International Journal of Economics and Financial Issues

ISSN: 2146-4138

available at http: www.econjournals.com

International Journal of Economics and Financial Issues, 2017, 7(3), 352-361.

From Population Age Structure and Savings Rate to Economic Growth: Evidence from Ecuador

Joel Alejandro Rosado[1]*, María Isabel Alvarado Sánchez[2]

[1]Faculty of Social Sciences and Humanities, Escuela Superior Politécnica del Litoral, Campus Gustavo Galindo Km 30.5 Vía, Perimetral, Guayaquil, Ecuador, [2]Faculty of Social Sciences and Humanities, Escuela Superior Politécnica del Litoral, Campus Gustavo Galindo Km 30.5 Vía, Perimetral, Guayaquil, Ecuador. *Email: jarosado@espol.edu.ec

ABSTRACT

This paper studied the relationship between the dependency ratio (DR), savings rate (SR) and real gross domestic product (GDP) for Ecuador for the period 1975-2015. Starting with the unit root tests given the use of time series and the cointegration results, the dynamic ordinary least squares and fully modified ordinary least squares (FMOLS) were used to show the relationship between the variables in the long-run. In the short-run, vector error correction model was applied to estimate the relationship. In several degrees, the long-run relationship between the DR, SR and real GDP was proved; Granger causality tests show a one-way causality running from the SR to GDP per capita. The interaction between the variables in the post-sample period is also forecast using impulse response functions and variance decomposition analysis. The overall result implies that changes in population age structure had a significant impact on real GDP per capita in Ecuador. However, this advantage of the age structure may disappear soon due to the projected rapid increase in the DR because of ageing of the population which may lead to a slowdown in the GDP growth.

Keywords: Cointegration, Dependency Ratio, Gross Domestic Product, Impulse Response Functions, Savings Rate, Structural Breaks, Variance Decomposition

JEL Classifications: J11, J14, O11

1. INTRODUCTION

In an empirical context, population growth could be considered to have a positive impact on economic growth. Specifically, population changes could have a powerful impact on economic growth. However, in the existent literature, the relationship between population changes and economic growth has been widely investigated but there are findings of both positive and negative relationships continuing debate about the real effects of demographic changes on economic growth. From our point of view, the sign of the relationship comes clearly related to the context of the country of study, but many scholars posed two distinct views: Those who believe population changes restrict economic growth (Barro, 1991; Mankiw et al., 1992; Solow, 1956; Mason, 1988; Smith, 1776) and those who believe it promotes economic growth (Boserup, 1965; Kremer, 1993; Simon, 1976; Kuznets, 1960, 1967; Grossman and Helpman, 1991).

There are strong opinions in which it is considered that the population increase can lead to a reduction of the available resources, reasoning that leads them to think that the changes in the population impede the economic growth. Malthus (1826) with his population theory, considered that the changes in the population follow a rhythm of growth similar to the per capita output growth. Solow (1956) supported this assumption by considering that population growth would be detrimental to economic growth. While Smith (1776) considered that economic growth can be a consequence of economic growth and not a cause.

On the other side of the coin, and under the assumption that a larger population drives innovation and in turn drives economic growth, we can mention Kuznets (1960) who highlighted the positive effects of changes in population on economic growth through increased production, consumption and savings. We can also mention Kremer (1993) who found a positive relationship between larger populations and faster improvements in living standards. Contributions such as those of Ehrlich and Lui (1997), Feyrery (2002) and Landreth and David (2002), provide evidence under which demographic changes have little economic impact.

Demographic variables that can potentially affect an economy such as fertility rate, life expectancy, population size, population growth and population density, which have been fully investigated in the literature, however, these variables alone cannot capture the full effect, since each capture only one part of the demography of a population. In our research design, dependency ratio (DR) which represents the age structure of a population can capture the overall impact of demographic changes in an appropriate way, taking account that may be considered as an index of population age structure and could be a good way to explore the effects of changing demographics on economic performance.

A few researchers have considered the DR a key variable in their studies on economic growth (Uddin et al., 2016; Wei and Hao, 2010; Fang and Wang, 2005). Prskawetz et al. (2004) found that DR instead of the growth rate of a population is that the growth of the working-age population is affected by the level of savings. Meanwhile, Bloom et al. (2003a) confirmed that the level of savings is affected by the population age structure. This study uses the DR as a proxy for demographic changes and savings rate (SR) changes in order to study their effect on the economic performance in Ecuador over the past 40 years trying to open this field to future research and given the null existence of a similar analysis in the Ecuadorian context.

This study uses non-stationary time series data for Ecuador for the period 1975-2015 to reveal the effects of population age structure and SR on economic growth. An analysis with similar characteristics has not been evidenced in Ecuador, which highlights the contribution of this research since its findings can be fundamental in the formulation of policies related to the population age structure and economic growth.

The Ecuadorian economy growth rate has gradually increased in the past decade with a decrease in recent semesters basically driven by high oil prices and through this to facilitate jobs in the public and private sectors. In the first trimester 2016, the economy decreased its growth rate to just under 1.9% with the most significant negative variation since 2007, so that the analysis of the behavior of economic growth from the changes in the population age structure has priority, even with the economic constraints currently facing Ecuador.

The remainder of this paper is organized as follows. Section 2 presents the review of the literature; Section 3 explains changes in the age structure of Ecuador's population over the study time period; Section 4 introduces the models, data and its sources and estimation strategies; Section 5 outlines and discusses the results of the study; and in Section 6 the conclusion of the study is presented.

2. REVIEW OF THE LITERATURE

The priority of the study of the population age structure has its preferential character from the findings that facilitate to know in which way affects the economic growth, considering that it can own different behavior in the different economies of the world. In addition, the population age structure and its impact on the economy has drawn much attention from researchers and policymakers from several disciplines. However, there are many theories about the way in which population age structure affects economic growth. In that sense, changes in population age structure affect the economy inversely, economic development itself has an impact on the population changes. The size of a population is not as important for economic development as either the age distribution or DR of the population (Macunovich, 2012; Guest, 2011).

There are many studies about the population and economic growth, with different findings. Mason (2003), found a negative correlation between the size of a population and economic growth meanwhile Kuznets (1960) observed that per capita output increased with increases in population. In the study of Kelley and Schmidt (2001), they found both positive and negative effects of population changes on economic growth.

From our perspective, it is not true that a population increase guarantees economic growth in a medium-term horizon of study, because it is more important to observe if this population growth is immersed that of the economically active population within the scenario of a country. Within this space of reasoning, Kelley and Schmidt (2005) estimated that total population has no impact on the economy as a whole, whereas changes in the age structure of a population have a significant impact. This is because an increase in total population does not necessarily indicate an increase in the labor force.

The population age structure has a positive effect on economic growth (Prskawetz et al. 2007; An and Jeon, 2006), but this conclusion was not supported in the Swedish context by de la Croix et al. (2009). Bloom et al. (2001) which showed that working age population, rather than total population, has a positive and significant effect on gross domestic product (GDP) per capita.

The study of the demographic structure and its influence on economic growth has been carried out both in the analysis of time series and in the analysis of panel data. In the panel data area, Bloom and Williamson (1998) investigated the nature and magnitude of the contribution of population age structure to economic growth for East Asia. They found that a decrease in the young DR contributed to economic growth in East Asia and they also showed that countries in South Asia are projected to gain from their age structure changes in future, which it was evidenced in the recent years. In the Irish case, demographic change also accounted for a large portion of economic performance in the 1990s (Bloom et al., 2003b). In contrast, Bloom et al. (2003a) explained that Africa's fertility transition contributed to its poor macroeconomic performance in the 1990s. This shows how the context of each country can change the relationship between economic growth and population age structure.

Kelley and Schmidt (1995) found that the young DR had a significant and positive effect on the growth rate of output per capita during the 1970s and 1980s in Europe, using panel data.

Similarly, Bloom and Williamson (1998) surmised that the working age population percentage has a greater impact on output per capita than does total population.

It is important to analyze in the Ecuadorian context how the relationship between population increase, SR and economic growth is, and what may be proposed in Barro's (1991) model is fulfilled, in which the growth rate of output per capita Is positively related to a lower fertility rate, which reduces the adverse impact rate that results from a high young DR. The SR may be influenced by population growth, due to the context of which it is invested in future generations, and this affected the economic growth. In that area, Mason (1988) showed that countries with a low DR have a higher SR, which is considered one of the driving forces of increases in income per capita. Similarly, Bloom et al. (2004) explained that increased longevity can lead to increased savings. However, an increase in longevity at the cost of low birth rates could affect economic growth in future periods.

In the present work, the signs of the variables used with the proposed methodologies, can indicate us about the acceptance of the DR hypothesis proposed by Leff (1969), which it mentions, that as the DR increases, the working generation falls into a heavier family consumption burden, which then decreases SRS. In addition, nations with a low DR devote more resources to investment, while those with a higher DR spend a large portion of their resources taking care of dependents.

Given the wealth and variety of econometric techniques to estimate relationships between variables, which may be applicable within the research design of the present work, previous work has used different approaches. For example, Bloom and Finlay (2009) employed a shift-share analysis to decompose the growth of income per capita. Weil (2007) used an alternative parametric approach; whilst on the other hand, An and Jeon (2006) used the non-parametric Kernel regression for estimation purposes. Palumbo et al. (2010) applied simple correlation with fixed effects estimation, while Savas (2008) used the autoregressive distributed lag approach. A few studies (Hsiao and Hsiao, 2006; Chowdhury and Mavrotas, 2006; Sakyi et al., 2012; Thuku et al., 2013) performed VAR estimation. To study the interrelationship between the DR, SR and the growth rate of real GDP per capita, this study uses a combination of three dynamic estimation models: Dynamic ordinary least squares (DOLS), fully modified ordinary least squares (FMOLS) and vector error correction model (VECM), to study the interrelationship between the DR, SR and the growth rate of real GDP per capita, which are widely accepted and used in different contexts with consistent estimates in the time series scenario.

3. CHANGES IN THE POPULATION AGE STRUCTURE OF ECUADOR

The size and structure of Ecuadorian's population over the past 50 years has been increase (INEC, 2016). Of the total population, 69.6% are of working age, 68.6% of the population of working age is economically active. The proportion of people in the older age groups is 5.9% (INEC, 2008) and the proportion hasn't an important change in the recent years. The population age structure in Australia is a constant proportion of elderly people (e.g., aged above 65 years).

However, the decrease in labor indicators is the worrying scenario, given its 4.08% decrease as of the first quarter of 2014 and its steady decline and unfavorable growth expectations for the current scenario (INEC, 2016).

A lower DR indicates a higher ratio of workers per capita and thereby a greater supply of labor for the economy. It also implies there are fewer people to feed and potentially more savings being accumulated for productive investment in the economy.

The working age group bears the responsibility for supporting the dependents. Thus, an increase (or decrease) in the number of dependents may increase (or decrease) the economic burden of the working age group. Furthermore, a smaller family size allows more investment in the education and health of children. Eventually, this results in more productive workers and increases in the stock of human capital in society.

A lower DR indicates a higher ratio of workers per capita and a greater supply of labor for the economy, in that scenario could there are fewer people to feed and potentially more savings being accumulated for productive investment in the economy. Thus, an increase (or decrease) in the number of dependents may increase (or decrease) the economic burden of the working age group. Furthermore, a smaller family size allows more investment in the education and health of children. Probably, this results in more productive workers.

4. MODEL, DATA AND ESTIMATION STRATEGIES

This study try to check two assumptions, first, that an increase in the DR creates a decrease in the GDP per capita, second, that the SR is positively related to the GDP. Then, to investigate these assumptions, the following econometric model which hypothesizes that log GDP per capita is a function of the DR and SR, was proposed:

$$\ln Y = \beta_0+\beta_1 DR_t+\beta_2 DR_t+\varepsilon_t \quad (1)$$

Where, the coefficients β_0, β_1 and β_2 represent the long-run elasticity estimates of log GDP per capita with respect to eh DR and SR. The data was obtained from the World Bank (2017), for the period 1975-2015.

SR is considered as a percentage of GDP and is calculated as gross national income less total consumption, plus net transfers, as shown in the following equation:

$$SR = \left(\frac{\text{Gross Savings}}{\text{GDP}}\right)\% = \left(\frac{\text{Gross national income} - \text{consumption} + \text{net transfers}}{\text{GDP}}\right)\% \quad (2)$$

The age DR is the ratio of dependents (people 14 years or younger, or 65 and older) to the working age population (those aged 15-64 years), as shown in the following equation:

$$DR = \left(\frac{\text{People younger than } 15 + \text{People older than } 64}{\text{Working age population } (15-65)} \right)\% \quad (3)$$

GDP per capita is GDP divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources and is adjusted for inflation and converted to international dollars using purchasing power parity rates, as shown in the following equation:

$$Y = \ln\left(\frac{GDP}{N}; \text{per capita GDP} \right) \quad (4)$$

In this study, we proposed an empirical methodology in eighth stages. Hence, in the first stage it was necessary to check whether the data is stationary or non-stationary, in that sense, the order of integration was established by implementing the Augmented Dickey-Fuller (ADF) unit root test (Dickey and Fuller, 1979) and the Kwiatkowski-Phillips-Schmidt-Shin unit root test (Kwiatkowski et al.,1992), considering that time series data estimation may give spurious results. The following regression equation shows how the ADF test was estimated with lagged difference terms:

$$\Delta y_t = \beta_0 + \beta_t + \lambda y_{t-1} + \sum_{j=1}^{\rho} \phi_j y_{t-j} + \varepsilon_t \quad (5)$$

Where β_0 is a constant, β_t is the coefficient on a time trend; ρ is the lagged difference term; and ε_t is the error term. If error term is homoscedastic, and establishing the null hypothesis as H_0:y = 0 and the alternative hypothesis as H_1:y<0, the ADF test examine the null hypothesis that a time series y_t is I(1) against the alternative that it is I(0). The KPSS test was used as a complementary tool to the ADF test, the null hypothesis is that the series being tested is stationary H_0:Y~I(0). The KPSS test statistic is shown in the next equation:

$$KPSS = \left(T^{-2} \sum_{t=1}^{T} \hat{S}_t^2 \right) / \hat{\lambda}^2 \quad (6)$$

The evidence from both tests is supportive of a unit root in the series if the ADF test fails to reject the null hypothesis, and the KPSS test rejects the null hypothesis. It is necessary to take first differences if the time series data are non-stationary in their levels but stationary with their first differences. The cointegration test needs to be applied as the second stage of the estimation process, we used the Johansen (1988) and Johansen and Juselius (1990) cointegration test. If the variables are found to be cointegrated, then it confirms a constant long-run relationship amongst the variables. As a third and fourth stage, the DOLS and FMOLS regressions were also applied to reinforce the results of cointegration.

The reason behind the use of the FMOLS and DOLS methods, instead of simple OLS, is that it accounts for small-sample bias and the poor significance levels sometimes experienced in the estimation process in the time series analysis, in addition, these methods take account the serial correlation and endogeneity in the regressors. Apart from correcting endogeneity and serial correlation, the FMOLS method asymptotically eliminates the sample bias in a semi-parametric way (Phillips and Hansen 1990; Phillips 1995), so it is used to support the consistency of the presented model.

As the fifth step, considering that neither the DOLS nor FMOLS estimator were able to reveal the short-run relationship between the variables. The VECM was used, in virtue of reveal both the short- and long-run relationship (Murphy, 2007). To check those relationships, the dynamic relationship between real GDP per capita (ln Y), the age DR and SR yielded a system of equations that can be explained through the following VECM (Uddin et al., 2016):

$$\Delta LY_{yt} = \beta_{yt} - \gamma_y \left(LY - \alpha_0 - \alpha_1 DR - \alpha_2 SR \right)_{t-1} + \sum_{i=p}^{j} \beta_{y,j} \Delta LY_{yt-p} + \sum_{i=p}^{j} \beta_{x,j} \Delta DR_{yt-p} + \sum_{i=p}^{j} \beta_{z,j} \Delta SR_{yt-p} + \varepsilon_{yt} \quad (7)$$

$$\Delta DR_{xt} = \beta_{xt} - \gamma_x \left(LY - \alpha_0 - \alpha_1 DR - \alpha_2 SR \right)_{t-1} + \sum_{i=p}^{j} \Delta LY_{xt-p} + \sum_{i=p}^{j} \Delta DR_{xt-p} + \sum_{i=p}^{j} \Delta SR_{xt-p} + \varepsilon_{xt} \quad (8)$$

$$\Delta SR_{zt} = \beta_{zt} - \gamma_z \left(LY - \alpha_0 - \alpha_1 DR - \alpha_2 SR \right)_{t-1} + \sum_{i=p}^{j} \Delta LY_{zt-p} + \sum_{i=p}^{j} \Delta DR_{zt-p} + \sum_{i=p}^{j} \Delta SR_{zt-p} + \varepsilon_{zt} \quad (9)$$

Where Δ is the differencing operator, such as $\Delta y_t = y_t - y_{t-1}$ and $y_t = \propto_0 + \propto_1 x_t + \propto_2 z_2$ is the long-run cointegrating relationship between the variables and γ_y, γ_x and γ_z are the short-run parameters; p denotes the number of lags.

As the sixth step, this study examined available stability tests of the model. The Breusch (1978) and Godfrey (1978) Lagrange multiplier (LM) test was used to verify the autocorrelation of the data. The presence of structural breaks throughout the period was also traced by a sequential Bai-Perron test (Bai and Perron, 2003), all this prior to implementing the VECM.

As a seventh step, we used a Granger causality test (Granger, 1969) with the following equation, given that the existence of a causal link among the variables is important for policy implications:

$$\begin{bmatrix} \Delta LY_t \\ \Delta DR_t \\ \Delta SR_t \end{bmatrix} = \begin{bmatrix} \sigma_1 \\ \sigma_2 \\ \sigma_3 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix} \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \end{bmatrix} \left[ECT_{-1} \right] + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \end{bmatrix} \quad (10)$$

Where Δ is the lag operator, and ECT_{-1} is the lagged error-correction term derived from the long-run cointegrating relationship. μ_{1t}, μ_{2t} and μ_{3t} are serially independent random error terms.

The optimal lag length p was based on the Johansen and Juselius (1990) maximum likelihood procedure. As the eighth step, interactions among the variables in the post-sample period was tested through impulse response function (IRFs) (Pesaran and Shin, 1998), given that the Johansen and Juselius (1990) causality test does not provide the dynamic properties of the system beyond the sample period. The IRFs trace the effect of a one standard deviation shock on the current and future values of all the endogenous variables, in addition, the variance decomposition analysis (VDC) was employed to examine the magnitude of the effects.

5. RESULTS

The results of the ADF unit root test are shown in Table 1. At level, the ADF test statistics for all the series are below the critical values (in absolute terms), this implies that there is no scope to reject the null hypothesis that the variables have unit root. At first difference, the values of the ADF test for all the series lies above the critical values, this implies that all the series are integrated of order one, i.e., I (1).

The results of the KPSS unit root test are shown in Table 2. The outcomes of the KPSS test are the opposite of the outcomes of the ADF test, which proves the presence of integration in the series. The KPSS test rejects the null hypothesis which try to prove stationarity, then the results clearly reveal that all the series are non-stationary. The values of the KPSS prove that all the series are integrated of order one, i.e., I(1).

After identifying the degree of integration, the next step is testing cointegration. At the initial stage, starting with the VEC model (equations 7-9) the estimation process requires the selection of the optimal lags usually determined by one or more of the "information criteria." Considering the final prediction error, Akaike information criterion (AIC), Schwarz information criterion (BIC) and Hannan-Quinn information criterion as options, the smaller the value of an information criterion, the better the result.

A maximum lag of 3 was chosen for the variables, given the VEC-based lag order selection results shown in Table 3. The results of the Johansen-Juselius cointegration test for the variables are summarized in Table 4. At the 5% level of significance, the value of the trace statistic and max statistic are statistically significant, indicating the presence of two cointegration equations. In this case, two cointegrating equations among real GDP per capita and its determinants is evident. Based on these results, the long-run relationship among the variables is established.

To reinforce the results of the cointegration test, this study tested two additional econometric estimation approaches. The results of the DOLS are shown in Table 5. The estimated long-run DR coefficient is −0.582567 and the SR coefficient is +0.162998. Both the coefficients have the expected sign and are significant at the 1% level. Although the expected signs and significant P-value of coefficients intensify the suitability, the Durbin-Watson statistic value of 0.371006 does not confirm the consistency of the model.

To eliminate endogeneity in the regressors and serial correlation in the errors the FMOLS estimator was used. The estimated coefficient lagged log GDP per capita, DR and SR are shown in Table 6. The estimated long-run DR coefficient is −0.547956 and the SR coefficient is +0.224164. Then, the negative sign and significant coefficient of the DR implies that changes in population age structure have an inverse relationship with economic growth, meanwhile, the positive sign and significant coefficient of the

Table 1: ADF unit root test results

Deterministic terms	Variables	Levels			1st differences		
		Test statistic	Critical value	Remarks	Test statistic	Critical value	Remarks
Intercept	lnY	0.983306	−2.936942		−5.566632*	−2.938987	I (0)
	DR	−1.936998	−2.938987	I (1)	−3.053953	−2.938987	I (0)
	SR	−2.073602	−2.936942	I (1)	−7.117749*	−2.938987	I (0)
Intercept and trend	lnY	−0.527329	−3.526609	I (1)	−6.035587*	−3.529758	I (0)
	DR	−3.021173	−3.526609	I (1)	−4.033212	−3.529758	I (0)
	SR	−2.677891	−3.526609	I (1)	−7.033212*	−3.529758	I (0)

The rest of the unit root test is carried out at the 5% of significance. lnY, DR and SR refers to lof real GDP, DR and SR, respectively. I (0) means integrated order zero and I (1) means integrated order one. *Indicates 1% level of significance, DR: Dependency ratio, SR: Savings rate, GDP: Gross domestic product, ADF: Augmented Dickey-Fuller

Table 2: KPSS unit root test results

Deterministic terms	Variables	Levels			1st differences		
		Test statistic	Critical value	Remarks	Test statistic	Critical value	Remarks
Intercept	lnY	81.203090*	0.463000	I (0)	0.381712	0.463000	I (1)
	DR	0.7290859*	0.463000	I (0)	2.022520*	0.463000	I (1)
	SR	4.734346*	0.463000	I (0)	0.042524	0.463000	I (1)
Intercept and trend	lnY	5.319296*	0.146000	I (0)	0.114097	0.146000	I (1)
	DR	2.397959*	0.146000	I (0)	0.470408*	0.146000	I (1)
	SR	0.967560*	0.146000	I (0)	0.036733	0.146000	I (1)

The rest of the unit root test is carried out at the 5% of significance. lnY, DR and SR refers to lof real GDP, DR and SR, respectively. I (0) means integrated order zero and I (1) means integrated order one. *Indicates 1% level of significance, DR: Dependency ratio, SR: Savings rate, GDP: Gross domestic product

Table 3: Lag order selection criteria results

Lag	LR	FPE	AIC	SC (BIC)	HQIC
0	-	0.00000221	−4.507800	−4.375840	−4.461742
1	367.2788	0.00000379	−15.48526	−14.95742*	−15.30103*
2	17.28421*	0.00000349*	−15.58127*	−14.65755	−15.25887
3	10.94212	0.00000389	−15.50212	−14.18252	−15.04155
4	11.98722	0.00000403	−15.52330	−13.80783	−14.92456

*Denotes lag order selected by each criterion, FPE: Final prediction error, AIC: Akaike information criterion, HQIC: Hannan-Quinn information criterion

Table 4: Johansen-Juselius test results

Hypothesized number of CE(s)	Trace test		Max test	
	Statistic	5% critical value	Statistic	5% critical value
r=0	71.31420	29.79707	36.46443	21.13162
r≤1	34.84978	15.49471	23.33611	14.26460
r≤2	11.51367*	3.841466	11.51367*	3.841466

*Denotes 5% level of significance

savings ratio implies that changes in the SR have a positive effect on economic growth.

The Durbin-Watson statistic value is 1.924492, which implies the correctness of serial correlation, opposite than the earlier DOLS results. In order to investigate both short-run and long-run relationships among the variables, the VEC model was estimated. The long-run equation showing the results of the VEC model is shown in Table 7.

The estimated parameters of the cointegrating vector are significant at 5% confidence level, which confirms the long-run relationship established by the Johansen-Juselius cointegration test. The percentage of the total variation in the dependent variable that is described for the independent variables is 89.26%. The coefficient of the DR (3.448972) and SR (0.694033) in the cointegrating equation are statistically significant and have the expected negative and positive sign, respectively. Then in the long run, a 1% decrease in the ratio of DR to real GDP per capita will lead to an increase of 3.448972% in per capita real GDP, meanwhile, an increase of 1% in the ratio of SR to real GDP per capita will lead to an increase of 0.694033% per capita real GDP.

The short-run adjustment parameters estimated through the VEC model are shown in Table 8. The adjustment parameters are correct in signs and significant at the 5% level, specifically, the short-run coefficient of real GDP per capita and the DR are significant in terms of their P-value.

The results of the Breusch-Godfrey LM test are shown in Table 9. The use of this test is because it is necessary investigate the problem of autocorrelation between the residuals of the model. The null hypothesis is not rejected at 1% of critical values for any lags, in that sense, there is no autocorrelation in the residuals of the model.

The results of the sequential Bai and Perron (2003) test are shown in Table 10. The use of this test is because it is necessary check if there are any structural breaks in the time series data and its impact on estimated parameters. At level, the sequential F-statistic determined three structural breaks but this problem was solved by differencing the data.

Table 5: DOLS method results

Dependent variable: Log GDP per capita (lnY)				
Variable	Coefficient	SE	t-statistic	P
DR	−0.582567	0.076161	−7.649099	0.0000
SR	0.162998	0.047505	3.431144	0.0015
Constant C	10.28350	0.419487	24.51447	0.0000
R-squared	0.791508	Mean dependent variance		8.293122
Adjusted R^2	0.780535	SD dependent variance		0.126825
SE of regression	0.059414	Sum squared residual		0.134139
Durbin-Watson stat	0.371006	Long-run variance		0.105027

SE: Standard error, SD: Standard deviation, DR: Dependency ratio, SR: Savings rate, DOLS: Dynamic ordinary least squares, GDP: Gross domestic product

Table 6: FMOLS method results

Dependent variable: Log GDP per capita (ln Y)				
Variable	Coefficient	SE	t-statistic	P
Log GDP per capita (lnY (−1))	0.839839	0.093129	9.017996	0.0000
DR	−0.547956	0.049365	−11.09999	0.0000
SR	0.224164	0.027612	8.118417	0.0000
Constant C	9.960591	0.266919	37.31689	0.0000
R^2	0.890129	Mean dependent variance		8.304020
Adjusted R^2	0.880434	SD dependent variance		0.125272
SE of regression	0.043317	Sum squared residual		0.063796
Durbin-Watson stat	1.924492	Long-run variance		0.001061

SE: Standard error, SD: Standard deviation, DR: Dependency ratio, SR: Savings rate, FMOLS: Fully modified ordinary least squares, GDP: Gross domestic product

Table 7: VEC model results

$\Delta LY_{t-1} = 21.77154 - 3.448972\Delta DR_{t-1} + 0.694033\Delta SR_{t-1}$			
Standard error		(6.21740)	(0.21386)
t-statistic		[0.55473]	[−3.24531]
R^2	89.26%		

The Granger causality test results based on VECM are shown in Table 11. Given the existence of a cointegrating relationship the Granger causality test was used to determinate the direction of the causality among the variables. The short-run causal effects can be obtained by the Chi-squared (χ^2) test statistics of the lagged differenced terms for explanatory variables, while the t-statistics on the coefficients of the lagged error-correction terms (ECT_{t-1}) indicate the long-run causal effect.

The results can reject the null hypothesis that the SR does not Granger-cause GDP per capita. Therefore, it appears that Granger causality runs one way from the savings ratio to GDP per capita and not the other way. The coefficient on the error correction term, ECT_{t-1}, measures the speed of adjustment to obtain equilibrium in the event of shock(s) to the system. The change in real GDP per capita is a function of disequilibrium in the cointegrating relationship, specifically, the lagged error correction term is negative and significant, which implies the series is non-explosive and the long-run equilibrium is attainable.

To compare results with the earlier estimated results, the IRFs were used, the Figure 1 shows the response of GDP per capita to a one standard deviation shock to the DR and SR, and the estimated two standard error boundaries are depicted as dashed lines.

The diagonal panels show the effects of shocks to each variable's growth on future values of its own growth. In this study, in the cases of "LY to LY" and "DR to DR" the shock does not die out, but for the case of "SR to SR," the shock dies out in an irregular nature. This result could be supportive of earlier results but is important to mention that the IRFs from a cointegrating VECM do not always die out.

A one standard deviation shock to GDP per capita in the top-left panel is almost 2%, a corresponding shock to the DR in the middle-diagonal panel and to SR in the bottom-right panel is 0.1% and 15%, respectively. In the top-middle panel, a one standard deviation shock in GDP per capita growth declines DR growth progressively every year. The initial response of GDP per capita to a unit shock in the DR is negative and but never dies out, which is referred to as permanent shock. The response of the DR to a unit shock in GDP per capita is positive and never dies. The initial response of the DR to SR is nearly neutral; meanwhile, the initial response of SR to DR is neutral.

Table 8: Short-run adjustment parameters by VEC model

Variables	Adjusted parameter	Coefficient	P value	Significance
D_lny	γ_{11}	−0.070599	0.07061	Yes
D_dr	γ_{21}	0.003291	0.00862	Yes
D_sr	γ_{31}	0.002128	0.00154	Yes

Table 9: LM autocorrelation test results

Lags	LM t-statistic	P value
1	20.03820	0.0177
2	8.495813	0.4851
3	5.143655	0.8216
4	4.921083	0.8411
5	11.03007	0.2737

Table 10: Sequential Bai-Perron test for structural breaks

Sequential F-statistics determined breaks: 3			
Break test	F-statistic	Scaled F-statistic	Critical value
0 versus 1*	111.5161	334.5484	13.98
1 versus 2*	5.689346	17.06804	15.72
2 versus 3*	8.752092	26.25628	16.83
3 versus 4	2.401191	7.203572	17.61

*Significant at the 5% level

5.1. VDCs Analysis

Figure 2 shows how each shock contributed to the variation in each variable. The left-column panels show the forecast errors for the log GDP per capita are comprised of 97% shocks to the log GDP per capita (LY), 1% shocks to the dependency rate (DR), and 2% shocks to the SR at a forecast horizon, the log GDP per capita declines gradually while the DR and SR changes at 7% and at 6% respectively, on average.

The middle-column panels show the forecast errors for the DR are comprised of 98% shocks to the DR, 2% shocks to the log GDP per capita (LY), and 1% shocks to the SR at a forecast horizon, on average. These values are not fixed, and as the DR decreases over time.

The right-column panels show the forecast errors for the SR are comprised of 96% shocks to the SR, 0% shocks to the DR, and 0% shocks to the log GDP per capita (LY), on average. These values are not fixed, and as SR decreases, the contribution of log GDP per capita and SR also changes at 15% and at 1%, respectively, on average.

6. CONCLUSIONS

In this paper was examined the literature referent about how changes in population age structure may influence GDP per capita. In that sense, the relationship was studied developing a model in which the demographic variables, SR and real GDP per capita interact. The main idea behind this is that changes in the age dependency ratio influence GDP per capita inversely through the channels of working age population and the SR (Uddin

Table 11: Granger causality test results based on VECM

Dependent variable	Independent variables			
	χ^2-statistics of lagged 1st differenced term (P value)			ECT_{t-1} (P value) [t-ratio]
	ΔLY	ΔDR	ΔSR	
ΔLY	-	0.30 (0.58)	2.77 (0.09)	−0.07 (0.02); [−2.50]
ΔDR	0.01 (0.94)	-	2.29 (0.12)	0.00 (0.00); [1.94]
ΔSR	0.36 (0.54)	0.42 (0.51)	-	0.70 (0.31); [2.24]

Estimated at 5% level of significance. The figures in parentheses denote the P values and the figures in the square brackets represent t-statistics, VECM: Vector error correction model, DR: Dependency ratio, SR: Savings rate

Figure 1: Impulse response functions

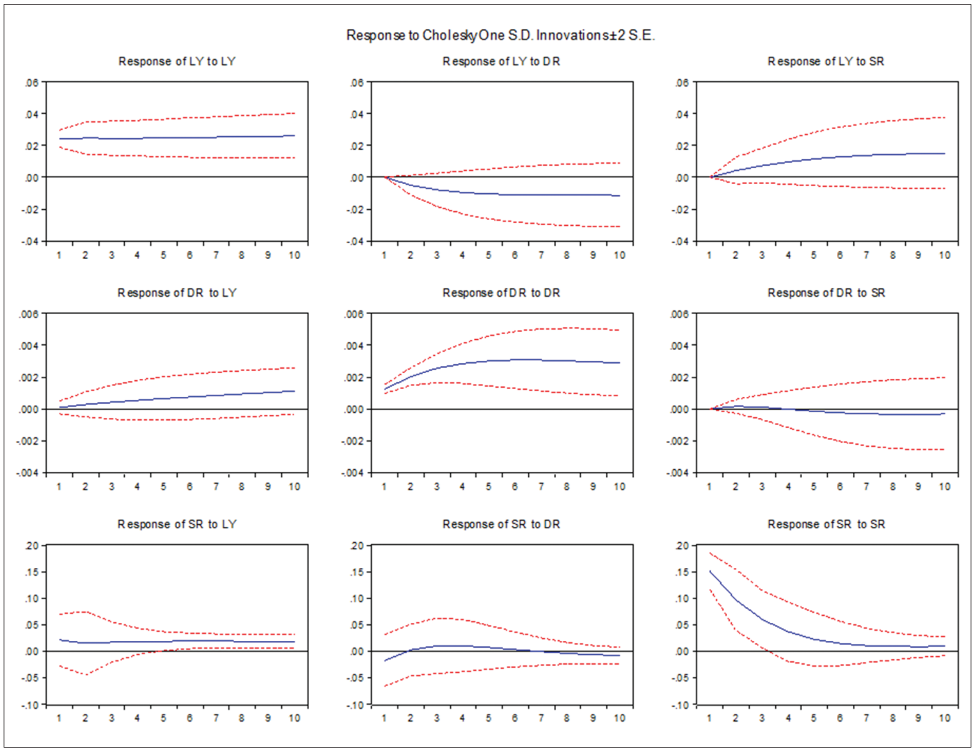
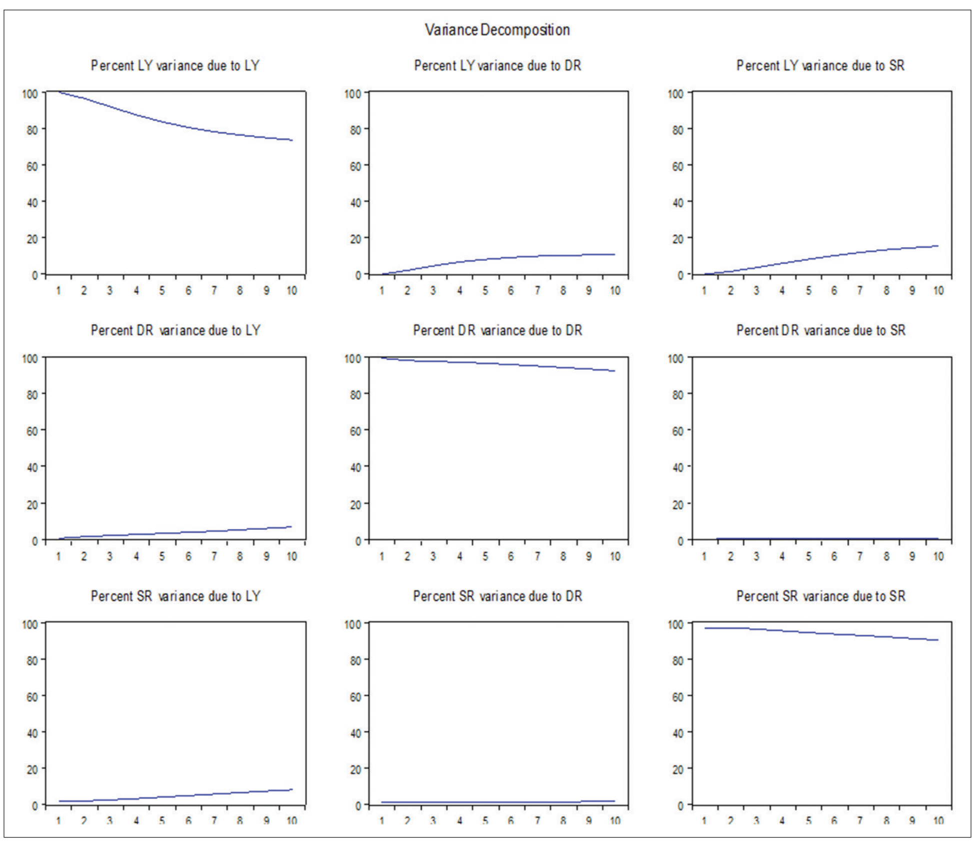


Figure 2: Forecast error variance decomposition



et al., 2016). With the goal to find the relationship between the selected variables, this study adopted three alternative time series approaches: DOLS, FMOLS and VECM for estimation of data for Ecuador for the annual period 1975-2015.

The findings were that the age DR has a negative and significant effect on GDP per capita, which inversely implies the positive significant relationship between working age population and GDP per capita. The findings of the causality test suggest that there appears to be a unidirectional short-run causality running from the SR to GDP per capita. Also, the findings support the population-driven economic growth hypothesis, which states that population increases in a country may promote its economic development.

The economic performance of Ecuador during the period 1975-2015 can be explained by the influence of demographic changes and the SR, but the advantages of age structure may disappear in the future given the imbalance between the young and elderly age DR, this may ultimately lead to a slowdown in the growth of the economy. In the case of Ecuador, this could need a demographic policy that targets increase in the working age population to counteract the issues caused by an increasingly ageing population, and a support in the number of work opportunities of the young population.

In addition, the findings show that the effect of demographic structure on GDP growth could be more pronounced in the long-run than in the short-run. By virtue of the contributions that the findings of this work can contribute to the formulation of local policies, a suggestion is that government should undertake initiatives that target reform in order to greatly improve labor productivity with a major participation of the young population, in that case, it will ensure that accumulated savings are channeled into productive investment.

REFERENCES

An, C.B., Jeon, S.H. (2006), Demographic change and economic growth: An inverted U-shape relationship. Economics Letters, 92, 447-454.

Bai, J., Perron, P. (2003), Computational and analysis of multiple structural change models. Journal of Applied Econometrics, 18, 1-12.

Barro, R.J. (1991), Economic growth in a cross section of countries. Quarterly Journal of Economics, 106, 407-443.

Bloom, D.E., Canning, D., Graham, B. (2003a), Longevity and life cycle savings. Scandinavian Journal of Economics, 105, 319-338.

Bloom, D.E., Canning, D., Sevilla, J. (2001), Economic Growth and the Demographic Transition. NBER Working Paper No. 8685. National Bureau of Economic Research, Cambridge, USA. Available from: http://www.nber.org/papers/w8685. [Last accessed on 2017 Apr 09].

Bloom, D.E., Canning, D., Sevilla, J. (2003b), The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change. Santa Monica, USA: R and Corporation.

Bloom, D.E., Canning, D., Sevilla, J. (2004), The effect of health on economic growth: A production function approach. World Development, 32(1), 1-13.

Bloom, D.E., Finlay, J.E. (2009), Demographic change and economic growth in Asia. Asian Economic Policy Review, 4(1), 45-64.

Bloom, D.E., Williamson, J. (1998), Demographic transitions and economic miracles in emerging Asia. World Bank Economics Review, 12(3), 419-455.

Boserup, E. (1965), The Conditions for Agricultural Growth: The Economics of Agrarian Change under Population Pressure. London, UK: George Allen and Unwin Ltd.

Breusch, T.S. (1978), Testing for autocorrelation in dynamic linear models. Australian Economic Papers, 17, 334-355.

Chowdhury, A., Mavrotas, G. (2006), FDI and growth: What causes what? World Economy, 29(1), 9-19.

de la Croix, D., Lindh, T., Malmberg, B. (2009), Demographic change and economic growth in Sweden: 1750-2050. Journal Macroeconomics, 31(1), 132-148.

Dickey, D.A., Fuller, W.A. (1979), Distribution of the estimators for autoregressive time series with a unit-root. Journal of the American Statistical Association, 74(366), 427-431.

Ehrlich, I., Lui, F. (1997), The problem of population and growth: A review of the literature from malthus to contemporary models of endogenous population and endogenous growth. Journal of Economic Dynamics and Control, 21, 205-242.

Fang, C., Wang, D. (2005), Demographic transition: Implications for growth. In: Garnaut, R., Song, L., editors. The China Boom and its Discontents. Canberra, Australia: ANU Press and Asia Pacific Press. p34-52.

Feyrery, J. (2002), Demographics and productivity. Dartmouth College Working Paper: Proceedings of the Midwest Business Economics Association. Hanover, USA: Dartmouth College.

Godfrey, L.G. (1978), Testing against general autoregressive and moving average error models when the regressors include lagged dependent variables. Econometrica, 46, 1293-1301.

Granger, C.W.J. (1969), Investigating causal relations by econometric models and cross-spectral methods. Econometrica, 37(3), 424-438.

Grossman, G.M., Helpman, E. (1991), Quality ladders in the theory of growth. Review of Economic Studies, 58, 557-586.

Guest, R. (2011), The Economics of a Sustainable Population. Canberra, Australia: Department of Parliamentary Services.

Hsiao, F.S.T., Hsiao, M.W. (2006), FDI, exports, and GDP in east and southeast Asia - Panel data versus time-series causality analyses. Journal of Asian Economics, 17, 1082-1106.

INEC. (2008), Study of the Socio-Demographic and Socioeconomic Situation of the Older Adult Population in Quito. Available from: http://www.ecuadorencifras.gob.ec/wpcontent/descargas/Libros/Demografia/documentofinal1.pdf.

INEC. (2016), National Employment, Unemployment and Unemployment Survey. Labor Indicators. Available from: http://www.ecuadorencifras.gob.ec/banco-de-informacion.

Johansen, S. (1988), Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control, 12(3), 231-254.

Johansen, S., Juselius, K. (1990), Maximum likelihood estimation and inference on cointegration - With applications to the demand for money. Oxford Bulletin of Economics and Statistics, 52(2), 169-210.

Kelley, A.C., Schmidt, J. (2001), Economic and demographic change: A synthesis of models, findings, and perspectives. In: Proceedings of the Symposium on Population Change and Economic Development. Lake Como, Italy: Bellagio Center.

Kelley, A.C., Schmidt, R.M. (1995), Aggregate population and economic growth correlations: The role of the components of demographic changes. Demography, 32(4), 543-555.

Kelley, A.C., Schmidt, R.M. (2005), Evolution of recent economic-demographic modeling: A synthesis. Journal of Population Economics, 18, 275-300.

Kremer, M. (1993), Population growth and technological change: One million B.C. to 1990. Quarterly Journal of Economics, 108, 681-716.

Kuznets, S. (1960), Population change and aggregate output. In: Roberts, G., editor. Demographic and Economic Change in Developed Countries. Washington DC, USA: National Bureau of Economic Research. p324-351.

Kuznets, S. (1967), Population and economic growth. Proceedings of the American Philosophical Society, 111(3), 170-193.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., Shin, Y. (1992), Testing the null hypothesis of stationary against the alternative of a unit root. Journal of Econometrics, 54(3), 159-178.

Landreth, H., David, C.C. (2002), History of Economic Thought. 4th ed. Boston, USA: Houghton Mifflin.

Leff, N.H. (1969), Dependency rates and savings rates. American Economic Review, 59, 886-895.

Macunovich, D.J. (2012), The role of demographics in precipitating

economic downturns. Journal of Population Economics, 25, 783-807.
Malthus, T.R. (1826), An Essay on the Principle of Population. 6th ed. London: John Murray. Available from: http://www.econlib.org/library/Malthus/malPlong1.html. [Last accessed on 2014 Mar 12].
Mankiw, N.G., Romer, D., Weil, D.N. (1992), A contribution to the empirics of economic growth. Quarterly Journal of Economics, 107, 407-437.
Mason, A. (1988), Saving economic growth, and demographic change. Population and Development Review, 14(1), 113-144.
Mason, A. (2003), Population change and economic development: What have we learned from the East Asia experience? Applied Population Policy, 1, 3-14.
Murphy, A. (2007), A Dynamic Model of Housing Supply. St. Louis, USA: Washington University, Mimeo.
Palumbo, L., Ferrara, A., Varra, P. (2010), Population and Economic Growth Evidence from EU and Emerging Countries. Gottingen, Germany: University of Gottingen Summer School.
Pesaran, H.H., Shin, Y. (1998), Generalized impulse response analysis in linear multivariate models. Economic Letters, 58(1), 17-29.
Phillips, P.C.B. (1995), Fully modified least squares and vector autoregression. Econometrica, 63, 1023-1078.
Phillips, P.C.B., Hansen, B. (1990), Statistical inference in instrumental variables regressions with I(1) process. Review of Economic Studies, 57, 99-125.
Prskawetz, A., Fent, K.T., Barthel, W. (2007), The Relationship between Demographic Change and Economic Growth in the EU, Working Paper. Stockholm, Sweden: Institute for Futures Studies.
Prskawetz, A., Fent, K.T., Sanderson, W.C., Scherbov, S. (2004), The Effects of Age Structure on Economic Growth: An Application of Probabilistic Forecasting in India. Working Paper No. 03/2004. Vienna, Austria: Vienna Institute of Demography.
Sakyi, D., Villaverde, J., Maza, A., Chittedi, K.R. (2012), Trade openness, growth and development: Evidence from heterogeneous panel cointegration analysis for middle-income countries. Cuadernos de Economía, 31(57), 21-40.
Savas, B. (2008), The relationship between population and economic growth: Empirical evidence from the central Asian economies. Oaka, 3(6), 161-183.
Simon, J.L. (1976), Population growth may be good for LDCs in the long run: A richer simulation model. Economic Development and Cultural Change, 24(2), 309-337.
Smith, A. (1776), An Inquiry into the Nature and Causes of the Wealth of Nations. London, UK: W Strahan.
Solow, R.M. (1956), A contribution to the theory of economic growth. Quarterly Journal of Economics, 70(1), 65-94.
Thuku, G.K., Paul, G., Almadi, O. (2013), The impact of population change on economic growth in Kenya. International Journal of Economics & Management Sciences, 2(6), 43-66. US Census Bureau; 2015. International Data Base: US Department of Commerce. Viewed 23, July. Available from: http://www.census.gov/population/international/data/idb/informationGateway.php.
Uddin, G.A., Alam, K., Gow J. (2016), Population age structure and savings rate impacts on economic growth: Evidence from Australia. Economic Analysis and Policy, 52, 23-33.
Wei, Z., Hao, R. (2010), Demographic structure and economic growth: Evidence from China. Journal of Comparative Economics, 38, 472-491.
Weil, D.N. (2007), Accounting for the effect of health on economic growth. Quarterly Journal of Economics, 122(3), 1265-1306.
World Bank. (2017), World Development Indicators: World Bank National Accounts Data. Viewed 29, March. Available from: http://www.databank.worldbank.org/data/reports.aspx?source=world-development-indicators.