by Landry in the 1990s and Thompson in the 1930s. The demographic transition is divided into three stages (Figure 1). The first or preliminary stage is characterized by high birth rate, high death rate and low natural growth rate; the second is the transitory stage in which a decrease in death rate is followed by a decrease in birth rate and the natural population growth rate falls before a short-term rise. The third correspond to the modernization stage with low death rate, low birth rate and low natural growth rate (see Yuan and Gao, 2020). According to Bloom and Williamson (1998), the demographic transition might have separate influences on economic growth for reasons cited by population pessimists or optimists. Moreover, like previous works, other authors will focus their reflections on the repercussions of the demographic change on human capital (see Becker and al. 1990; Mankiw and al. 1992; Jones 2002). Indeed, a constant rate of investment in human capital leads to an increase in human capital per worker if labor force growth slows (Lee and Mason, 2010). According to Fry and Mason (1982); Bloom and al., (2003), the presence of children increases the consumption requirements of young families, so that high rates of youth dependency can depress saving and lower the impact on economic growth. In general, national savings are higher when dependency rates are low and economic growth is rapid (see Higgins, 1998; Leff, 1969).

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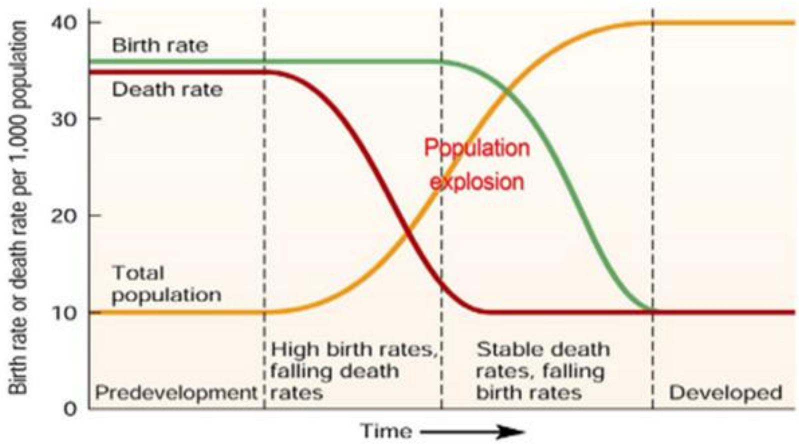

Figure 1. Classic model of demographic transition (Yuan and Gao, 2020)

However, the majority of the studies above have focused on developed economies, showing that very little attention has been given to developing countries, especially African countries where WHO statistics in 2015 show that more than 29,000 children under five die each day. The ECOWAS countries are not on the margins of this observation (see the ECA report, 2020). Indeed, the population of West Africa was estimated at 386.9 million inhabitants in 2019, or 5% of the world population and will rise to 8% in 2050. At the regional level, it represented 29, 6% in 2019 and will be 31.6% in 2050. In addition, the demographic dependency rate in 2020 was 85%, which reflects a relatively slow demographic transition in the sub-region, linked to still high fertility rates in most countries. Indeed, the synthetic fertility rate is more than 5 children on average per woman in five countries of the community (Burkina Faso, Gambia, Nigeria, Mali and Niger) and more than four children per woman in seven other countries (Benin, Guinea, Ivory Coast, Senegal, Guinea Bissau, Togo, Liberia and Sierra Leone). Niger is the country with the highest fertility rate in the region and in the world (6.9 children per woman on average). Furthermore, in 2019, ECOWAS accounted for about a quarter of Africa's GDP Economic growth in the region was estimated at 3.6%, compared to 3.4% in 2018. In addition, education is the one of the main challenges facing the community. Indeed, the sub-regional average enrollment rate in primary schools increased from 74% in 2007 to 78% in 2018. However, it remains relatively low in many countries and is declining in others. School dropout rates are also high. The proportion of out-of-school children in ECOWAS was around 24.6% between 2010 and 2018.

The contribution of this paper is threefold. The first is the used of demographic variable decomposition in demographic transition studies in ECOWAS countries with human capital variables. The second contribution concerns ECOWAS insofar as it presents a strong demographic growth and very few studies to our knowledge have focused on this area. The third is the method of analysis. We applied a bias corrected least square dummy variable developed by Kiviet (1995) Judson and Owen (1999) and Bruno (2005). To the best of our knowledge, to date in demographic research, only a limited number of studies have applied LSDVC estimators. This econometric estimation is better than a system generalized method of moments (GMM) estimator, as it is robust and provide consistent and efficient estimates especially for short dynamic panels with fixed effects (Dahir and al. 2018).

The remainder of this paper is structured as follows. Section 2 describes the theoretical and empirical models. Section 3 presents the summary analysis, the cross-sectional dependence, the unit root tests and then the estimation results and discussions. Section 4 concludes the paper and provides some policy implications.

2. Methodology

This section presents the theoretical and empirical model binding age structure variables with human capital and economic growth using an augmented neoclassical growth framework.

2.1. Theoretical Economic Modeling

The standard neoclassical growth models neglect the influence of demographic transition and assumed constant labor force participation and stable population growth. But, the importance of age-structural transition for economic growth became popular since nineties of last century. The pioneer's studies in this field are Freedman and Bloom (1988), Higgins and Williamson (1997), Bloom and al. (2001) and Kelly and Schmidt (2005). For this, we use the augmented conditional convergence growth model by incorporating the variables of demographic transition unlike the standard neoclassical model. We then take the aggregate production function including human capital as a factor input to derive unified conditional convergence model augmented for demographic and human capital variables (see Mankiw and al., 1992; Hall and Jones, 1999; Benhabib and Spiegel, 2002; Ahmad and Khan, 2018):

$$Y_{it} = A_{it} K_{it}^{\theta} H_{it}^{1-\theta} \quad (1)$$

Where Y_{it} is the GDP, A_{it} represent the Total Factor Productivity, K_{it} is the physical capital stock and N_{it} is the total labor input. $H_{it} = h_{it} N_{it}$ where h_{it} is the human capital per worker that is defined by $h_{it} = e^{\psi S_{it}}$ while ψ refers to schooling and S_{it} is average years of schooling of labor force used as proxy for human capital. To transform the expression (1) into per-worker form, we divide it by N_{it}. Hence, we obtain the expression (2) in per-worker form:

$$y_{it} = A_{it} k_{it}^{\theta} \left\langle e^{\psi S_{it}} \right\rangle^{1-\theta} \quad (2)$$

After the log transformation and taking difference, the Eq. (2) follow this:

$$\Delta \ln y_{it} = \Delta \ln A_{it} + \theta \Delta \ln k_{it} + (1-\theta)\psi \Delta S_{it} \quad (3)$$

Where y_{it} is the GDP per-worker and k_{it} is the physical capital per-worker. The conversion of GDP per-worker to GDP per-capita given by:

$$y_{it} = \frac{Y_{it}}{N_{it}} \equiv \frac{Y_{it}}{N_{it}} \cdot \frac{P_{it}}{P_{it}} = \tilde{y}_{it} \cdot \frac{P_{it}}{N_{it}} \quad (4)$$

Where $\tilde{y}_{it}$ is the output per-capita and P_{it} is the total population. Substituting Eq. (4) in Eq. (3) yields:

$$\Delta \ln \tilde{y}_{it} = \Delta \ln A_{it} + \theta \Delta \ln k_{it} + (1-\theta)\psi \Delta S_{it} \quad (5)$$
$$+ \Delta \ln N_{it} - \Delta \ln P_{it}$$

Assuming that due to technology adoption and output convergence dynamics, the TFP (Total Factor Productivity) depends on how much distant country is from the global technology frontier, which in turn is proxy by level of labor productivity or GDP per-worker.

$$\Delta \ln A_{it} = \mu + \eta \ln y_{i,t-1} \quad (6)$$

Where μ is the trend parameter and η is the coefficient of initial GDP per-worker. Substituting Eq. (6) in Eq. (5) yields:

$$\Delta \ln \tilde{y}_{it} = \mu + \eta \ln y_{i,t-1} + \theta \Delta \ln k_{it} + (1-\theta)\psi \Delta S_{it} \quad (7)$$
$$+ \Delta \ln N_{it} - \Delta \ln P_{it}$$

This model has been extended by including the level of education as a determinant of TFP growth rate and by augmenting the model to include the variables of age-structure changes and labor force participation ratio. The change in human capital cannot alone explain the influence of human capital dynamics on economic growth. The speed of changes in human capital is dependent on the prevailing stock of capital (Nelson and Phelps, 1996). Following Benhabib and Spiegel (2005), the level of existing human capital stock is assumed to affect the TFP growth rate by accelerating technology adoption process which in turn directly affect the TFP growth rate. In view of the role of human capital, we have to add level of education as a determinant of growth rate of TFP

$$\Delta \ln A_{it} = \mu + \sigma S_{i,t-1} + \eta \ln y_{i,t-1} \quad (8)$$

In order to augment the model with the variable capturing age-structure dynamics, i.e. working-age population ratio and labor force participation ratio, the decomposition approach of mathematical algebra is used. The GDP per-capita is decomposed into GDP par-worker, working-age population ration and labor force participation ratio. By decomposition approach Eq. (4) yield the following with W_{it} the working-age population:

$$y_{it} = \tilde{y}_{it} \cdot \frac{P_{it}}{N_{it}} \equiv \tilde{y}_{it} \cdot \frac{P_{it}}{W_{it}} \cdot \frac{W_{it}}{N_{it}} \quad (9)$$

Taking log transformation of Eq. (9) we obtain:

$$\ln y_{it} = \ln \tilde{y}_{it} - \ln \left\langle \frac{W_{it}}{P_{it}} \right\rangle - \ln \left\langle \frac{N_{it}}{W_{it}} \right\rangle \quad (10)$$

Taking the first lag of Eq. (10) and substituting it in Eq. (8) yields the following

$$\Delta \ln A_{it} = \mu + \sigma S_{i,t-1} + \eta \ln \tilde{y}_{i,t-1} \cdot \quad (11)$$
$$- \eta \ln \left\langle \frac{W_{i,t-1}}{P_{i,t-1}} \right\rangle - \eta \ln \left\langle \frac{N_{i,t-1}}{W_{i,t-1}} \right\rangle$$

Finally, by substituting Eq. (11) into Eq. (5) yields:

$$\Delta \ln \tilde{y}_{it} = \mu + \sigma S_{i,t-1} + \eta \ln \tilde{y}_{i,t-1} - \eta \ln \left\langle \frac{W_{i,t-1}}{P_{i,t-1}} \right\rangle \quad (12)$$
$$- \eta \ln \left\langle \frac{N_{i,t-1}}{W_{i,t-1}} \right\rangle + \theta \Delta \ln k_{it} + (1-\theta)\psi \Delta S_{it} -$$
$$+ \Delta \ln N_{it} - \Delta \ln P_{it}$$

Where $\Delta \ln \tilde{y}_{it}$ represent the growth rate of GDP per-capita, $\frac{W_{i,t-1}}{P_{i,t-1}}$ is the lagged working-age population share of total population, $\frac{N_{i,t-1}}{W_{i,t-1}}$ is the lagged labor force participation ratio, $\Delta \ln k_{it}$ denotes the growth rate of physical capital per-worker, $\Delta \ln N_{it}$ reflects the growth rate of total labor force, $\Delta \ln P_{it}$ is the growth rate of total population, $S_{i,t-1}$ shows the lagged level of human capital while ΔS_{it} is the change in human capital and $\ln \tilde{y}_{i,t-1}$ is the log of lagged dependent variable used as regressor to represent convergence of the model we use the Least Squares Dummy Variable (LSDV) bias corrected. In the first case, the coefficient of $\ln \tilde{y}_{i,t-1}$ should be negative (< 0) and statistically significant to ensure the conditional convergence of the model. Lagged variables other than the lagged dependent variable are instruments for the first differenced explanatory variables and level variable for the explained variable used to tackle the endogeneity problem. When $\Delta \ln N_{it} = 1$ and $\Delta \ln P_{it} = 1$ when the net demographic effects are no more and the population is stable. When the population, in this study, is unstable during a dynamic transition so we can relax this theoretical restriction and consequently their coefficients would be different from unity.

2.2. Econometric Model Specifications and Method

Based on the theoretical models, the econometric models for economic growth can be estimated as:

$$g_{\tilde{y}_{it}} = \alpha_1 y_{i,t-1} + \alpha_2 X_{it} + \alpha_3 Z_{it} + \alpha_4 g_{k_{it}} + \alpha_5 g_{N_{it}} + \alpha_6 g_{P_{it}} + \Delta e_{1it} \quad (13)$$

Where $g_{\tilde{y}_{it}}$ is the GDP per-capita growth rate, $y_{i,t-1}$ is the log of lagged value of GDP per-capita level, X_{it} represents the log of lagged value of working-age population ratio, Z_{it} shows the log of lagged value of labor force participation ratio used as instrument. In addition, $g_{k_{it}}$ denotes the growth rate of capital stock, $g_{N_{it}}$ is growth rate of total labor force, $g_{P_{it}}$ shows the growth rate of total population and Δe_{1it} is the difference of observation specific error term left after the removal of fixed effects error.

$$g_{\tilde{y}_{it}} = \beta_1 y_{i,t-1} + \beta_2 X_{it} + \beta_3 Z_{it} + \beta_4 g_{k_{it}} + \beta_5 g_{N_{it}} + \beta_6 g_{P_{it}} + \beta_7 g_{T_{it}} + \beta_8 g_{L_{it}} + \beta_9 EE_{it} + \beta_{10} HE_{it} + \beta_{11} AP_{it} + \beta_{12} \Delta E_{it} + \Delta e_{2it} \quad (14)$$

The model specification (14) adds others controller variables like $g_{T_{it}}$ which shows the growth rate of trade openness, $g_{L_{it}}$ representing the growth rate of life expectancy, EE_{it} represents education expenditures, HE_{it} denotes health expenditures, AP_{it} represents agriculture productivity and ΔE_{it} denoting the difference of human Capital. Similarly, Δe_{2it} is the difference of error term excluding country specific fixed effects as in case of model (13).

$$g_{\tilde{y}_{it}} = \gamma_1 y_{i,t-1} + \gamma_2 X_{it} + \gamma_3 Z_{it} + \gamma_4 g_{k_{it}} + \gamma_5 g_{N_{it}} + \gamma_6 g_{P_{it}} + \gamma_7 g_{T_{it}} + \gamma_8 g_{L_{it}} + \gamma_9 EE_{it} + \gamma_{10} HE_{it} + \gamma_{11} AP_{it} + \gamma_{12} \Delta E_{it} + \gamma_{13} E_{it} + \Delta e_{3it} \quad (15)$$

In addition to the variables of model specification (14), the model (15) includes E_{it} which represents the lagged value of level of human capital. Δe_{3it} is similar than that explained earlier.

$$g_{\tilde{y}_{it}} = \theta_1 y_{i,t-1} + \theta_2 DR^y_{it} + \theta_3 DR^o_{it} + \theta_4 g_{k_{it}} + \theta_5 g_{N_{it}} + \theta_6 g_{P_{it}} + \theta_7 g_{T_{it}} + \theta_8 g_{L_{it}} + \theta_9 EE_{it} + \theta_{10} HE_{it} + \theta_{11} AP_{it} + \theta_{12} \Delta E_{it} + \theta_{13} E_{it} + \Delta e_{4it} \quad (16)$$

In model (16), the log of lagged value of working-age population ratio and log of lagged value of labor force participation ration are replaced by DR^y_{it} which is log of lagged value of youth dependency ratio (ratio of population in the age bracket of below 15 years to population in the age bracket of between 15 and 65 years) and DR^o_{it} which denotes the log of lagged value of old dependency ratio (ratio of population in the age bracket of above 65 years to the population in the age bracket of 15-65 years). The remaining model is the same as model (13).

$$g_{\tilde{y}_{it}} = \theta_1 y_{i,t-1} + \theta_2 DR^y_{it} + \theta_3 DR^o_{it} + \theta_4 g_{k_{it}} + \theta_5 g_{N_{it}} + \theta_6 g_{P_{it}} + \theta_7 g_{T_{it}} + \theta_8 g_{L_{it}} + \theta_9 EE_{it} + \theta_{10} HE_{it} + \theta_{11} AP_{it} + \theta_{12} \Delta E_{it} + \theta_{13} E_{it} + \theta_{14} E_{i,t-1} + \Delta e_{5it} \quad (17)$$

The Eq. (17) has the same variables than (16) except $E_{i,t-1}$ which represents the lag of human capital variable in its level form. The lag term of human capital is included in the model because human capital accumulation may be important for economic growth.

To analyze the influence of demographic and economic variables on economic growth, we then use the bias corrected least square dummy variable method.

Tests and method

In this sub-section, we present some preliminary tests namely the cross section dependence, the second generation unit root tests and the LSDVC estimator.

Cross section dependence tests

To examine the cross-sectional dependence, we consider the sample estimate of the pair-wise correlation of the residuals, u_{it} and u_{jt} for $i \neq j$

$$\rho_{ij} = \rho_{ji} = \frac{\sum_{t=1}^{T} u_{it} u_{jt}}{\left(\sum_{t=1}^{T} u^2_{it}\right)^{1/2} \left(\sum_{t=1}^{T} u^2_{jt}\right)^{1/2}}$$

$$i = 1, \ldots, N, \; t = 1, \ldots, T \quad (18)$$

Under the null hypothesis of no cross-sectional dependence

$$H_0 : \rho_{ij} = 0 \text{ for } i \neq j \quad (19)$$

where ρ_{ij} is the pair-wise correlation coefficient of the residuals. For N fixed and $T \to \infty$, Breusch and Pagan (1980) proposed an LM test to test the null of no cross-sectional correlation in (19) without imposing any structure on this correlation. It is given by,

$$LM_{BP} = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \quad (20)$$

LM_{BP} is asymptotically distributed as a Chi-squared distribution with $N(N-1)/2$ degrees of freedom under the null. However, for a micro-panel dataset, N is larger than T, Breusch-Pagan LM test statistic is not valid under this large N, small T setup. Pesaran (2004) proposed a scaled version of this LM test as follows,

$$LM_P = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \left(T \hat{\rho}_{ij}^2 - 1 \right) \quad (21)$$

Pesaran (2004) shows that LM_P is distributed as $N(0,1)$ with $T \to \infty$ first, then $N \to \infty$ under the null hypothesis. However, $E\left(T \hat{\rho}_{ij}^2 - 1\right)$ is not correctly centered at zero with fixed T and large N. Hence, Pesaran and al. (2008) propose a bias adjusted version of this LM test, denoted by LM_{PUY},

$$LM_{PUY} = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \frac{(T-k)\hat{\rho}_{ij}^2 - \mu_{Tij}}{V_{Tij}} \quad (22)$$

where μ_{Tij} and V_{Tij} depends on T, k. Pesaran and al. (2008) show that LM_{PUY} is asymptotically distributed as $N(0,1)$ under the null (22) and the normality assumption of the disturbances as $T \to \infty$ followed by $N \to \infty$ (see Baltagi and al., 2016). Pesaran (2004) proposes a test based on the average of pair-wise correlation coefficients rather than their squares and the test statistic is given by,

$$CD_P = \sqrt{\frac{2}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \right) \quad (23)$$

This test has exactly mean zero for fixed values of T and N. As N, $T \to \infty$ in any order, CD_P tends approximately to a standardized normal.

Unit roots tests

For panel unit root-testing there are two generation of tests. The first generation assumes that cross-section units are cross-sectionally independent while the second generation of panel unit root tests relaxes this assumption and allow for cross-sectional dependence. Table 1 summarize the first and second generation panel unit root tests generally used (Tugcu, 2018).

All the tests among the first generation panel unit root tests, except for Hadri (2000), test the null hypothesis of a unit root. For second generation of panel unit root tests, all the tests except for the Bai and Ng (2005) and Harris et al. (2005) assume that there is a unit root in the data.

We will put the emphasis only on the Im, Pesaran and Shin (2003) and Maddala and Wu (1999) panel unit root tests. The Im, Pesaran and Shin begin by specifying a separate ADF regression for each cross section:

$$\Delta y_{it} = \alpha_i y_{i,t-1} + \sum_{j=1}^{P_i} \varphi_{ij} \Delta y_{i,t-j} + z_{it}' \gamma + \varepsilon_{it} \quad (24)$$

The null hypothesis is defined as $H_0 : \alpha_i = 0$ for all i, whereas now the alternative hypothesis is given as

$$H_1 : \begin{cases} \alpha_i = 0 & for \ \ i = 1, 2, \ldots, N_1 \\ \alpha_i < 0 & for \ \ i = N_1 + 1, N_1 + 2, \ldots, N \end{cases} \quad (25)$$

After estimating the separate ADF regressions, the average of the *t*-statistics for α_i from the individual ADF regressions $t_{iT_i}(p_i)$:

$$t - bar_{NT} = \frac{1}{N} \sum_{i=1}^{N} t_{iT_i}(p_i) \quad (26)$$

In the limit, the IPS test as $T \to \infty$ followed by $N \to \infty$ converges to

$$W_{t-bar_{NT}} = \frac{\sqrt{N}\left(t - bar_{NT} - N^{-1} \sum_{i=1}^{N} E\left(\bar{t}_{iT}(p_i)\right) \right)}{\sqrt{N^{-1} \sum_{i=1}^{N} Var\left(\bar{t}_{iT}(p_i)\right)}} \to N(0,1) \quad (27)$$

Table 1. Panel unit root tests

First generation		Second generation	
Nonstationarity tests	Stationarity tests	Nonstationarity tests	Stationarity tests
Im et al. (2003)	Hadri (2000)	Pesaran (2007)	Bai and Ng (2005)
Levin et al. (2002)		Moon and Perron (2004)	Harris et al. (2005)
Choi (2001)		Bai and Ng (2004)	
Breitung (2000)		Chang (2002)	
Maddala et al. (1999)			

(see Tugcu, 2018)

The expressions for the expected mean and variance of the ADF regression *t*-statistics, $E\left(\bar{t}_{iT}(p_i)\right)$ and $Var\left(\bar{t}_{iT}(p_i)\right)$, have been computed by IPS via simulation for various values of T and p.

The Maddala and Wu (1999) panel unit root test is inspired in a Fisher type test that combines P-values from unit root tests for each cross-section i.

The Maddala and Wu (MW) unit root test is defined as

$$P = -2\sum_{i=1}^{N} \ln P_i \tag{28}$$

Where P being distributed as χ^2 with $2N$ degrees of freedom as $T_i \to \infty$ for all N.

Least Square dummy variable (LSDV)

We apply Bruno's (2005) bias-corrected least-square dummy variable estimator, developed for short dynamic panels with fixed effects, and extended to accommodate unbalanced data. When we consider the nature of dataset, this seems to be a solid choice.

A strategy to correct for the fixed effects is to draw them out of the error term by entering dummies for each individual-the so called least-square dummy variables (LSDV) estimator. Since pioneer paper by Nickell (1981), where he shows that the LSDV estimator is not consistent for finite T in autoregressive panel-data models, a number of consistent instrumental variable (IV) and generalized method of moments (GMM) estimators have been proposed in the econometric literature as an alternative to LSDV. Anderson and Hsiao (1982); Arellano-Bond (1991); Blundell-Bond (1998) suggest IV-GMM estimators. Then Kiviet (1995) use asymptotic expansion techniques to approximate the small sample bias of the LSDV estimator to also include terms of at most order $N^{-1}T^{-1}$, so offering a method to correct the LSDV estimator for samples where N is small or only moderately large.

Bun and Kiviet (2003) analyze the accuracy of Kiviet's (1998) approximation using simpler formulas. Judson and Owen (1999), using a Monte Carlo simulation show that the corrected LSDV estimator (LSDVC) is strongly supports compared to more traditional GMM estimator when N is only moderately large. However, the LSDVC for an unbalanced panel has not yet been implemented.

We present here the LSDVC estimator building upon the theoretical estimation formulas in Bruno (2005) and estimates a bootstrap variance covariance matrix for the corrected estimator.

Consider the standard autoregressive panel data model (see Stojkov and Warin, 2016; Bruno, 2005):

$$y_{it} = \gamma y_{i,t-1} + x_{it}'\beta + \eta_i + \varepsilon_{it}$$

$$i = 1,\ldots,N \text{ and } t = 1,\ldots,T \tag{29}$$

Where y_{it} is the dependent variable; x_{it} is the $\left((k-1)\times 1\right)$ vector of strictly exogenous explanatory variable; η_i is an unobserved individual effect and ε_{it} is an unobserved white noise disturbance.

Collecting observations over time and across individuals gives

$$y = D\eta + W\delta + \varepsilon \tag{30}$$

Where y is the $(NT\times 1)$ vector of observations for the dependent variable; $D = I_N \otimes \iota_T$ is the $(NT\times N)$ matrix of individual dummies, with ι_T being the $(T\times 1)$ vector of all unity elements; η is the $(N\times 1)$ vector of individual effects; $W = \left[y_{-1} \vdots X\right]$ is the $(NT\times k)$ matrix of explanatory variables; y_{-1} is y lagged one time; X is the $\left(NT\times(k-1)\right)$ matrix of strictly exogenous explanatory variables; ε is the $(NT\times 1)$ vector of white noise disturbances; $\delta = \left[\gamma \vdots \beta'\right]'$ is the $(k\times 1)$ vector of coefficients.

Finally, with an increasing level of accuracy, the following three possible bias approximations emerge:

$$B_1 = c_1\left(\bar{T}^{-1}\right);\ B_2 = B_1 + c_2\left(N^{-1}\bar{T}^{-1}\right);$$

$$B_3 = B_2 + c_3\left(N^{-1}\bar{T}^{-2}\right) \tag{31}$$

In principle, bias-corrected LSDV estimators could be obtained by subtracting any of the above terms from LSDV. In practice, however, depending upon the unknown parameters σ_ε^2 and γ approximations (31) are not feasible for bias correction. Nevertheless, consistent estimators for σ_ε^2 and γ plugging them into the bias-approximations formulas, and the subtracting the resulting bias approximation estimates, $\hat{B}_i$ from LSDV as follows:

$$LSDVC_i = LSDV - \hat{B}_i \quad i = 1,\ 2,\ \text{a n} \tag{32}$$

Possible consistence estimators for γ are AH, AB, BB for example. Depending on the estimator of choice for γ, say h, a consistent estimator for σ_ε^2 is then given by:

$$\sigma_h^2 = \frac{e_h' M_s e_h}{(N-k-T)} \tag{33}$$

Where $e_h = y - W\delta_h$ and $h = AH, AB, BB$.

To analyze the influence of demographic and economic variables on economic growth, we then use the bias corrected least square dummy variable method.

2.3. Variable Construction and Data

Following Ahmad and Khan (2018) and regarding the theoretical and econometric modeling, the variable of GDP per-capita growth rate is used as a proxy for economic growth, gross capital formation as a proxy capital stock, total labor force, working-age population, total population, labor force participation ratio, life expectancy, education expenditures, health expenditures, female labor force participation rat, agriculture productivity and trade openness. Others variables could be adding but we cannot take all of them. In order to quantify the effect on human capital on economic performance, the empirical literature use different measures of human capital. These are most frequently the mean years of schooling (see Barro and Lee, 1996; Basu et al., 2013), literacy rate (see Benhabib and Spiegel, 1994), school enrolment rate (see Mankiw and al., 1992). The empirical literature shows that the quality of human capital should be taken into consideration (see Jones and Schneider, 2006). For that, two adjustments have been made (see Ahmad and Khan, 2018) in total mean years of schooling of population in 15 plus years' age group. Firstly, the non-working people and unemployed labor have been excluded from the data:

E_{it} = mean years of schooling × labor force × labor force participation rate

Secondly, human capital variable is used in three forms, i.e., level form, difference form and lagged form. The age-structure dynamics is represented by the ratio of working-age population to total population. The data of working-age population and total population has been transformed into working-age population ratio like this:

Working-age population ratio (W/P) = Working-age population/ Total population.

Variables have been taken from World Development Indicators (WDI). We use annual data from 1990 to 2020 considering 15 Economic Community West African States (ECOWAS) countries which are: Benin, Burkina Faso, Capo-Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo. The variables of education expenditures (EE) and health expenditures (HE) are the public expenditures in education and health sectors in percentage of GDP form. The agriculture productivity (AP) is taken in the form of agriculture value added percentage of GDP. Finally, the data of openness (trade, percent of GDP) was also collected from WDI.

3. Empirical Results and Discussion

This section presents the summary analysis, the cross-sectional dependence and unit root tests and then the estimation results and discussions.

Table 2. Descriptive statistics

Variables	Obser	Mean	St. Dev.	Min.	Max.
GDP per capita growth rate (Y_{it})	434	1.325	4.468	-29.461	21.027
Human capital (E_{it})	434	23.469	1.351	20.637	26.477
Change in human capital (ΔE_{it})	420	0.033	0.070	-0.527	0.340
Growth rate of gross capital stock ($g_{K_{it}}$)	434	19.862	9.104	-2.424	53.186
Growth rate of labor force ($g_{N_{it}}$)	433	7.964	96.338	-98.524	18.426
Labor force participation ratio (Z_{it})	434	4.186	0.124	3.852	4.443
Population growth rate ($g_{P_{it}}$)	433	8.456	103.250	-98.383	20.448
Working-age population ratio (X_{it})	434	11.373	1.348	-14.690	-8.112
Trade openness (TO_{it})	434	4.022	0.336	3.031	4.878
Life expectancy ($g_{L_{it}}$)	433	0.001	0.029	-0.275	0.025
Education expenditures (EE_{it})	434	3.066	0.436	1.615	4.180
Health expenditures (HE_{it})	434	1.809	0.472	0.470	3.427
Youth dependency ratio (DR_{it}^{y})	434	4.429	0.141	3.733	4.668
Agriculture productivity (AP_{it})	434	7.178	0.628	5.781	8.641
Old dependency ratio (DR_{it}^{o})	434	1.746	0.159	-14.690	-8.112

Table 3. Correlation matrix analysis

Variables	Y_{it}	X_{it}	Z_{it}	$g_{N_{it}}$	$g_{P_{it}}$	$g_{K_{it}}$	$g_{L_{it}}$	TO_{it}	EE_{it}	HE_{it}	AP_{it}	ΔE_{it}	E_{it}	DR_{it}^{y}	DR_{it}^{0}
Y_{it}	1.000														
X_{it}	-0.003*	1.000													
Z_{it}	-0.020*	0.041	1.000												
$g_{N_{it}}$	-0.042	-0.046	0.027	1.000											
$g_{P_{it}}$	-0.046	-0.045	0.023	0.992*	1.000										
$g_{K_{it}}$	0.166*	-0.166*	-0.104*	-0.048	-0.047	1.000									
$g_{L_{it}}$	0.125*	0.001	-0.048	-0.265*	-0.268*	-0.125*	1.000								
TO_{it}	0.160*	0.305*	-0.255*	-0.022	-0.019	0.195*	-0.025	1.000							
EE_{it}	-0.062	0.121*	0.193*	0.068	0.066	-0.237*	-0.114*	-0.061	1.000						
HE_{it}	0.042	0.204*	0.245*	0.028	0.033	-0.078	0.036	-0.031	0.023	1.000					
AP_{it}	0.051	-0.077	-0.529*	0.057	0.052	0.140*	-0.048	0.305*	-0.118*	0.059	1.000				
ΔE_{it}	0.225*	0.016	0.132*	0.227*	0.139*	-0.009	0.035	-0.017	0.011	0.042	-0.206*	1.000			
E_{it}	0.043	-0.974*	0.059	0.050	0.047	0.178*	0.010	-0.254*	-0.110*	-0.152*	0.068	0.012	1.000		
DR_{it}^{y}	-0.047	-0.118*	0.303*	0.005	0.009	-0.341*	0.076	-0.514*	0.054	-0.164*	-0.633*	0.144*	0.117*	1.000	
DR_{it}^{0}	0.154*	0.473*	-0.040	-0.045	-0.040	0.200*	-0.031	0.233*	0.052	0.170*	-0.001	0.057	-0.468*	-0.145*	1.000

Note: * represents significant at 5% level.

Table 4. Residual CD test

Test	Statistic Eq. 13	Statistic Eq. 14	Statistic Eq. 15	Statistic Eq. 16	Statistic Eq. 17
$LM_{BP}(BP,1980)$	120.195	104.107	104.538	107.029	107.031

Notes: The null hypothesis is no cross section dependence.

Table 5. MW (1999) and IPS (2003) panel unit root tests

	Intercept only			
	Number of lags			
Variables in levels	MW lags (0)	MW lags (1)	MW lags (2)	IPS
Y_{it}	295.230***	133.641***	91.528***	106.968***
X_{it}	601.826***	85.781***	74.301***	66.074***
Z_{it}	7.982***	17.469***	24.037***	18.468**
$g_{N_{it}}$	0.760***	37.005***	44.805***	41.303**
$g_{P_{it}}$	1.020***	95.274***	353.046***	57.640***
$g_{K_{it}}$	539.692***	230.414***	142.852***	115.814***
$g_{L_{it}}$	263.158***	219.114***	181.102***	225.784***
ΔE_{it}	282.697***	106.038***	72.129***	37.549
TO_{it}	77.869***	39.611*	41.126**	45.727**
EE_{it}	88.452***	59.651***	63.826***	51.985***
HE_{it}	33.320**	29.682***	29.490***	36.882**
AP_{it}	22.085***	13.274***	15.128***	13.528***
DR_{it}^{y}	34.013***	24.260***	17.458**	14.456***
DR_{it}^{0}	58.453***	59.115***	53.791***	32.979

Notes: ***, ** and * represent 1%, 5% and 10% rejections respectively.

Table 6. MW (1999) and IPS (2003) panel unit root tests

	Intercept and trend			
	Number of lags			
Variables in levels	MW lags (0)	MW lags (1)	MW lags (2)	IPS
Y_{it}	260.730***	123.000***	72.780***	80.379***
X_{it}	119.156***	100.584***	71.615***	67.535***
Z_{it}	7.222***	22.444**	44.456**	55.540***
$g_{N_{it}}$	0.938**	21.313***	27.615***	28.167***
$g_{P_{it}}$	0.220***	124.125***	228.034***	13.822**
$g_{K_{it}}$	455.398***	181.752***	125.947***	77.601***
$g_{L_{it}}$	196.238***	2.961***	14.811***	4.493***
ΔE_{it}	246.152***	86.617***	61.691***	31.741**
TO_{it}	82.311***	46.694**	36.989*	59.719***
EE_{it}	76.522***	42.951**	44.398**	39.237**
HE_{it}	17.339***	11.537*	12.959**	20.665**
AP_{it}	127.813***	34.766***	12.801**	10.291***
DR_{it}^{y}	44.027***	45.623***	36.296**	19.091**
DR_{it}^{0}	55.021***	59.297***	56.505***	35.175***

Notes: ***, ** and * represent 1%, 5% and 10% rejections respectively.

3.1. Summary Analysis

Table 2 reports the descriptive statistics for all variables used in the panel regressions. The mean value GDP per-capita growth rate is 1.325, which is between -29.461 and 21.027 with a standard deviation of 4.468. This mean value suggests that in ECOWAS, the GDP per capita growth rate is 1.325 annually. The average of human capital is 23.469, with a variability of 1.351, ranges between 20.637 and 26.477. The change in human capital has mean score of 0.033, which as minimum and maximum values of -0.527 and 0.340 respectively and variability of 0.07. The growth rate of gross capital formation has mean value of 19.862 and variation of 9.104, which ranges between -0.527 and 0.340. The growth rate of labor force has mean value of 7.964 and a standard deviation of 96.338, which is between -98.524 and 18.426. On average, the labor force participation ration, the population growth rate, the working-age population ration, the trade openness have mean values of 4.186, 8.456, 11.373, 4.022 respectively and standard deviation of 0.124, 103.250, 1.348, 0.336 respectively. In the end, life expectancy, education expenditures, health expenditures, youth dependency ratio and agriculture productivity have mean values of 0.001, 3.066, 1.809, 4.429 and 7.178 respectively with standard deviation of 0.029, 0.436, 0.472, 0.141 and 0.628 respectively.

Table 3 presents the correlation matrix. As we can see, most of variables are statistically significant at 5% level. Growth rate of capital stock, the growth rate of life expectancy, trade openness and the change in human capital are positively correlated with GDP per-capita growth suggesting that increases in these variables increases the growth rate in ECOWAS. In contrast, the youth dependency ratio, old dependency ratio and the population growth rate are negatively and statistically significant at 5% level of significance.

3.2. Cross Section Dependence Test

We first test for the cross-section dependence using Breusch-Pagan (1980) test because $N < T$. Table 4 shows statistics for cross-section independence in residuals of a fixed effect regression model under the null hypothesis of cross-section independence. The test use the residuals obtained from Eq. (13), Eq. (14), Eq. (15), Eq. (16) and Eq. (17). Results could not reject the null hypothesis of cross section independence. Thus, the absence of cross-section dependence (CD) makes the standard panel unit root tests appropriate.

3.3. Unit Root Tests

In table 5 and 6, we report the results of Maddala and Wu (1999) panel unit root test without trend and with trend at lag orders $p = 0,1,2,3$. These lags allow us to control for possible serial correlation in data. The results reveals that GDP per-capita growth rate, working age population ratio, labor force participation ratio, growth rate of total labor force, growth rate of population, growth rate of capital stock, growth rate of life expectancy, trade openness, education expenditures, health expenditures, agriculture productivity, difference of human capital, youth dependency ration and old dependency ratio are non-stationary at levels and stationary at first difference as well as without trend and with intercept and linear trend (generally with lags 0 and 1).

3.4. Empirical Linear Regression Analysis

One of efficient method to estimate the impact of demographic transition and human capital on economic growth is the panel data estimation. The use of panel data estimation provides several advantages: better estimates with large sample size, control for unobservable and immeasurable variables, control for individual heterogeneity and it tackles address the omitted variable bias problem (Ahmad and Khan, 2018). In this work, we apply LSDVC (AH), LSDVC (AB) and LSDVC (BB) estimates. Tables 7 shows results of the linear regression between economic growth, demographic transition and human capital variables through three differents specifications: the first specification displays empirical results of the baseline regression in columns 1, 2 and 3 (Eq. 13) and the second reported in columns 4, 5 and 6 (Eq. 14) and the third in columns 7, 8 and 9. We replicated 100 repetitions using a bootstrap procedure to produce the estimated standard errors. Furthermore, in order to save space, we will only interpret LSDVC (BB) results.

A common finding for all specifications is the significance of the lagged dependent variable which is positive and statistically significant at 5% level, suggesting that GDP per-capita effect in ECOWAS countries is persistent. But the hypothesis of conditional convergence in ECOWAS countries is rejected because of non-negative coefficient of the lagged dependent variable of GDP per-capita (0.068; 0.060; 0.056; 0.058 and 0.055 respectively for specifications 1,2,3,4 and 5). This result is in line with those of Dufrénot and al. (2006) and Jalloh (2012).

Table 7. Influence of demographic transition and human capital on economic growth (Eq.13-14-15) using LSDVC

Dependent variable: GDP per-capita growth									
	Specification 1			Specification 2			Specification 3		
	(AH)	(AB)	(BB)	(AH)	(AB)	(BB)	(AH)	(AB)	(BB)
GDP per-capita growth rate $Y_{i,t-1}$	0.065*** (0.053)	0.063*** (0.052)	0.068*** (0.052)	0.058*** (0.053)	0.054*** (0.051)	0.060*** (0.051)	0.050*** (0.053)	0.048*** (0.052)	0.056*** (0.051)
Demographic variables									
Working age pop ratio x_{it}	3.650*** (1.258)	3.722*** (1.226)	3.762*** (1.288)	4.167** (2.106)	4.707*** (1.421)	4.789*** (1.492)	4.543** (1.964)	4.830*** (1.434)	4.900*** (1.499)
Labor force participation ratio Z_{it}	-0.146** (0.078)	-0.162** (0.074)	-0.165** (0.078)	-0.020 (0.158)	-0.021 (0.106)	-0.017 (0.111)	-0.002 (0.145)	-0.001 (0.107)	0.002 (0.112)
Growth rate of total labor force $g_{N_{it}}$	-0.001 (0.266)	-0.006 (0.256)	-0.003 (0.261)	-0.710 0.437	-0.713** (0.293)	-0.708** (0.299)	-0.691* (0.397)	-0.690** (0.291)	-0.685** (0.297)
Growth rate of pop $g_{P_{it}}$	1.653** (0.852)	1.677** (0.814)	1.721** (0.852)	2.094* (1.194)	2.099*** (0.790)	2.171*** (0.828)	1.967* (1.102)	1.977** (0.798)	2.056** (0.833)
Economic variables									
Growth rate of capital stock $g_{K_{it}}$	0.361** (0.617)	0.384** (0.596)	0.390** (0.617)	0.825** (0.846)	0.844*** (0.571)	0.843*** (0.587)	0.732** (0.818)	0.731*** (0.601)	0.735*** (0.616)
Growth rate of life expectancy $g_{L_{it}}$				47.433*** (15.750)	47.202*** (10.580)	47.016*** (10.791)	48.518*** (14.559)	48.251*** (10.689)	48.004 (10.867)
Trade openness TO_{it}				0.512** (0.923)	0.689** (0.275)	0.728* (0.327)	0.185** (0.774)	0.366* (0.285)	0.419*** (0.335)
Education expenditures EE_{it}				0.606 (0.944)	0.535 (0.626)	0.589 (0.644)	0.681 (0.874)	0.602 (0.633)	0.664 (0.650)
Health expenditures HE_{it}				0.421* (0.776)	0.419* (0.511)	0.406* (0.522)	0.396** (0.719)	0.406* (0.517)	0.390** (0.525)
Agriculture productivity AP_{it}				1.131 (1.597)	1.749* (1.044)	1.895* (1.094)	0.765* (1.566)	1.343** (1.116)	1.510*** (1.510)
Difference of human capital ΔE_{it}				17.509*** (5.532)	17.326*** (3.690)	17.251*** (3.758)	16.840*** (5.004)	16.963*** (3.658)	16.919*** (3.712)
Level of human capital E_{it}							1.285** (1.165)	0.944** (0.821)	0.904** (0.868)

Notes: ***, ** and * denote 1%, 5% and 10% level of significance respectively. Bootstrapped standard errors using 100 iterations are in parenthesis (Bruno, 2005). Bias correction initialized by Anderson-Hsiao (1982), Arellano-Bond (1991) and Blundell-Bond (1998) estimators. Bias approximation is accurate up to O($1/NT^2$).

Table 8. Influence of demographic transition and human capital on economic growth (Eq.16-17)

Dependent variable: GDP per-capita growth						
	Specification 4			Specification 5		
	LSDVC(AH)	LSDVC(AB)	LSDVC(BB)	LSDVC(AH)	LSDVC(AB)	LSDVC(BB)
GDP per-capita growth rate $Y_{i,t-1}$	0.053*** (0.052)	0.050*** (0.051)	0.058*** (0.051)	0.048*** (0.053)	0.044*** (0.051)	0.055*** (0.051)
Demographic variables						
Lagged value youth dependency ratio DR_{it}^{y}	7.675 (5.790)	8.256** (4.022)	9.004** (4.261)	7.025 (5.776)	7.677** (3.973)	8.155** (4.437)
Lagged value old dependency ratio DR_{it}^{0}	2.649 (6.471)	1.771 (4.471)	1.592 (4.742)	1.216 (6.599)	0.326 (4.513)	0.300 (5.058)
Growth rate of total labor force $g_{N_{it}}$	-0.793* (0.414)	-0.790*** (0.290)	-0.782*** (0.297)	-0.647 (0.423)	-0.645** (0.294)	-0.644** (0.320)
Growth rate of pop $g_{P_{it}}$	2.259* (1.254)	2.256** (0.877)	2.278** (0.924)	2.108* (1.260)	2.111** (0.874)	2.138** (0.973)
Economic variables						
Growth rate of capital stock $g_{K_{it}}$	0.457 (0.978)	0.461** (0.312)	0.474** (0.709)	0.795* (0.013)	0.795** (0.707)	0.797** (0.770)
Growth rate of life expectancy $g_{L_{it}}$	48.829*** (14.315)	48.463*** (10.071)	48.121*** (10.305)	45.954*** (14.345)	45.588*** (10.002)	45.676*** (10.908)
Trade openness TO_{it}	1.445** (1.885)	1.641** (1.312)	1.664* (1.374)	1.483** (1.882)	1.683** (1.298)	1.646** (1.421)
Education expenditures EE_{it}	0.849 (0.916)	0.764 (0.639)	0.811 (0.658)	0.852 (0.913)	0.767 (0.630)	0.800 (0.686)
Health expenditures HE_{it}	0.442** (0.756)	0.448*** (0.523)	0.469*** (0.540)	0.248* (0.773)	0.265** (0.530)	0.250** (0.575)
Agriculture prod.	0.734* (0.293)	1.350** (0.895)	1.487** (0.943)	-0.493* (1.418)	0.190** (0.971)	0.318** (0.077)
Difference of human capital ΔE_{it}	16.072*** (5.420)	16.241*** (3.792)	16.186*** (3.885)	18.162*** (5.591)	18.271*** (3.860)	18.140*** (4.181)
Level of human capital E_{it}	1.605* (1.392)	1.200* (0.937)	1.187* (0.999)	0.520** (1.589)	0.151* (1.061)	0.167** (1.199)
Lag of human capital $E_{i,t-1}$				0.608** (0.295)	0.580*** (0.208)	0.590** (0.231)

Notes: ***, ** and * denote 1%, 5% and 10% level of significance respectively. Bootstrapped standard errors using 100 iterations are in parenthesis (Bruno, 2005). Bias correction initialized by Anderson-Hsiao (1982), Arellano-Bond (1991) and Blundell-Bond (1998) estimators. Bias approximation is accurate up to O($1/NT^2$).

In model specification 1, working-age population ratio and the growth rate of capital stock have shows a positive and significant effect on economic growth while labor force participation ratio shows a negative effect on economic growth. The growth rate of total labor force has an insignificant effect on GDP per-capita growth which confirms the findings of Ahmad and Khan (2018) who found a positive effects of working-age population ratio, growth rate of labor force and growth rate of capital stock with an insignificant effect of labor force participation ratio on economic growth. The growth rate of population has a positive and significant effect on economic growth rate corroborating the findings of Gubry and Wautelet (1993) and Kelly and Schmidt (2005) who found a positive impact of population on the GDP growth in developing countries.

In model specification 2, we include the difference (change) of human capital. Working-age population ratio and growth rate of population present a positive and statistically significant effect on economic growth while the growth rate of total labor force has a negative and statistically negative effect on economic growth. All the control variables (growth rate of capital stock, growth rate of life expectancy, trade openness, health expenditures and agriculture productivity) indicate positive and significant effect on economic growth. Only education expenditures are not significant according to LSDVC (AH), LSDVC (AB) and LSDVC (BB). The variable of change in human capital has a high significant effect on economic growth. This result is similar to Bloom and al. (2009).

The model specification 3 includes the level of human capital which indicates a positive and significant effect on economic growth like Coulombe and al. (2009) and Lucas (1988). Once again, working-age population ratio and growth rate of population have a positive and significant effect on economic growth but the growth rate of total labor force has a negative and statistically negative effect on economic growth. Control variables lead to a positive effect on GDP per-capita growth except for education expenditures. The change of human capital keeps it sign like in specification 2.

In model specification 4 and as suggested by the theory, dependency ratios are added instead of working-age population ratio and labor force participation ratio. Youth and old dependency ratios are then adding. Surprisingly, the lagged value of youth dependency ratio has a positive and significant effect on GDP per-capita growth in ECOWAS while some studies found a negative and significant effect. This result can be explained by the fact that the ratio of youth dependency is weak in ECOWAS countries because in rural or urban areas, young people begin working early in life. Old dependency ratio has an insignificant effect on economic growth. Growth rate of total labor force has negative effect on economic growth rate and all the rest of variables are significant and positive except for education expenditures.

In model specification 5, the lagged value of human capital is adding because theoretically, the human capital accumulation in a previous time period may be important for economic growth in the current time period. Then the lagged value of human capital exerts a positively significant influence on economic growth. The rest of variables have the same signs like in specification 4.

4. Conclusions

The aim of this paper is to analyze the influence of demographic transition and change in human capital on economic growth in ECOWAS countries using annual data covering the period from 1990 to 2020. The neoclassical growth model augmented for demographic and human capital dynamics have been used to estimate empirically these variables influence on economic growth. to analyze the dynamic panel data, the Bruno's (2005) bias-corrected least-square dummy variable estimator is used with three alternative initial estimators: Anderson-Hsiao, Arellano-Bond and Blundell-Bond.

As it can be seen, the working-age population ratio and population growth rate have a positive influence on economic growth for all specifications at different magnitudes. The negative and significant value of labor force participation ratio in model specification 1 become insignificant in model specifications 2 and 3 while the growth rate of total labor force insignificant in model specification 1 become significant and contributing negatively to economic growth in specifications 2 and 3. According to dependency ratios, the lagged value of youth dependency ratio leads to a positive effect on economic growth and the lagged value of old dependency ratio is insignificant.

The economic variables (growth rate of capital stock, growth rate of life expectancy, trade openness, education expenditures, health expenditures agriculture productivity) used as control variables exercise positive and statistically significant effect on economic growth except for education expenditures variable which is insignificant.

For human capital, the results show that the change in human capital, the human capital in level form and the lagged value of human capital have a positive and significant effect on economic growth. Finally, the coefficient of lagged value of GDP per-capita is non-negative. For this purpose, the conditional convergence hypothesis is rejected for each specification. The human capital dynamic and demographic transition have an important role on economic growth. Policy makers should create a dynamic labor market to insert youth people who will have working-age. Other policy is to invest in formation in order to grow and accumulate working-age population qualifications.

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