International Journal of Economics and Finance; Vol. 14, No. 11; 2022
ISSN 1916-971X E-ISSN 1916-9728
Published by Canadian Center of Science and Education

The Determinants of National Savings in West African Countries: A Time Series and Dynamic Panel Data Analysis

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Received: August 21, 2022 Accepted: October 18, 2022 Online Published: October 27, 2022

doi:10.5539/ijef.v14n11p74 URL: https://doi.org/10.5539/ijef.v14n11p74

Abstract

The objective of this paper is to analyze the determinants of national savings in West African countries, using both time series analysis and panel data over the period 1980–2020. To do so, we used the Autoregressive Distributed Lag (ARDL) model through the cointegration approach of boundary tests to check the robustness of the long-run relationship and the error correction mechanism (ECM) to capture the short-run dynamics between savings and its determinants. The results revealed that domestic income was a statistically significant determinant of national savings in the short and long run in West Africa. Based on the empirical results of the panel data, the results reveal that the current account positively influences savings in English countries in both the short and long run. On the other hand, domestic income and value added in agriculture were found to be determinants of savings in Francophone countries. It is recommended that, in order to promote savings, growth and economic development, policies aimed at improving labor productivity and the balance of trade are essential to increase savings rates in West Africa.

Keywords: savings, determinant, time series, panel

1. Introduction

National savings finance different sectors of the economy, including the sector related to investment in development projects. The financing of this sector is important for the economic development of a country. Several studies have been carried out on savings and have highlighted its importance on the economy, such as the neo-classical growth model of (Solow, 1956) and (Cass, 1965), (Ramsey, 1928) and (Koopmans, 1965). There are also (Frankel, 1962) and (Romer, 1986), (Akkoyunlu, 2020) and (Aghion & Howitt, 2006). All these authors have shown that capital accumulation is one of the sources of economic growth of a country.

According to macroeconomic theory, national savings are one of the foundations of all economic progress and development. The recent economic progress of developing countries in Asia such as China, India, Turkey, etc. is possible because of the role played by savings. For example, China and some Southeast Asian countries have savings rates in the range of 30-40% (Agrawal et al., 2010). Dovi (2008) noted that some Sub-Saharan African countries have the lowest savings rate among developing countries. West African countries face many economic problems such as unemployment, rapid population growth, low economic growth, and low national savings rates, which are undesirable for sustainable economic development.

In addition, several researchers defend the idea that, in order to achieve a satisfactory level of development and strong and sustainable growth, a country's economy must have the necessary internal resources to finance itself, hence the importance of mobilizing domestic savings. As far as ECOWAS (Economic Community of West African States) is concerned, the level of domestic savings is insufficient to finance the investments needed to achieve sustained growth. Indeed, the West African economy is dependent on external financing. In addition to its inadequacy, domestic savings are liquid and short-term, which makes them volatile and difficult to use to finance the economy.

For the region as a whole, gross domestic savings averaged only 8 percent of GDP in the 2000s, compared with 23 percent for Southeast Asia and 35 percent in the newly industrialized economies of Korea, Hong Kong, Singapore, and Taiwan (World Bank, 2013). In addition to being generally low, savings rates have been steadily declining over the past 30 years in most of sub-Saharan Africa in general and West Africa in particular. Where

increases have been seen, they have been very modest. Only a few serious reformers saw a slight improvement in savings. One reformer, Ghana, had a very low average domestic savings rate of about 5 percent of GDP over the same period. Lucas (1988), indicated that high savings rates and growth in wealth creation and capital formation can have a very positive effect on a country's economic growth. Savings rates in most West African countries have been depressed, whereas economic concepts for financial development suggest that the required savings rate is 22-25 percent.

Having identified the importance of savings in economic development, it is necessary to study the factors that determine savings. The analysis of these factors will make it possible to propose measures to facilitate economic development. Understanding the determinants of savings is fundamental to many economic issues (smoothing consumption over time, investment, monetary policy decisions, etc.). For any country, but especially for developing countries, it is therefore necessary to increase their savings in order to increase their capital accumulation. Among the explanations for developing countries' recourse to international debt, it is often argued that their domestic savings rate is too low to allow them to achieve the desired growth rate.

Insufficient domestic resources would limit the desired rate of accumulation. To ease this constraint, it would be in the interest of developing countries to go into debt. But one must take into account the effects of this recourse to debt on internal macroeconomic equilibria and, in particular, whether external resources do not have a depressing effect on the domestic savings rate. In addition, it is necessary to determine the optimal conditions for recourse to debt on the part of a developing country, so that the country does not end up unable to repay its debts. How will developing countries be able to mobilize domestic resources in the future, when it is partly their inability to do so in the past that explains their massive reliance on external capital ? In what follows, we consider that policies of financing through domestic resource mobilization are consistent with the willingness of countries to finance economic growth.

The general objective of our study is to identify the determinants of national savings in ECOWAS countries. The rationale for focusing on ECOWAS in our analysis is that ECOWAS is an economic integration zone, specifically a full economic union among member countries. The underlying objective put forward by the authorities is to put in place an effective shield against external shocks, which destroy the positive effects of economic growth.

The latter is at the heart of the aspirations of West African governments, who are convinced that economic catch-up is conditioned by the assurance of strong and sustainable growth. To this end, savings mobilization is another key factor in promoting sustainable and inclusive economic development in the ECOWAS common market.

The relevance of the research lies in the fact that studies on national savings for separate and distinct countries are numerous, compared to those that focus on a group of countries. This study seeks to contribute to the limited empirical work on the determinants of national savings in West African countries.

The rest of the paper is structured as follows: In the second session, we review the theoretical and empirical literature on the determinants of savings. Section III presents some stylized facts about national savings behavior in West African countries during the study period. Section IV presents the methodology and data used to conduct this study. In the fifth section, we discuss the different econometric results obtained by applying the procedures developed in the fourth section. Finally, we presented concluding remarks, as well as policy implications arising from this study in section six.

2. Review of Theoretical and Empirical Literature

Classical economic theory links variations in the aggregate savings rate to the rate of interest, but recent theory revolves around the consumption function, i.e. the percentage of income spent, or what represents the savings rate. For Smith, Ricardo, but also Walras, savings are necessarily used in the form of consumption or investment. According to them, the propensity to save is an increasing function of the interest rate. A high interest rate encourages people to reduce their current consumption in order to increase their savings, according to a substitution effect. According to Keynes (1936), savings depends directly on current disposable income (income after payment of direct taxes). According to him, the propensity to save a portion of current disposable income increases with income. For Duesenberry (1949), consumption and savings depend not only on current income but also on previous income levels and past consumption patterns.

Friedman (1957), considers that consumption represents a constant proportion of permanent income, and that any accumulated savings come mainly from transitory income, that is, unexpected, exceptional income, such as that generated by changes in the value of assets, changes in relative prices, National Lottery winnings and other

unpredictable windfalls. According to Modigliani (1963), during their working lives, households save in order to accumulate capital that they need for their retirement. They consider that income varies over a lifetime and that savings is the means by which households move their income from one year to the next.

Empirically, several studies have also been conducted on national savings and their determinants. But understanding the nature of countries' savings behavior is essential for designing policies to promote savings and investment. It is not surprising, therefore, that the analysis of savings behavior has become one of the central issues in empirical macroeconomics (Jappelli & Pagano, 1998). Abasimi and Martin (2018) examine the determinants of national savings in four West African countries, namely Ghana, Togo, Burkina Faso, and Ivory Coast over the period 1997-2016. Their long-run results reveal that gross domestic product, per capita income, and the real interest rate have a statistically significant and positive effect on gross savings. Epaphra (2014) examined the factors affecting savings in Tanzania over the period 1970-2010 using time series data and Granger causality test and found that real GDP growth rate, as well as disposable income, life expectancy and population growth had a positive impact on savings in Tanzania while inflation had a negative impact.

Horioka and Terada (2011) analyzed the determinants of domestic savings rates in twelve developing Asian economies over the period 1966-2007 by estimating both a country fixed effects model and a random effects model with robust standard errors. They also estimated trends in domestic savings rates in these same economies over the next twenty years (period 2011-2030) based on their estimation results. Although their empirical results indicate that there were substantial differences across economies, the main determinants of these trends appear to have been the age structure of the population (particularly the old-age dependency ratio), income levels, and the level of financial sector development. They also indicated that the domestic savings rate in developing Asia as a whole will remain roughly constant over the next two decades, as the negative impact of population aging on this rate will be roughly offset by the positive impact of rising income levels on this rate.

Nagawa et al. (2020) examined the determinants of gross domestic savings in Uganda for the period 1980-2017. Their results indicate that in the long run, gross domestic product (GDPg) growth rate, foreign domestic investment (FDI), and broad money (M2) have positive and statistically significant effects on savings, while current account balance (CAB) and gross national expenditure (GNE) have negative effects on savings. They found that the deposit interest rate (DIR) was a statistically insignificant determinant of savings in Uganda.

Mojekwu and Ogbulu (2017) examined the determinants of national savings in Nigeria for the period 1981-2015 using a multiple regression model. The results of their analyses reveal that only financial deepening plays a significant role in contributing positively to national savings in Nigeria, while the other variables are not significant in determining national savings during the period under consideration. Ogbokor and Samahiya (2014) analyzed the determinants of savings in Namibia using cointegration and error correction mechanisms for the period from 1991 to 2012. The results of the cointegration tests suggest that there is a long-run relationship between savings and the explanatory variables used in the study. The results suggest that inflation and income have a positive impact on savings, while the population growth rate has negative effects on savings. In addition, the deposit rate and financial deepening do not have a significant effect on savings.

In general, we can conclude from the preceding literature that the determinants of savings performance are diverse. However, given the differences in economic, social, and demographic conditions across countries, we should not assume that the factors that successfully explained savings performance in one country or group of countries would certainly be appropriate or successful elsewhere. Some of these factors may be significant in one case but not in others, and so they need to be carefully considered in light of the characteristics of each case. Thus, in this study we will examine the macroeconomic factors that explain the behavior of national savings in the ECOWAS zone, which can help policy makers formulate policies that improve savings rates.

3. Savings Performance in ECOWAS Countries: A Stylized Fact

A feature of all the data on national savings rates is that they declined for most ECOWAS countries over the 1980-96 period and have recovered slightly. Nigeria's trends in aggregate savings have been interesting and different from the situation in many other countries in the subregion. As a giant of Africa, Nigeria has recorded the best savings performance throughout the period 1980-2018. The first notable reason for Nigeria's rising savings rate could be explained by the fact that Nigeria is the largest oil producer in Africa. The domestic savings rate rose to over 30 percent between 2000 and 2005, an increase that was largely driven by private savings as public savings fell. However, during this time, rising debt service payments reversed the trend.

Ghana had a very low average domestic savings rate of about 4.8 percent and 5.47 percent of GDP between 1980 and 1990. Indeed, Ghana's savings rate only increased from 4.8 percent to 7.5 percent after a decade of reforms. However, this rate doubled between 2010 and 2018. Ivory Coast experienced impressive growth in its savings

rate, which also exceeded 15 percent, reaching 20 percent in 2000-2005 and 22 percent in 2014-2018. Guinea-Bissau experienced negative savings in 1980-1990, 2000-2006, and 2010-2013, but a slight increase in 2014-2018. This may be due to the recovery of their agricultural product, as the majority of the population is in agriculture. In Sierra Leone savings increased from 4.13 to 13% in 1980-1990, which was supposed to increase but has continuously decreased, and Sierra Leone recorded a negative rate of -7.6% between 2000 and 2006 and -3.4 to -9.5% in 2010-2018. This decline may be due to the civil war that decimated the infrastructure and precipitated an economic depression in the country. In Togo, savings increased by 12.3 percent in 1994-2003, but this trend declined slightly in 2005-2012 and then increased in 2015-2018. In Cape Verde, overall savings rates remained remarkably low throughout the adjustment period. This can be attributed to the huge losses incurred by public enterprises, as the majority of the population is in the industries.

Senegal's savings rate was below 5 percent between 1980-1989 but increased by 5.4 and 9 percent between 1990-1999 and 2000-2006 respectively. This is due to the increase in FDI and tourism is also an important source of income between these two periods. This trend saw a decline in 2008-2013 to 7.23% and 4.18% respectively and then stabilized at over 13% in 2015-2018. Mali, for example, experienced a negative rate of -0.4 percent between 1980 and 1989. This may also be due to a decline in its GDP during this period. Thus, an increase in GDP between 2000-2005 and 2008 also led to a large increase in savings of 7.6 and 11.5 percent between 2000-2006 and 2008 respectively. Niger's savings rate was 7.3 percent between 1980-1989, but surprisingly declined to 2.7 percent between 1990-1999 and then increased to 5.6 percent between 2000-2006 and 9 and 12 percent in 2010-2018.

The figure 1 shows that there are large disparities between countries in the volume of domestic savings. This situation reflects the level of economic performance of these countries. In this case, it is important to analyze the structure of savings held by economic agents to better understand the situation of domestic resource mobilization. In Sub-Saharan Africa, and particularly in West Africa, the problem of mobilizing domestic resources is faced with a problem of insufficient savings and the type of savings that promote better financial intermediation. Unlike savings practices in Western countries (savings accounts and purchases of monetary assets intended for savings), the behavior of savers in Sub-Saharan Africa is paced according to future needs.

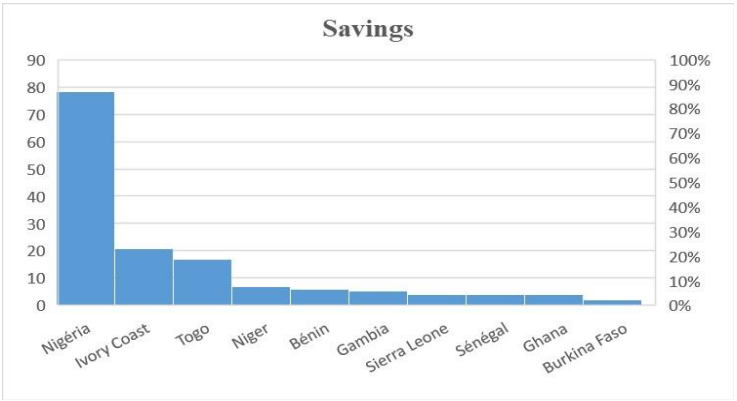

Figure 1. Comparison of savings rate in 10 countries of the ECOWAS zone

Source: The authors.

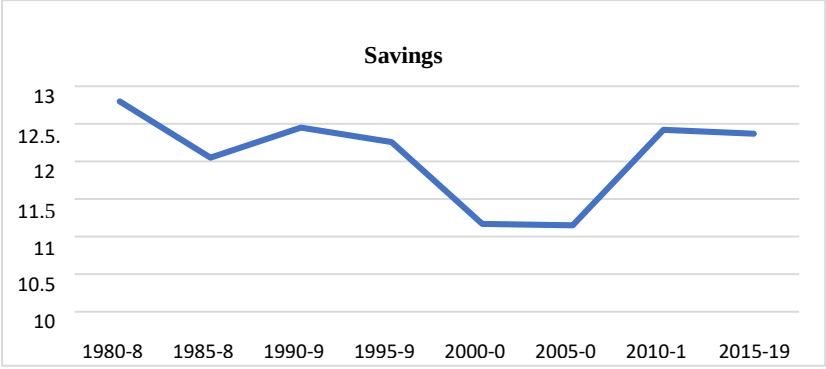

Figure 2. Evolution of the savings rate in the ECOWAS zone

Source: The Authors.

Figure 2 shows that since 2010, the savings trend has been on the rise in the ECOWAS zone. This trend reflects the financial health of some states in the zone, following the surge in oil prices and certain commodities at a certain period, which largely increased their disposable income. However, it should be noted that compared to other regions of the world, this upward trend remains weak and insufficient to sustain growth and finance domestic investment and reduce the dependence and risks associated with external borrowing. However, not only have questions been raised about the importance of the savings effort as a dependent determinant of economic progress, but the formulation of policies to increase savings has suffered from a lack of knowledge about the variables that determine savings in developing countries, particularly in African countries.

3.1 Savings Trends in West Africa Compared to Other Regions in Africa

Figure 3 shows the comparison of savings rates across regions in Africa over the period 1980-2019. We observe that savings rates vary considerably across regions and over time. Over the period 1980-1995, North Africa had the highest savings rate at 22.43 percent, followed by Central Africa at 20.46 percent. It is also observed that during the periods 1995-1999 and 2000-2010 and even during the recent period (2010-2019), Central Africa had the highest savings rate of all regions. In contrast, over the entire period studied, West Africa lagged behind all other African subregions. To this end, several studies have contributed to the literature on the fundamental question of whether there is a long-run relationship between savings and the level of the income growth rate. This long-debated relationship has provided a strong incentive for researchers to further analyze the determinants of savings in most countries of the world.

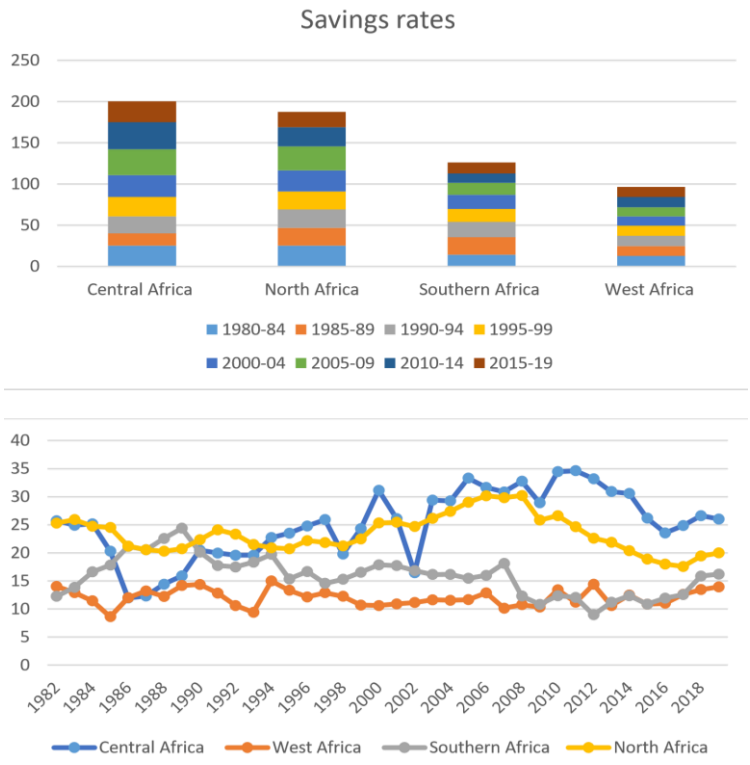

Figure 3. Comparison of savings rates across African subregions

Source: The Authors.

However, the aggregation of these figures hides the performance of some West African economies whose level of savings mobilization is higher than 20%. For example, Nigeria has a domestic savings rate of between 20 and 35 percent. It should be noted that the low savings rate is a consequence of the low income of economic agents, low income growth, and the ratio of inactive to active people (Loayza et al., 2000).

4. Methodological Approach

The literature review suggests a number of factors that may be important in determining the behavior of domestic savings in the ECOWAS zone. This study attempts to explain the behavior of domestic savings as a function of macroeconomic variables covering the period 1980-2020.

The estimates are done in two steps : First, we do the time series estimates at the individual ECOWAS country level. In the second step, we do a panel estimation, including a panel made up of all ECOWAS countries; then a panel made up only of French-speaking ECOWAS countries and another panel made up of English-speaking countries in the ECOWAS space. This procedure will allow us to compare performance in terms of savings behavior between these two groups. This approach seems particularly relevant insofar as these countries have very different capital market imperfections.

4.1 Model Specification

The ARDL (Autoregressive Distributed Lag) model developed by Pesaran et al. (2001) is used to achieve our objectives since it will allow us to highlight the short and long term relationships between our different variables. However, a necessary condition is that the study variables must be integrated of an order less than or equal to 1. The following ARDL model is developed for the estimation :

$$\Delta GDSAV_t = \Psi_0 + \sum_{i=1}^{p} \Psi_i \Delta GDSAV_{t-i} + \sum_{i=1}^{p} \Psi_i \Delta GDI_{t-i} + \sum_{i=1}^{p} \Psi_i \Delta M2_{t-i} + \sum_{i=1}^{p} \Psi_i \Delta CACCOUNT_{t-i}$$
$$+ \sum_{i=1}^{p} \Psi_i \Delta CONSUM_{t-i} + \sum_{i=1}^{p} \Psi_i \Delta AGR_{t-i} + \gamma_1 GDSAV_{t-1} + \gamma_2 GDI_{t-1} + \gamma_3 M2_{t-1} + \gamma_4 CACCOUNT_{t-1}$$
$$+ \gamma_5 CONSUM_{t-1} + \gamma_6 AGR_{t-1} + \mu_t \quad (1)$$

Where Ψ_0 and Ψ_i denotes the constant term and the numerical coefficients respectively; t denotes the time factor. GDSAV represents gross domestic savings, and is the dependent variable; GDI is gross domestic income. Therefore, it is expected to have a positive relationship with savings. Given the permanent income assumption, a lagged variable for gross domestic income was included in the model. M2 represents the broad money supply, should also have a positive relationship with savings. CACCOUNT represents the current account balance. In addition, final consumption expenditure (CONSUM), which is a proxy for savings, should have a negative sign. AGR is the value added of agriculture. The dynamics of the error correction is denoted by the summation sign, while the second part of the equation corresponds to the long-run relationship.

4.2 The Bounds Test Approach or Cointegration Test of Pesaran et al. (2001)

Cointegration between series implies the existence of one or more long-run equilibrium relationships between them. To test the existence or not of cointegration between series, the econometric literature provides several tests or approaches, including the Engle and Granger (1987) test, those of Johansen (1988, 1991) and Johansen and Juselius (1990) and that of Pesaran and Shin (1996) Pesaran and Shin (1995) and Pesaran et al. (2001).

The Engle and Granger (1991) cointegration test only helps to verify cointegration between two integrated series of the same order (i.e. order of integration = 1), and is therefore adapted to the bivariate case and is therefore less effective for multivariate cases (Pesaran et al., 1987). Johansen's (1988, 1991) cointegration test allows us to verify cointegration on more than two series and was designed for multivariate cases. However, although Johansen's test based on vector autoregressive error correction modeling (VECM) is a remedy for the limitations of Engle and Granger's test for the multivariate case, it also requires that all series or variables be integrated of the same order, which is not always the case in practice.

So, when we have several integrated variables of different orders I(0), I(1), we can use the Pesaran et al. (2001) test of cointegration called "bounds test to cointegration", originally developed by Pesaran and Shin (1999). If we use Pesaran's cointegration test to verify the existence of one or more cointegrating relationships between the variables in an ARDL model, we say that we are using the "ARDL approach to cointegrating" or that we are applying the staggered lag test to cointegration.

In this study, we will use the cointegration test of Pesaran et al. (2001).

There are two steps to apply the Pesaran et al. cointegration test, namely :

i) Determining the optimal lag first (AIC, SIC). AIC (Akaike information criterion), SIC (Shwarz information criterion). Moreover, SIC is parsimonious because it uses the minimum acceptable delay while selecting the maximum delay and avoiding the unnecessary loss of degrees of freedom. For this reason, the SIC criterion will be used, as a criterion for selecting the optimal lag, in all cointegration estimates. The SIC is slightly superior to the AIC (Pesaran & Shin, 1999).

(ii) The use of Fisher's test to test the hypotheses.

In the ARDL model, we will first estimate the value of the F-statistic using the appropriate ARDL models. Then, the Wald test (F-statistic) will be used to investigate the long-term relationship between the series. The Wald test (F-statistics) derived from the above is an essential part of the ARDL procedure, which is useful for assessing the

existence of a long-term relationship between the variables included in the model. The null and alternative hypotheses for the Wald test are as follows : The null hypothesis of no cointegration is rejected if the calculated F-test statistics exceed the upper critical limit (UCL) value. The results are said to be inconclusive if the F-test statistics fall between the upper and lower critical limit. Finally, the null hypothesis of no cointegration is accepted if the F-statistic is below the lower critical limit. The following model will be used to estimate the long-run coefficients :

$$GDSAV_t = \zeta_0 + \sum_{i=1}^{p} \zeta_1 GDSAV_t + \sum_{i=1}^{p} \zeta_2 GDI_t + \sum_{i=1}^{p} \zeta_3 M2_t + \sum_{i=1}^{p} \zeta_4 CACCOUNT_t + \sum_{i=1}^{p} \zeta_5 CONSUM_t + \sum_{i=1}^{p} \zeta_6 AGR_t + \nu_t \quad (2)$$

The coefficients ζ_i describe the long-run relationship between savings and its regressors. To test for the presence of a long-run relationship between the variables, we perform an F-test of the null hypothesis, H0: $\zeta_1 = 0$ and $\zeta_i = 0$ against the alternative hypotheses of long-run relationships H1: $\zeta_1 \neq 0$ and $\zeta_i \neq 0$. The rejection of the null hypothesis implies the existence of a long-run relationship between savings and its determinants when the alternative is $\zeta_1 \neq 0$ and $\zeta_i \neq 0$. The other alternative hypotheses correspond to what Pesaran et al. (2001) call a “degenerate” level relationship. In this case, the fact that we have GDSAV~I(1) will allow us to conclude that there is a cointegrating relationship. Two critical values are provided by Pesaran et al. (2001). The lower bound critical value corresponds to the case where all variables are integrated of order zero I(0), i.e. there is no cointegrating relationship, while the upper bound critical value corresponds to the case of a cointegrating relationship. If the F- statistic is greater than the upper bound, H0 is rejected and if the F value is less than the lower bound, H0 is not rejected. When the F is between the two bounds, we cannot conclude. If we find evidence of the long-term relationship between the variables, the short-term dynamic parameters can be obtained by estimating the VEC model as shown below :

$$\Delta GDSAV_t = \varphi_0 + \sum_{i=1}^{p} \varphi_i \Delta GDSAV_{t-i} + \sum_{i=1}^{p} \varphi_i \Delta GDI_{t-i} + \sum_{i=1}^{p} \varphi_i \Delta M2_{t-i} + \sum_{i=1}^{p} \varphi_i \Delta CACCOUNT_{t-i} + \sum_{i=1}^{p} \varphi_i \Delta CONSUM_{t-i} + \sum_{i=1}^{p} \varphi_i \Delta AGR_{t-i} + nECM_{t-i} + \omega_t \quad (3)$$

The error correction model shows the speed of adjustment required to restore long-run equilibrium after a short-run shock. The n is the coefficient of the error correction term in the model that indicates the speed of adjustment. The stability and diagnostic tests will be performed to test the goodness of fit of the autoregressive distributional shift (ARDL). In the diagnostic test, we will apply to discover the serial correlation between the error terms, the specification problem, the normality of the residual term, and the heteroscedasticity. These approaches are concerns for the short-run model.

4.3 Unit Root Test and Order of Integration of Series

In most cases, time series data are characterized by non-stationarity. Regression involving nonstationary data often leads to spurious regression results. Several testing methods for unit roots are available in the literature. These include the Dickey Fuller (DF) test, the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test, the Kahn and Ogaki test, the Ley-borneMcCabet test, and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test. DF, ADF, and PP tests are the most popular types of unit root tests applied in empirical work. This is mainly due to their simplicity and generality (Harris & Sollis, 2003). Therefore, we will apply the ADF and PP test for this study. The ADF test is preferred over the DF test due to its technical superiority over the latter. The implementation strategy of the test is based on the following equation depending on whether we consider the presence of a unit root:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{k} d_j \Delta Y_{t-j} + \vartheta_t \quad (4)$$

Where ϑ_t is the pure white noise error term, Δ is a first difference operator, Y_t is a time series, α_0 is the constant and k is the optimal number of lags of the dependent variable. The variable is said to be stationary, if the value of the coefficient d is lower than the critical values of the table.

4.4 ARDL Panel Model

The use of panel data will allow us to gain degrees of freedom here. Indeed, it has been shown that results obtained from single period cross-country regressions suffer from a series of shortcomings such as the omission of variable biases and the loss of degrees of freedom Islam (1995); Caselli et al. (1997); Baltagi (2001); Hsiao (2003). The main model of the panel ARDL approach to obtain the short and long run relationship between savings and its determinants is represented as follows :

$$\Delta GDSAV_{it} = \phi_0 + \sum_{j=1}^{p_1} \phi_{ij} \Delta GDSAV_{it-j} + \sum_{j=1}^{p_2} \phi_{ij} \Delta GDI_{it-j} + \sum_{j=1}^{p_3} \phi_{ij} \Delta M2_{it-j} + \sum_{j=1}^{p_4} \phi_{ij} \Delta CACCOUNT_{it-j}$$

$$+ \sum_{j=1}^{p_5} \phi_{ij} \Delta CONSUM_{it-j} + \sum_{j=1}^{p_6} \phi_{ij} \Delta AGR_{it-j} + \tau_i GDSAV_{it-1} + \tau_i GDI_{it-1} + \tau_i M2_{it-1} + \tau_i CACCOUNT_{it-1}$$

$$+ \tau_i CONSUM_{it-1} + \tau_i AGR_{it-1} + U_{it} \quad (5)$$

$U_{it} = \alpha_i + \varepsilon_{it}$ With i and t representing the country and time respectively.

By reparameterizing equation (5), we have :

$$\Delta Z_{it} = \Phi_i (z_{i,t,j} - \theta X_{i,t,j}) + \sum_{j=1}^{p-1} \lambda_{ij} \Delta z_{i,t,j} + \sum_{j=1}^{k} \sum_{j=0}^{q-1} \lambda_{ij} \Delta X_{it-j} + U_{it} \quad (6)$$

The notations λ, λ′, are the short-run coefficients for the lagged dependent variable and other explanatory variables respectively. The long-run coefficients are θ_i for the explanatory variables. Finally, Φi indicates the speed of adjustment. Following the extensive literature on dynamic panel data, we implement several estimators to assess the relationship between savings and its determinants, using the mean group (MG) and pooled mean group (PMG) estimators, (Pesaran & Smith 1995; Pesaran et al., 1999).

4.5 Data Sources

The study used annual secondary data for the period 1980-2020. Data on the variables selected for the study were obtained from the World Bank's World Development Indicators database. The choice of the study period was based on the availability of consistent data on the selected variables. With the exception of Guinea, Guinea-Bissau, Cape Verde and Liberia due to lack of data availability, the countries included in the study are: Benin, Burkina Faso, Ivory Coast, Gambia, Ghana, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo.

5. Empirical Results and Discussion

Unlike other cointegration tests, the ARDL boundary test approach to cointegration does not require the same order of integration for all variables. However, since the ARDL (autoregressive distributed lag) cointegration test is developed on the basis that the variables are I(0) or I(1), before applying the bounds test procedure, the implementation of unit root tests may still be necessary to ensure that all variables satisfy the underlying assumption. In addition, ARDL cannot be used for I(2) variables.

Therefore, before testing whether our variables are cointegrated, we investigated the order of integration of each variable using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. For both unit root tests, the null hypothesis is non-stationarity.

The results of the Phillips-Perron (PP) and Augmented Dickey-Fuller (ADF) tests presented in Table 1 reveal that all variables are non-stationary in levels and stationary in first differences at the 5% significance level in all cases except for caccount for Ivory Coast and Nigeria ; consum for Togo and gdi, M2, caccount for Ghana which are stationary at level. Thus, unit root tests ensure that our variables are I(0) and I(1) and that there is no I(2) variable. Therefore, an ARDL cointegration testing procedure can be applied to this study.

We can now confidently apply the boundary test procedure to examine the presence of long-run relationships between savings and its determinants. We use the Shwarz information criterion to determine the appropriate lag structure. The results of the cointegration test for the full sample period are presented in Table 2. For each ECOWAS country, the corresponding F-statistics are calculated.

Table 1. Unit root test results

	ADF (Augmented Dickey-Fuller Test)											
	Level						first difference					
Countries	gdsav	gdi	M2	caccount	consum	agr	gdsav	gdi	M2	caccount	consum	agr
Benin	-1.86	-2.73	-1.23	-2.37	-2.53	-1.95	-10.06**	-8.44**	-6.05**	-8.03**	-8.04**	-6.58**
Burkina Faso	-1.44	-0.42	0.82	-1.55	-2.01	-1.85	-6.08**	-4.60**	-6.01**	-6.71**	-8.80**	-8.72**
Ivory Coast	-2.33	4.02	-1.84	-3.53**	3.72	-1.47	-5.01**	-3.87**	-7.12**		-4.01**	-5.45**
Gambia	-0.24	4.85	1.34	-0.20	0.44	-1.96	-8.89**	-3.50**	-18.19**	-5.41**	-6.38**	-6.68**
Ghana	5.29	-4.64**	-9.32**	-4.75**	0.74	0.14	-4.84**				-6.52**	-7.24**
Mali	-1.99	-1.81	-1.66	-2.67	-1.51	-1.58	-6.29**	-6.56**	-6.77**	-7.81**	-5.47**	-7.61**
Niger	-2.57	0.12	-1.36	-2.26	0.21	-2.41	-8.66**	-5.66**	-6.04**	-8.43**	-5.59**	-7.11**
Nigeria	-2.42	-2.16	-0.91	-3.54**	-1.71	-2.53	-5.52**	-6.25**	-5.05**		-9.12**	-6.81**
Sénégal	-0.59	-1.15	2.68	-2.54	-2.11	-1.60	-8.03**	-7.23**	-4.90**	-5.12**	-7.54**	-8.83**
Sierra Leone	-1.35	-2.85	-1.25	-2.09	-2.32	-1.78	-10.14**	-6.27**	-5.98**	-8.40**	-8.77**	-5.84**
Togo	-4.02	-1.86	-1.10	-2.61	-3.45**	-2.27	-5.99**	-7.88**	-6.73**	-6.97**		-6.34**
	PP (Philips Perron test)											
	Level						first difference					
Countries	gdsav	gdi	M2	caccount	consum	agr	gdsav	gdi	M2	caccount	consum	agr
Benin	-1.59	-2.68	-1.58	-2.48	-2.49	-1.91	-10.67**	-9.14**	-6.07**	-8.26**	-9.24**	-7.24**
Burkina Faso	-1.44	-0.78	1.04	-1.51	-1.79	-1.58	-6.08**	-4.57**	-6.02**	-6.93**	-8.96**	-8.89**
Ivory Coast	-2.56	4.02	-1.96	-3.41**	3.72	-1.63	-4.90**	-3.92**	-7.07**		-4.06**	-5.45**
Gambia	-2.02	5.47	0.72	-0.09	-0.42	-1.88	-9.53**	-3.53**	-2.68**	-5.30**	-6.38**	-10.69**
Ghana	5.68	11.62**	13.5**	-7.86**	0.96	0.35	-4.37**				-6.52**	-7.21**
Mali	-1.99	-1.89	-1.52	-2.59	-1.55	-2.22	-6.29**	-6.58**	-6.58**	-9.10**	-5.48**	-7.47**
Niger	-2.68	0.15	-1.40	-2.12	0.17	-2.36	-10.16**	-5.64**	-6.04**	-8.93**	-5.58**	-7.05**
Nigeria	-2.40	-2.11	-0.73	-3.55**	-2.33	-2.70	-8.49**	-6.73**	-6.60**		-10.83**	-6.29**
Sénégal	-0.55	-1.19	3.61	-2.49	-2.14	-1.85	-7.80**	-12.09**	-4.94**	-7.64**	-7.61**	-16.40**
Sierra Leone	-2.32	-2.88	-1.25	-1.91	-2.11	-1.80	-10.49**	-10.66**	-5.99**	-8.70**	-11.01**	-5.82**
Togo	-4.03	-1.76	-1.23	-2.49	-3.50**	-2.19	-5.99**	-7.86**	-6.72**	-10.60**		-9.09**

Note. ** indicates rejection of the null hypothesis at the 5% significance level.

Based on the results of the cointegration tests, three groups of countries emerge. The first group consists of countries where cointegration is found. Using the asymptotic limits of the critical values calculated by Pesaran et al. (2001), the F-statistic is above the upper limit of 5% in 7 of the ECOWAS countries, namely: Benin, Burkina, Gambia, Ghana, Niger, Nigeria and Togo. The null hypothesis of no long-term relationship is therefore rejected. For these countries, there is evidence of cointegration between savings and its determinants.

The second group of countries includes those where no cointegration is found : Senegal. Finally, the F-test results for the cases of Ivory Coast, Mali and Sierra Leone are between the upper and lower limits and we interpret these results as inconclusive at the 5% significance level.

Table 2. Results of the cointegration test

Countries	F-statistic	5% Lower Bound value	5% Upper Bound value	Cointegration
Benin	5.115	2.39	3.38	Yes
Burkina Faso	7.036	2.39	3.38	Yes
Ivory Coast	3.266	2.39	3.38	Not conclusive
Gambia	3.382	2.39	3.38	Yes
Ghana	42.826	2.39	3.38	Yes
Mali	2.476	2.39	3.38	Not conclusive
Niger	5.373	2.39	3.38	Yes
Nigeria	6.905	2.39	3.38	Yes
Sénégal	0.922	2.39	3.38	No
Sierra Leone	2.573	2.39	3.38	Not conclusive
Togo	7.049	2.39	3.38	Yes

Tables 3 and 4 present the set of long- run and short-run coefficients of the variables studied for all the countries in our study. The results suggest that there is a statistically positive relationship between gross domestic income and savings in the short and long run for all the countries studied. We also find that for all of these countries, consumption has a negative and statistically significant effect on national savings in the short and long run. On the other hand, our results reveal that, with the exception of Benin and Niger, the value added of agriculture has a negative effect on savings in all cases. The negative effect of agricultural income on savings may be due to the income effect, where an increase in income leads to an increase in consumption of necessities and, consequently, to low savings, especially for low-income individuals. The current account and money supply coefficients were found to be negative in some cases and positive in others.

The negative coefficient on the money supply (M2) implies that the increase in the money supply will induce inflation, so the increase in the inflation rate in these countries reduces the domestic savings rate, either by reducing the purchasing power of people's income or through a portfolio adjustment from money deposits in banks to other fixed assets. This result can also be explained by the fact that the increase in the money supply will induce inflation and a reduction in interest rates, which suggests a reduction in savings in the economy. On the other hand, the positive coefficient on the current account implies that increasing exports will lead to an increase in investment in the country, which will increase the number of jobs available, which in turn leads to an increase in employment, income and ultimately savings.

The coefficient of ECM(-1) explains the speed of adjustment to the long-run equilibrium. The sign of ECM(-1) must be negative and significant Bannerjee et al. (1998). ECM(-1) is an additional explanation of the long-run relationship between the said variables. It is the most reliable way to examine cointegration between variables.

In summary, the empirical results suggest that income growth is crucial to improving the level of savings in ECOWAS countries.

The diagnostic tests, important for the validation of the model, presented in table (a) in the appendix, indicate that the null hypothesis is accepted for all the tests, so our model is statistically good at the 5% threshold. It is observed that the normality test of the residuals based on the Jacques-Bera tests concludes to the normality of the residuals. Moreover, the Breush Godfrey test of autocorrelation of the residuals concludes that the residuals are not serially autocorrelated. In addition, the homoscedasticity test based on the Breush-Pagan-Godfrey test also confirms the homoscedasticity of the residuals.

Table 3. Long-term coefficients

Countries	GDI	M2	CACCOUNT	CONSUM	AGR	Cons
Benin	0.158	0.015	0.202**	-1.039***	0.190**	82.847***
	(0.438)	(0.792)	(0.011)	(0.000)	(0.016)	(0.000)
Burkina Faso	0.108	-0.825	0.710	-0.085	0.083	-30.177
	(0.294)	(0.139)	(0.115)	(0.250)	(0.999)	(0.719)
Ivory Coast	/	/	/	/	/	/
Gambia	0.119**	0.230**	0.341**	-0.439***	-0.449***	4.947***
	(0.004)	(0.054)	(0.022)	(0.007)	(0.000)	(0.000)
Ghana	0.522***	-0.871***	-0.377*	-0.525***	0.234	12.038***
	(0.000)	(0.000)	(0.079)	(0.000)	(0.349)	(0.000)
Mali	/	/	/	/	/	/
Niger	0.184***	0.533***	0.010	-3.759	0.039	71.081
	(0.001)	(0.000)	(0.948)	(0.103)	(0.744)	(0.135)
Nigeria	0.232	-0.986**	0.296	-0.757***	-0.459	115.544***
	(0.890)	(0.032)	(0.423)	(0.009)	(0.371)	(0.000)
Sénégal	/	/	/	/	/	/
Sierra Leone	/	/	/	/	/	/
Togo	0.615**	-0.090	0.028	-0.037	0.214**	-46.574
	(0.033)	(0.167)	(0.839)	(0.861)	(0.015)	(0.282)

Source: Authors' calculations from the World Development Indicators database on Eviews software; Values in parentheses indicate estimated P-values. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 4. Short-term coefficients

countries	GDI	M2	CACCOUNT	CONSUM	AGR	ECM(-1)
Benin	0.786***	-0.030	0.108***	-0.905***	0.119**	-0.491***
	(0.000)	(0.510)	(0.006)	(0.000)	(0.013)	(0.000)
Burkina Faso	0.712***	0.023	0.622***	-0.685***	-0.013	-0.197***
	(0.001)	(0.746)	(0.000)	(0.000)	(0.859)	(0.000)
Ivory Coast	0.379***	-0.170*	0.443***	-0.570***	-0.207*	/
	(0.000)	(0.064)	(0.000)	(0.000)	(0.092)	/
Gambia	0.186***	0.460***	0.470***	-0.334***	-0.264***	-0.300***
	(0.001)	(0.000)	(0.000)	(0.005)	(0.006)	(0.000)
Ghana	0.720***	-0.248*	-0.363**	-0.668***	0.247	-0.564***
	(0.000)	(0.095)	(0.038)	(0.000)	(0.355)	(0.000)
Mali	0.455***	-0.159*	0.253***	-0.758***	-0.487***	/
	(0.000)	(0.074)	(0.000)	(0.000)	(0.000)	/
Niger	0.262***	0.110	0.399***	-7.251***	0.453***	-1.025***
	(0.007)	(0.484)	(0.000)	(0.001)	(0.001)	(0.000)
Nigeria	0.320	-0.351	0.827***	-0.319***	-0.454**	-0.410***
	(0.782)	(0.112)	(0.000)	(0.004)	(0.028)	(0.000)
Sénégal	0.162	0.045	0.297**	-0.362***	0.057	/
	(0.649)	(0.533)	(0.023)	(0.003)	(0.757)	/
Sierra Leone	0.476**	-0.290	0.315***	-0.199*	-0.213*	/
	(0.026)	(0.292)	(0.005)	(0.067)	(0.068)	/
Togo	0.841***	0.207**	0.086	-0.611***	-0.108**	-0.658***
	(0.000)	(0.010)	(0.293)	(0.000)	(0.048)	(0.000)

Source: Authors' calculations from the World Development Indicators database on Eviews software; Values in parentheses indicate estimated P-values. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

5.1 Robustness Check with Panel Estimation

The fact that we only have 40 observations for the estimation of the series could be a critical point for our results. In order to improve the robustness of our results, we perform an estimation in panel data.

Table 5. Result of the ARDL panel model estimation

	Panel A	Panel B	Panel C
Indenpendent variable	MG (a)	MG (b)	MG(C)
short-run			
Gross Domestic Income	0.121	0.306***	0.322***
	(0.139)	(0.007)	(0.001)
money supply	-0.338	-0.584	-0.786
	(0.307)	(0.228)	(0.114)
Current account	0.103*	0.259	0.203***
	(0.089)	(0.021)	(0.008)
Consumption	-0.770***	-0.290**	-0.509***
	(0.000)	(0.011)	(0.000)
Agriculture	-0.894	0.233	0.043
	(0.133)	(0.188)	(0.979)
Error Correction Term	-0.445***	-0.424***	-0.416***
	(0.000)	(0.000)	(0.000)
long-run			
Gross Domestic Income	0.745**	0.818***	0.493***
	(0.038)	(0.002)	(0.001)
money supply	-0.684	0.854	0.987
	(0.695)	(0.112)	(0.201)
Current account	0.503*	-0.131	0.075
	(0.061)	(0.638)	(0.770)
Consumption	-0.586**	-0.084**	-0.186***
	(0.025)	(0.011)	(0.003)
Agriculture	-0.412**	0.080*	-0.337*
	(0.044)	(0.098)	(0.071)
Obs	152	273	418
Number of countries	4	7	11
Obs per group	38	39	38

Note. Numbers in parentheses are p-values ; ***, **, * significant at 1%, 5% and 10% respectively.

As mentioned earlier, we used an ARDL panel model, including a panel made up of all ECOWAS countries; then a panel made up of only the francophone ECOWAS countries and another panel made up of the anglophone countries in the ECOWAS space. We proceed in this way in order to establish a comparison of savings performance between Francophone and Anglophone countries in the ECOWAS region and to check the robustness of our results. The results presented in Table 5 above show that for Panel A (English-speaking countries), the current account has a positive influence on both short-term and long-term savings. In contrast, consumption and agriculture have negative effects on savings. For panel B (French-speaking countries), the results indicate a significant positive short-term and long-term impact of domestic income and agriculture on savings. However, consumption has negative effects on savings. For Panel C (all ECOWAS countries), income and current account are also confirmed as statistically significant determinants of savings in the ECOWAS region in the short run. On the other hand, consumption and agriculture have negative effects on savings in the zone.

In order to make a comparison between these two groups of countries, it is very important to clarify and understand what may actually determine the difference in national savings in each of these two groups considered. It should be noted that the positive impact of agricultural value added on savings in the Francophone space can be explained by the fact that most of the population in these countries lives in agriculture. In contrast, the positive effect of the current account on savings in English-speaking countries reveals that these countries export more than they import. This implies that export earnings are therefore used to improve technological know-how, training of the local labor force and thus increase export competitiveness, which in turn leads to increased employment, income and ultimately savings.

6. Conclusion and Policy Implications

This study analyzed the determinants of national savings in ECOWAS countries over the period 1980-2020. To this end, we used the Autoregressive Distributed Lag (ARDL) model to estimate our equations first at the individual level and then for panel data. This study shows that the determinants of savings performance are diverse across countries. Some variables are significant in one case, but not in others. However, we need to take into account the characteristics of each case given the differences in economic, social, and demographic conditions across countries. The main policy implication of our study is related to the positive effect of income on national savings, which suggests that governments should use policy that improves worker productivity.

Based on the empirical results of the panel data, the policy implications and recommendations suggested by the study are as follows: A policy measure to improve the trade balance should focus on expanding exports by implementing the industrial and export strategy adopted in industrialized countries and reducing excessive imports, especially of goods that can be produced in the ECOWAS zone.

Such policies will reduce imports and improve export earnings, which in turn will increase savings. This can be done by focusing primarily on sectors that are the main drivers of the economy, such as the service sector and the agricultural sector, among others. It is also recommended that in order to promote savings, growth and development, pragmatic and realistic economic policies be formulated to strengthen all monetary and financial institutions in the respective countries. In particular, the establishment of new and more sophisticated financial markets and the adaptation of new instruments are essential to increase savings rates in developing countries, especially in West Africa.

However, it is important to note that the most powerful determinant of long-term savings is economic growth as presented in the life-cycle hypothesis. According to this view, West Africa's chronically low savings rate is primarily a consequence, rather than a cause, of the region's history of low and volatile economic growth. Hence the need for policymakers to formulate policies to stimulate economic growth.

Author Contributions

All authors have contributed equally to all parts of the document.

Conflicts of interest

The authors declare no conflicts of interest.

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Appendix

Table a. Results of the diagnostic test

Countries	(A) Autocorrelation	(B) Heteroscedasticity	(c) Normality
Benin	1.7444 (0.192)	1.053 (0.419)	6.270 (0.430)
Burkina Faso	0.170 (0.844)	1.320 (0.289)	1.358 (0.507)
IVory coast	1.221 (0.317)	0.515 (0.903)	0.797 (0.671)
Gambia	0.319 (0.730)	1.824 (0.103)	0.053 (0.973)
Ghana	0.223 (0.801)	0.483 (0.919)	0.220 (0.895)
Mali	1.042 (0.372)	1.152 (0.376)	0.432 (0.805)
Niger	0.533 (0.594)	0.324 (0.9831)	0.405 (0.816)
Nigeria	0.487 (0.620)	0.583 (0.834)	5.690 (0.0581)
Sénégal	0.013 (0.986)	1.690 (0.141)	2.516 (0.284)
Sierra Leone	0.071 (0.931)	1.690 (0.141)	2.516 (0.284)
Togo	0.451 (0.643)	0.866 (0.605)	0.081 (0.959)

Note. The numbers in parentheses are the p-values.

Table b. Results of the panel unit root test

unit root test									
	Panel A			Panel B			Panel C		
Variables	Levels	First Diff	Decision at the 5%	Levels	First Diff	Decision at the 5%	Levels	First Diff	Decision at the 5%
GDSAV	-0.9013 0.1837	-8.6639 0.0000	I(1)	-1.394 0.0816	-10.1684 0.0000	I(1)	-0.8011 0.2115	-12.2101 0.0000	I(1)
GDI	2.8303 0.9977	-6.3180 0.0000	I(1)	7.1531 1.0000	-8.8043 0.0000	I(1)	7.6626 1.0000	-10.9909 0.0000	I(1)
M2	0.2641 0.6041	-7.8857 0.0000	I(1)	1.5164 0.9353	-8.8133 0.0000	I(1)	1.3590 0.9129	-11.3845 0.0000	I(1)
CACCOUNT	-1.0821 0.1396	-8.8306 0.0000	I(1)	-3.159 0.0008		I(0)	-2.9177 0.0018		I(0)
CONSUM	2.8022 0.9975	-5.8095 0.0000	I(1)	6.7417 1.0000	-10.0065 0.0000	I(1)	6.7797 1.0000	-11.4203 0.0000	I(1)
AGR	-1.2898 0.0986	-8.6801 0.0000	I(1)	-0.542 0.2938	-10.3862 0.0000	I(1)	-1.1893 0.1172	-13.5138 0.0000	I(1)

Source: Authors' calculations based on the World Development Indicators database on STATA software.

Table c. Panel estimation results

	Panel A				Panel B			
Indenpendent variable	PMG (a)		MG (a)		PMG (b)		MG (b)	
	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run
GDI	0.139*	0.363***	0.121	0.745**	0.366***	0.234*	0.030***	0.818***
	(0.061)	(0.001)	(0.139)	(0.038)	(0.000)	(0.089)	(0.007)	(0.002)
M2	-0.410	0.138***	-0.338	-0.684	-0.662	0.426***	-0.584	0.854
	(0.187)	(0.003)	(0.307)	(0.695)	(0.135)	(0.000)	(0.228)	(0.112)
CACCOUNT	0.197	0.680***	0.103*	0.5032*	0.271***	0.422***	0.259	-0.131
	(0.148)	(0.000)	(0.089)	(0.061)	(0.003)	(0.004)	(0.021)	(0.638)
CONSUM	-0.208**	-0.225***	-0.770***	-0.586**	-0.207***	-0.221**	-0.029**	-0.084**
	(0.010)	(0.000)	(0.000)	(0.025)	(0.000)	(0.017)	(0.011)	(0.011)
AGR	-0.147*	-0.156***	-0.894	-0.412**	0.0471	-0.778***	2.233	0.080*
	(0.086)	(0.003)	(0.133)	(0.044)	(0.596)	(0.000)	(0.188)	(0.098)
Obs	152	152	152	152	273	273	273	273
Number of countries	4	4	4	4	7	7	7	7
Obs per group	38	38	38	38	38	38	38	38

Source: Authors' calculations based on the World Development Indicators database on STATA software; Numbers in parentheses are p-values ; ***, **, * indicate significance at 1%, 5% and 10% respectively.

Indenpendent variable	PMG (c)	PMG (c)	MG (c)	MG (c)
	Short run	Long run	Short run	Long run
GDI	0.692***	0.933***	0.322***	0.493***
	(0.000)	(0.001)	(0.001)	(0.000)
M2	-0.986*	0.154***	-0.786	0.987
	(0.080)	(0.000)	(0.114)	(0.201)
CACCOUNT	0.223***	0.606***	0.203***	0.075
	(0.001)	(0.000)	(0.008)	(0.770)
CONSUM	-0.395***	-0.618***	-0.509***	-0.186***
	(0.000)	(0.000)	(0.000)	(0.003)
AGR	-0.055	-0.909***	0.043	-0.337*
	(0.404)	(0.000)	(0.979)	(0.071)
Obs	418	418	418	418
Number of countries	11	11	11	11
Obs per group	38	38	38	38

Table d. Hausman test result

Equation	Hausman specification test	Prob>chi2
Ho : model support the PMG estimator	Panel A	0.0005
H1 : model support the MG estimator	chi2(1) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 12.19	
	(V_b-V_B is not positive definite)	
Decision : reject the null hypothesis if the p-value < 0.05	Panel B	0.0580
	chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 10.69	
	(V_b-V_B is not positive definite)	
	Panel C	0.0042
	chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 17.15	
	(V_b-V_B is not positive definite)	

Source: Authors.