THE RELATIONSHIP AMONG HUMAN CAPITAL, FINANCIAL DEVELOPMENT AND ECONOMIC GROWTH: PANEL VARX EVIDENCE FROM ECOWAS COUNTRIES*

İnsan Sermayesi, Finansal Kalkınma ve Ekonomik Büyüme Arasındaki İlişki: ECOWAS Ülkelerinden Panel VARX Kanıtları

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Abstract
This paper analyses the relationship among economic growth, financial development, and human capital for 14 ECOWAS countries from 1970 to 2021 years using panel VARX (Vector Auto–Regressive with eXogenous variable). Results suggested evidence of bidirectional causality between money supply and life expectancy at birth and unidirectional causality running from GDP to domestic credit, education, human capital to GDP, money supply to GDP, health-based human capital to domestic credit, and domestic credit to broad money. Overall, financial development, as measured by broad money, hurt economic growth, while when measured by domestic credit, it had a positive but statistically insignificant effect on growth. Human capital, while represented by education did have a positive impact on GDP, while the impact of human capital when represented by health on GDP was also positive but statistically insignificant. Also, health-based human capital interacted positively with financial development, irrespective of the proxy used, but education-based human capital had no statistically significant interaction with any financial development measures. Economic growth has a significant positive impact on financial development through domestic credit, but has a positive and insignificant impact on money supply and human capital.

Anahtar Kelimeler:
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Büyüme,
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Öz
Bu makale, 14 ECOWAS ülkesi için 1970'ten 2021'e kadar panel VARX (Dışsal değişkenli Vektör Oto-Regresif). kullanarak iktisadi büyüme, finansal gelişme ve beşeri sermaye arasındaki ilişkiyi analiz etmektedir. Çalışmada, para arzı ile doğumda beklenen yaşam süresi arasında çift yönlü bir nedensellik ve GSYİH'den yurtiçi krediye, beşeri sermayeden (eğitim göstergesi ile temsil edildiğinde) GSYİH'ye, para arzından GSYİH'ye, beşeri sermayeden (sağlık göstergesi ile temsil edildiğinde) yurtiçi krediye ve yurtiçi krediden geniş para arzına doğru tek yönlü bir nedensellik ilişkisi elde edilmiştir. Genel olarak, geniş para arzı ile ölçülen finansal gelişme, iktisadi büyümeyi geriletirken, yurtiçi kredi ile ölçüldüğünde büyüme üzerinde pozitif ancak istatistiksel olarak anlamsız bir etkiye sahiptir. Çalışmada, beşeri sermayenin (eğitim göstergesi ile temsil edildiğinde) GSYİH üzerinde pozitif bir etkisi olduğu sonucuna varılmıştır. Ne var ki, beşeri sermayenin (sağlık göstergesi tarafından temsil edildiğinde) GSYİH üzerindeki etkisi pozitif ancak istatistiksel olarak anlamsız olduğu sonucuna varılmıştır. Ayrıca, beşeri sermaye (sağlık göstergesi ile temsil edildiğinde), kullanılan vekilden bağımsız olarak finansal gelişme ile pozitif etkileşim içerisinde olduğu ancak beşeri sermayenin (eğitim göstergesi ile temsil edildiğinde) herhangi bir finansal gelişme ölçüsü ile istatistiksel olarak anlamlı bir etkileşimi olmadığı sonucu bulunmuştur. İktisadi büyümenin, yurtiçi kredi yoluyla finansal gelişme üzerinde anlamlı pozitif bir etkisi olduğu, ancak para arzı ve beşeri sermaye üzerinde pozitif ve anlamsız bir etkisi olduğu sonucu elde edilmiştir.

1. Introduction

Africa contains the largest number of the world's LDCs (Least Developed Countries). It accounts for 32 of the 45 countries designated by the United Nations as LDCs, underscoring the continent's disproportionate representation in this category, and thus its underdevelopment (List of LDCs, 2024). Moreover, among the 15 member states of ECOWAS (Economic Community of West African States), up to 11 fall under the LDCs designation.

So, to question and understand some key factors underlining this relatively lower development of the ECOWAS countries, this study wanted to examine the interlinkages and the contributions of the financial sector and human capital to the development or underdevelopment of these economies.

Firstly, the link between finance and economic growth may run through various transmission channels. The so–called AK model ($Y_t=AK_t$) illustrates three meaningful connections between financial variables and economic activity. Financial Development might (1) reduce the loss of resources required to allocate capital, (2) increase the savings ratio, and (3) raise capital productivity (Thiel, 2001).

Secondly, human capital refers to the workforce's knowledge, skills, creativity, and abilities. The recipient of the 1992 Nobel Prize in Economic Science, Gary S. Becker (1993), demonstrates how investment in an individual's education and training is like business investments in equipment. Moreover, Becker (2007) extends the concept of human capital to include health (among others) in addition to education and training. Overall, investing in the development of its workers or population generally promotes innovation, boosts production, and improves profitability, all of which spur economic growth, which in turn tends to lift more people out of poverty by improving their living conditions.

Finally, an interdependency may exist between human capital and financial development. Consequently, a financially developed market allocates more efficiently available resources to promote investments in human capital via access to credits for education/training expenditure, health expenditure, and welfare activities; conversely, human capital may affect financial development since skilled and well–educated people may create financial innovations necessary for financial development; additionally, education allows economic agents to transit from informal sector to formal sector opportunities, thus, reducing the size of the informal economy (Kılıç and Özcan, 2018).

Consequently, the aim of this paper is to assess the impact of Human Capital and Financial Development on growth and vice versa for 14 ECOWAS countries from 1970 to 2021 years using panel VARX (Vector Auto–Regressive with eXogenous variable) model. The specific research questions of this study include:

RQ (Research Question)1: Does Human Capital or Financial Development have any statistically significant impact on the economic growth of ECOWAS countries?

RQ2: Does growth statistically significantly affect Human Capital or Financial Development in the ECOWAS zone?

This study seeks to contribute to the existing literature by filling the research gap given the fact that no research has yet analyzed in detail the relationship between human capital,

financial development, and economic growth for the ECOWAS region by applying a panel VARX methodology.

The study is organized into six sections. The context section gives an overview of key socio-economic indicators across ECOWAS member countries. The literature review section presents a summary of recent empirical literature. The data and econometric methodology section covers the methodology, including data, variables, models, and econometric techniques. The empirical results and discussions section reports and discusses the findings, and the conclusion and policy implications section summarizes the paper and makes recommendations.

2. Context

ECOWAS was established via the Treaty of Lagos on May 28, 1975 (ECOWAS, 1975). Headquartered in Abuja (Nigeria), it is a 15–member[1] regional group with a mandate of promoting economic integration, ensuring peace and political stability, and improving living standards and social development in the constituent countries.

The ECOWAS total population, total surface area, and total real GDP (Gross Domestic Product) are 440421599, 5113115 Km^2, and 800,827 billion US dollars (constant 2015 US$), respectively, as of 2022, according to the WDI (World Development Indicators) (World Bank, 2025a; World Bank, 2025b) and the ECOWAS website (Land area, 2024). To better understand these numbers, the figures below represent the percentage distribution across countries.

Figure 1 shows that Nigeria only accounts for slightly more than half of the region's population. It is followed by Ghana, which has about 8% of the population, and Cabo Verde, which has only 0,12% of the total regional population.
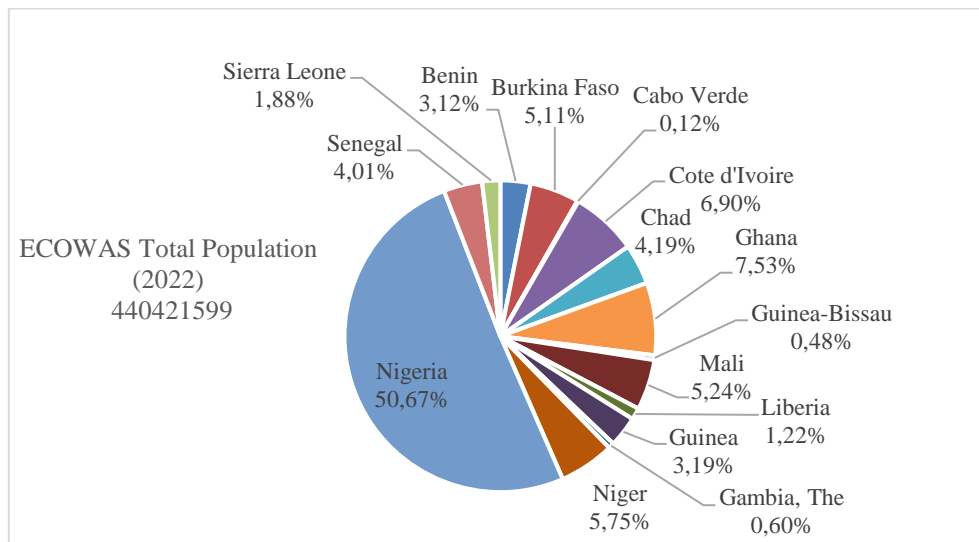

Figure 1. ECOWAS Total Population (2022)
Source: Authors' own generation using Excel and fetched data (World Bank, 2025b).

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[1] Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, The Gambia, Ghana, Guinea, Guinea–Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo.

In terms of surface area (see Figure 2), Nigeria is third, preceded by Mali and Niger, having each almost a quarter of the total area. Cabo Verde has the smallest surface area, with less than 1%.
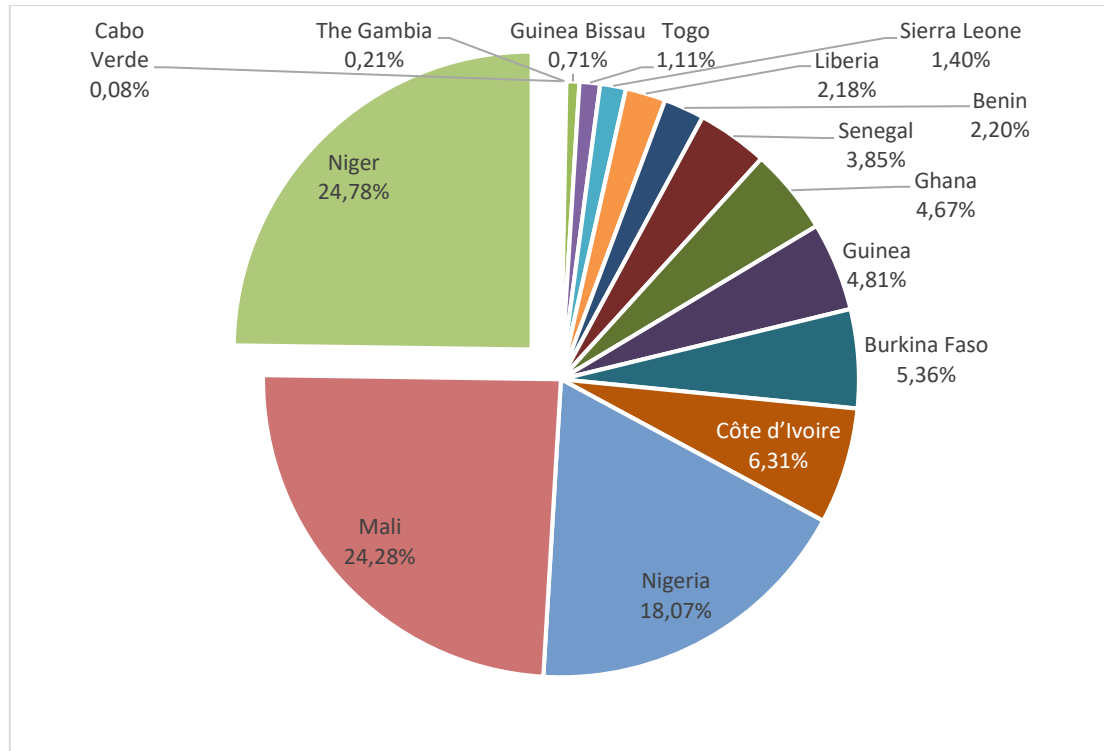

Figure 2. ECOWAS Total Surface Area > 5 million Km2
Source: Generated by the Authors using Excel and fetched data (Land area, 2024).

Furthermore, looking at the economic performance in terms of real GDP, Nigeria is the biggest economy, with almost 67% of the total GDP of the community. It is followed by Ghana and the Ivory Coast, each with about 8,5% of the total income. Up to eight countries account for less than 7% of the regional income (Niger: 1,79%, Guinea: 1,73%, Togo: 0,98%, Sierra Leone: 1,10%, Liberia: 0,43%, Cabo Verde (0,26%), Gambia (0,23%), and Guinea-Bissau: 0,20%). (see Figure 3).

So, Nigeria is the regional power economically and demographically, with the third largest surface area in the region. Cabo Verde is among the last third countries in terms of income and the smallest in terms of population and area size.
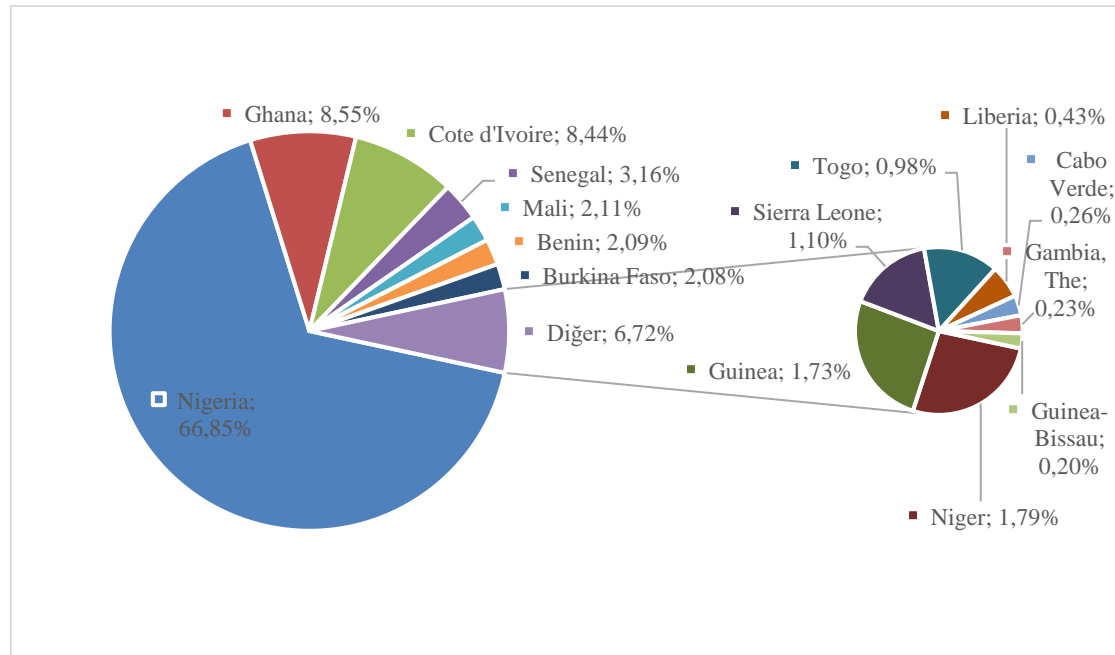
Figure 3. ECOWAS Real GDP (Constant 2015 US$): About 800,827 Billion Dollars (2022)
Source: Authors' Generation using Excel and fetched data (World Bank, 2025a).

Nevertheless, out of 15 ECOWAS member countries, up to 11 are among those 45 countries (United Nations, 2024a, 2024) classified as LDCs, defined by the United Nations (United Nations, 2024b) as countries that have low levels of income (average per capita income of below USD$1018 for inclusion, and above USD$1222 for graduation) and face severe structural impediments to sustainable development. The remaining four member countries (Nigeria, Ivory Coast, Ghana, Cabo Verde) still fall in the category of lower–middle–income economies (Gross National Income per capita of $1136 to $4465 in 2022 for the 2024 fiscal year) according to the World Bank (World Bank, 2024).

3. Literature Review

Numerous studies have investigated the relationship between financial development, human capital, and economic growth and have found varying results. Some studies found statistically significant positive impacts of human capital and financial development on the real sector, irrespective of the proxies used. Moreover, those studies emphasize the complementarity effects of these indicators (Financial Development, Human Capital) on the economy.

Dwyfor et al. (2002) evaluate the contributions of human capital (primary and secondary school enrolment rates and public expenditure on education) and financial development (the ratio of M2 to GDP, the ratio of domestic credit to GDP) to economic growth in a panel of 82 countries covering 21 years (1972–93) based on the random effects estimation procedure. Results suggest that money makes a statistically significant contribution to growth, irrespective of whether money or credit is employed as a measure of the monetary factor. Also, the interaction between credit and human capital makes a statistically significant contribution to growth, irrespective of the precise measure of human capital. Overall, results suggest that financial development is at least as important as human capital in the growth process.

Hakeem and Oluitan (2012) investigate the relationship between human capital and financial development (the domestic credit to the economy, broad money, and liquid liabilities) in South Africa for the period of 1965–2005 using Dynamic OLS (Ordinary Least Squares), Error Correction Model, and Levels VAR (Vector Auto–Regressive) techniques. The study uses primary school, secondary school, and tertiary institution enrolment rates as indicators of education-based human capital and life expectancy at birth as indicators of health-based human capital. The results suggest evidence of bi–directional causality and that income is a possible transmission mechanism.

Kargbo et al. (2016) examine the link between financial development and human capital accumulation on economic growth in Sierra Leone for the 1980–2012 period, using the OLS regression estimation technique. They show that the simultaneous interaction of financial development and human capital accumulation is significant and positively impacts growth.

Ibrahim (2018) uses the System GMM (Generalized Method of Moments) technique on a sample of 29 SSA (Sub-Saharan Africa) countries over the period 1980–2014 to find that both human capital (primary pupils–teacher ratio and secondary school gross enrolment rate) and financial development (the ratios of private and domestic credits to GDP) unconditionally promote economic growth.

Oyinlola and Adedeji (2019) examine the impact of human capital (secondary school enrolment index, life expectancy, and total factor productivity) on inclusive growth (GDP per worker) and interrogate how the financial sector catalyzes this process by applying the system GMM technique on 19 sub–Saharan African countries over the period 1999–2014. Their findings support a positive direct impact of both human capital and financial development (Private credit to GDP (%), Bank overhead costs to total assets (%), and Bank net interest margin (%)) on inclusive growth. Their results also show that financial development promotes the extent to which human capital can facilitate inclusive growth.

Using the ARDL (Autoregressive Distributed Lag) model on the Nigerian Economy, Orji et al. (2019) showed that financial development (Credit to Private Sector/GDP Ratio) through the human capital development (School Enrollment Rate) channel has a positive and significant impact on economic growth in Nigeria. Also, the study showed the existence of unidirectional causality running from financial development to human capital development in Nigeria.

GMM technique was applied to data from 23 Indian states for the period 1999–2013 by Arora and Jalilian (2020) to examine the mutual influence mechanism among financial development, human capital, and economic growth at the sub–national level. They suggest evidence of a positive relationship between human capital, financial development, and economic growth.

Sarwar et al. (2021) investigate the critical aspect of financial development, human capital, and their interactive term on economic growth from the perspective of emerging economies. They applied the two–step system GMM technique on 83 emerging countries' data for 2002–2017. The study used two financial development indicators: domestic credit provided by the financial sector and domestic credit to the private sector, and two human capital indicators: secondary school enrollment and primary pupil–teacher ratio. The findings indicate that financial development positively and significantly affects economic growth. Human capital

also has a positive impact on economic growth. Financial development and human capital interactively affect economic growth for emerging economies positively and significantly.

Some studies have linked the positive impacts of human capital and/or financial development on the real sector to some conditions. Therefore, Oyinlola and Adedeji (2020), using the Difference GMM econometric technique on eleven SSA countries' data covering the period between 1999 and 2014, find that human capital has a direct positive impact on growth only when measured in terms of its efficiency, but irrespective of the measures of financial development.

Also, Tinta (2022) found that using the Augmented Mean Group algorithm on a sample of 48 SSA countries and covering the period 1980 to 2019, there is a threshold of the level of economic development beyond which the effects of human capital (the percentage of tertiary educated people) occur on the performance of the financial system (Financial development index as proxy), and thus on the economic growth. According to him, the effects of human capital are only observed in high–income and upper–middle–income countries. Nevertheless, the findings confirm the feedback hypothesis between economic growth and financial development.

Finally, some studies found mixed or inconclusive results. Thus, Hakeem (2010) employs a panel data fixed effect, random effects, and maximum likelihood estimation techniques on SSA countries and finds that the stock of human capital (the average of the educational attainment) is important for growth in the region but does not find strong impact of financial development (liquid liabilities, broad money, private credit and domestic credit ratios of the GDP) in the region. He, however, finds robust complementarity features in the interaction of both finance and Human Capital on growth.

Also, Abubakar et al. (2015) use the ratios of broad money, domestic and bank credits to GDP as financial development indicators and employ panel Fully Modified and Dynamic OLS techniques on ECOWAS countries (1980–2011) and reveal that bank private credit and domestic private credit contribute significantly to economic growth in the ECOWAS, both directly and through their influence on human capital accumulation. They concluded that broad money as a ratio of GDP is not statistically significant in influencing economic growth, both directly and indirectly, via the human capital accumulation channel. On the contrary, real economic activities instead cause broad money growth. However, the financial intermediation activities of banks and related institutions (in the form of credit facilities) support the accumulation of human capital, which has also contributed significantly to the real GDP growth of the ECOWAS region.

Forouheshfar (2017) examines the impact of the financial markets on economic growth for 15 Middle East and North Africa (MENA) countries. The GMM estimates suggest a negative effect of financial sector development (proxied by Private credit, Bank deposit, and Liquid liabilities ratios to GDP (%)) on the real sector. According to her, the results underline the expansion of an inefficient financial sector in the region, meaning that there are problems of credit allocation and weak financial supervision and regulation.

Ali et al. (2021) applied fixed and random effects models on 12 low–income countries from 1980–2016 to examine how financial development and economic growth influence human capital in low–income countries. Broad money supply and private sector credit positively and

significantly impact human capital. Interestingly, bank credit showed a negative and significant effect on human capital. Nonetheless, they found a significant positive relationship between human capital and economic growth.

To sum up, the results of the studies so far conducted still have mixed findings, and very limited studies have assessed the mutual impacts and the feedback hypothesis between human capital, financial development, and economic growth (that is, also the economic growth impact on human capital and financial development), especially for the ECOWAS zone. No study has yet analyzed the relationship between human capital, financial development, and economic growth within ECOWAS countries using the panel VARX approach. This research gap is precisely what this study aims to address.

4. Data and Methodology

ECOWAS comprises WAEMU (West African Economic and Monetary Union) countries (Benin, Burkina Faso, Cote d'Ivoire, Guinea–Bissau, Mali, Niger, Senegal, and Togo); ZMAO or WAMZ (West African Monetary Zone) countries (The Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone); and Cabo Verde. However, Liberia (2,18%, 1,22%, and 0,43% of the total regional surface area, population, and income, respectively)[2] was excluded from the study because of the unavailability of sufficient data.

Annual data (1970–2021) fetched from the World Bank database (WDI, Last Updated: 05/10/2023), and the WBCPD (World Bank Commodity Price Data) (The Pink Sheet, Last updated June 02, 2023) are used. In line with standard literature, the variables of interest are real GDP as a proxy for economic development, Broad Money and Domestic Credit to Private Sector ratios to GDP as proxies for financial development, and Pupils–Teacher ratio and Life Expectancy as human capital proxies. Based on the standard neoclassical growth theory, some control variables are also included: trade/economic openness (sum of imports and exports), government expenditure (final government consumption), and inflation (Consumer Price Index) to control respectively for external influences, public sector activities, and macroeconomic stability. Also, Crude Oil Prices are considered as an exogenous variable given that Crude Oil is an important export commodity in four ECOWAS countries (Côte d'Ivoire, Ghana, Niger, and Nigeria). The remaining 11 are net oil importers, which makes them very susceptible to fluctuations in global oil prices (Paye Gbatu et al., 2017).

One lag of endogenous variables is assumed, while only contemporaneous values of the exogenous variable are included in the model. Variable plots, summary statistics, cross–sectional dependence, correlations, and unit root tests are conducted using the STATA 17 package. A PVARX (1,0) (Panel Vector Auto–Regressive with eXogenous variable) is estimated (Dynamic Panel VARX estimation, GMM Style), its stability checked (eigenvalues/modulus), IRFs (Impulse Response Functions), and FEVDs (Forecast Error Variance Decompositions) computed.

The estimations are conducted following the methodology of Abrigo and Love (2016), who consider a k-variate homogeneous panel VAR of order p with panel–specific fixed effects represented by the following system of linear equations:

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[2] Refer to figures 1, 2 and 3.

$$Y_{it} = Y_{it-1}A_1 + Y_{it-2}A_2 + \ldots + Y_{it-p-1}A_{p-1} + Y_{it-p}A_p + X_{it}B + u_i + e_{it}$$

$$i \in \{1,2,\ldots,N\}, t \in \{1,2,\ldots,T_i\}$$

(1)

where Y_{it} is a (1×k) vector of dependent variables (GDP, BM (Broad Money), DCP (Domestic Credit to Private Sector), PTR (Pupils Teacher Ratio), LE (Life Expectancy at birth), TRD (Trade Opennes), CPI10 (Consumer Price Index), and PCGE (Per Capita Government Expenditure))[3], X_{it} is a (1×l) vector of exogenous variables (OPr), and u_i and e_{it} are (1×k) vectors of dependent variable–specific panel fixed–effects and idiosyncratic errors, respectively. The (k×k) matrices A_1, A_2, ..., A_{p-1}, A_p and the (l×k) matrix B are parameters to be estimated. It is assumed that the innovations have the following characteristics: Zero Mean, uncorrelated across individuals, and no serial correlation (uncorrelated across time periods). That is to say, the error terms have a white noise behavior.

The model is fitted simultaneously as a system of equations using the GMM estimation procedure. The GMM-style procedure is widely used in Panel VARX modeling because it controls for endogeneity, accounts for unobserved heterogeneity or fixed effects, allows for exogenous shocks (e.g., crude oil prices), and yields efficient estimation.

The Panel VARX model is an extension of the traditional Panel VAR model that allows for richer dynamics and more flexible modeling of economic systems. In contrast to the traditional Panel VAR, Panel VARX incorporates both endogenous and exogenous variables, allows weak exogeneity for external shocks modeling, and is applicable to open systems and regional spillovers. Researchers have been using Panel VARX models to treat oil price volatility, exchange rate fluctuations, and global interest rate movements as exogenous variables. Since ECOWAS countries are open economies, exposed to external shocks and structural heterogeneity, this study uses the model to account, also, for oil price external influences on the ECOWAS region. For detailed information on the model, consult Abrigo and Love (2016).

Table 1. Overview of Key Variables

Indicator Name	Acronym	Definition	Data Source
GDP per capita (constant 2015 US$)	GDP	GDP per capita is gross domestic product 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. Data are in constant 2015 U.S. dollars.	WDI
Domestic credit to private sector (% of GDP)	DCP/DC	Domestic credit to the private sector (% of GDP) refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of non-equity securities, trade credits, and other accounts receivable, that establish a claim for repayment.	
Broad money (% of GDP)	BM/BMi	Broad money (% of GDP) is the sum of currency outside banks; demand deposits other than those of the central government; the time savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.	

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[3] See Table 1 for explanations of the variables and Appendix for abbreviations.

Table 1. Continued

Primary school pupils-teacher ratio	PTR	The primary school pupils-teacher ratio (referred to as education-based human capital) is the average number of pupils per teacher in primary school.	
Life expectancy at birth	LE	Life expectancy at birth (referred to as health-based human capital) indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	
Trade (% of GDP)	TRD	Trade (% of GDP) is the sum of exports and imports of goods and services measured as a share of gross domestic product.	
Consumer Price Index	CPI10	The consumer price index reflects changes in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. Here, the base year is 2010.	WDI
Per Capita General government final consumption Expenditure	PCGE	General government final consumption expenditure includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most national defense and security expenditures but excludes government military expenditures that are part of government capital formation. It is divided by the total population to obtain per capita government expenditure. Data are in constant 2015 prices, expressed in U.S. dollars.	
Real Crude Oil Price / barrel	OPr	It is the average of the Brent, Dubai, and WTI crude oil annual prices in real US dollars per barrel.	WBCPD

## 5. Empirical Results and Discussions

5.1. Summary Statistics

Below (see Table 2) are summarized the mean, the standard deviation, the minimum and maximum values, and the number of observations of the level and log forms of the variables in the model. For the subsequent estimations, the log forms of the variables are considered in line with the standard empirical literature.

Table 2. Summary Statistics

Variable	Level Form				Log Form				
	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max	Observations
GDP	953,45	633,88	274,35	3318,93	6,69	0,56	5,61	8,11	702
DC	14,88	11,69	0,0000016	73,19	1,73	3,08	–13,35	4,29	681
BM	23,55	16,82	0,01	125,30	2,55	1,96	–4,61	4,83	681
PTR	40,45	9,50	21,07	80,44	3,67	0,23	3,05	4,39	653
LE	52,47	8,11	32,53	76,59	3,95	0,16	3,48	4,34	728
PCGE	12,46	5,21	0,766	36,86	2,40	0,59	–0,27	3,61	458
CPI10	72,12	55,86	0,0018	354,30	3,62	1,87	–6,33	5,87	588
TRD	56,93	22,21	6,32	140,86	3,96	0,41	1,84	4,95	699
OPr	42,33	24,88	5,21	95,29	3,54	0,69	1,65	4,56	728

5.2. Average Values of the Principal Variables Across Countries for the Interval 1970-2021

On average, over the period 1970 to 2021, the highest real GDP per Capita is observed in Cote d'Ivoire with 2038 $, followed by Nigeria and Ghana; the smallest being Burkina Faso with only 436 $ preceded by Niger and Togo. Only 5 countries did have a real income per capita above 1000 $ (Graphic 1)
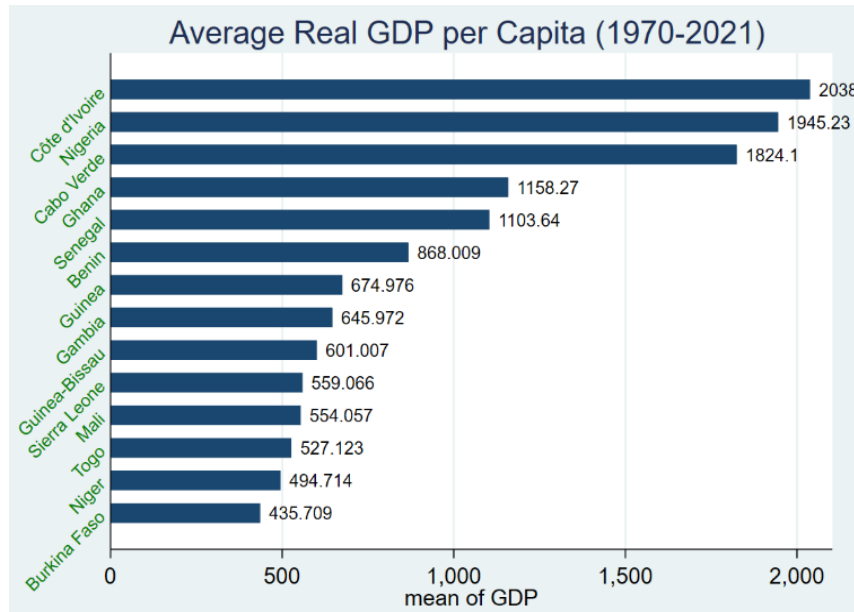
Graphic 1. Average GDP per Capita

Based on Graphics 2 and 3, three countries have the highest average and maximum life expectancy achievement: 1st Cabo Verde, 2nd Senegal, and 3rd Ghana. Despite their economic power, Nigeria and the Ivory Coast have the lowest maximum life expectancy (Graphic 3), and Nigeria is second to last in the average life expectancy (Graphic 2).
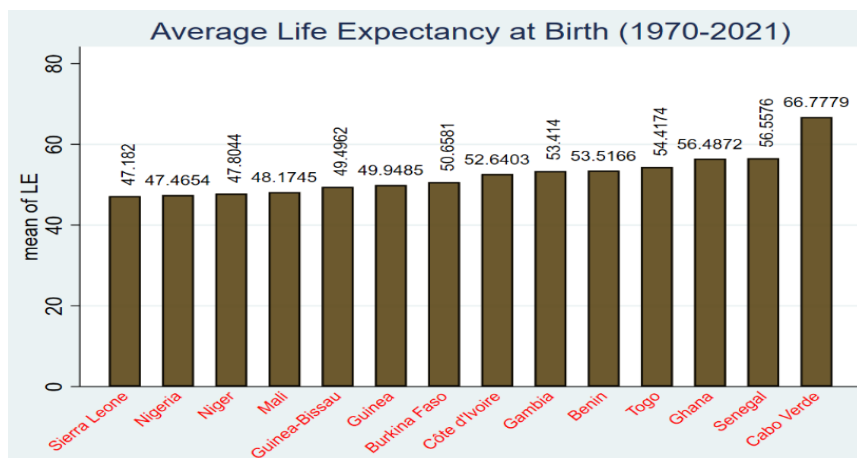
Graphic 2. Average Life Expectancy at Birth

Despite ranking last in average life expectancy, Sierra Leone has significantly improved its maximum life expectancy. A similar conclusion can be drawn for Niger, which, although on av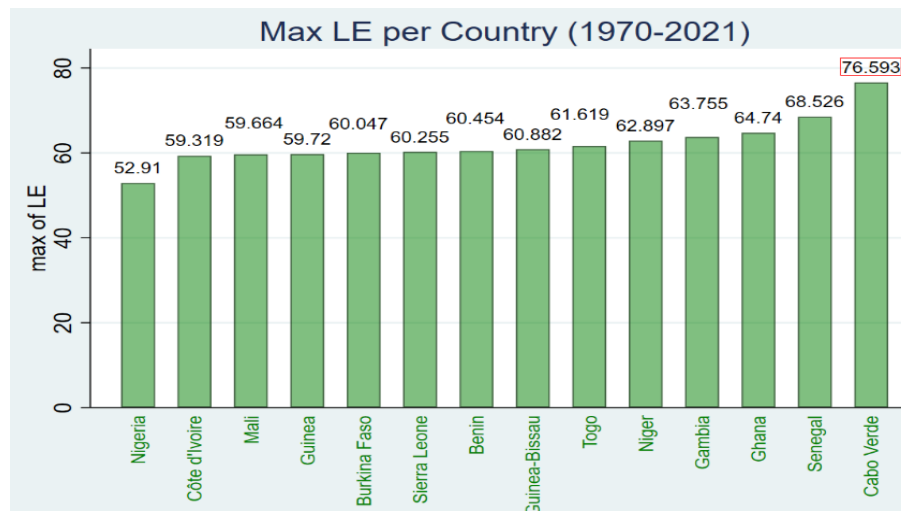erage, ranks among the bottom three, has achieved a maximum life expectancy that places it among the top five (Graphic 3).

Graphic 3. Max Life Expectancy

The average pupils-teacher ratio in the study period is the shortest for Ghana, with almost 30 students per teacher, and is the highest for Burkina Faso, with about 51 students per teacher. Niger is around the mean of this average, with about 40 pupils per instructor. Nigeria and Cabo Verde have a ratio of less than the mean, which is 40 students/teacher, while Senegal and Cote d'Ivoire have a ratio of more than 40 pupils/teacher (Graphic 4).
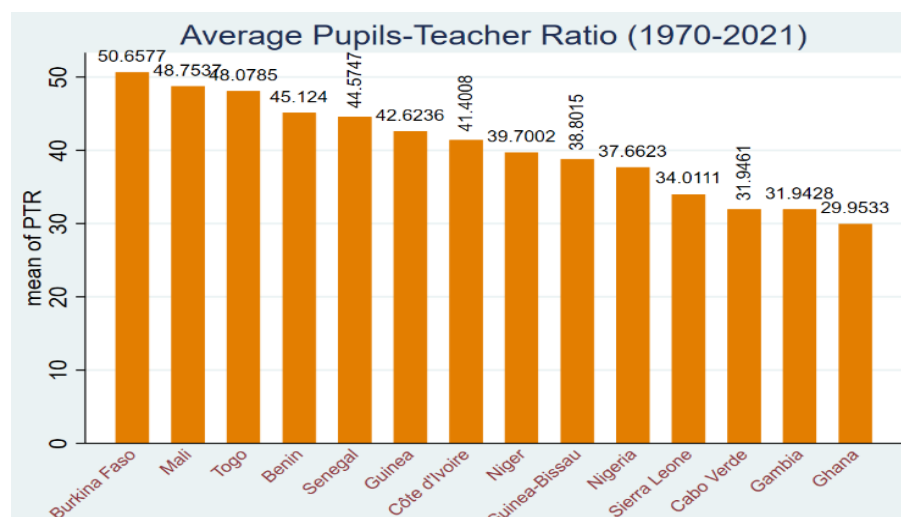
Graphic 4. Average Students – Teacher Ratio

Cabo Verde has the highest average domestic credit to the private sector (Graphic 5) and broad money (Graphic 6) ratios to GDP. In contrast, the smallest average of both domestic

credit to the private sector and broad money ratios to GDP is observed in Sierra Leone. Nigeria has the third smallest average ratio of domestic and broad money. At the same time, Senegal and the Ivory Coast have the 4th and 2nd highest averages of domestic credit ratio, and the 7th and 5th highest averages of broad money ratio to GDP.
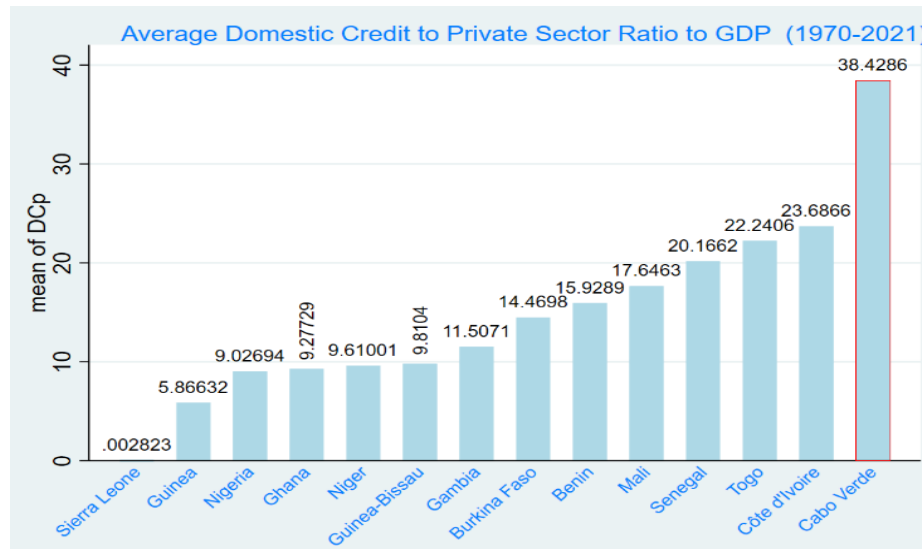
Graphic 5. Average Domestic Credit to Private Sector
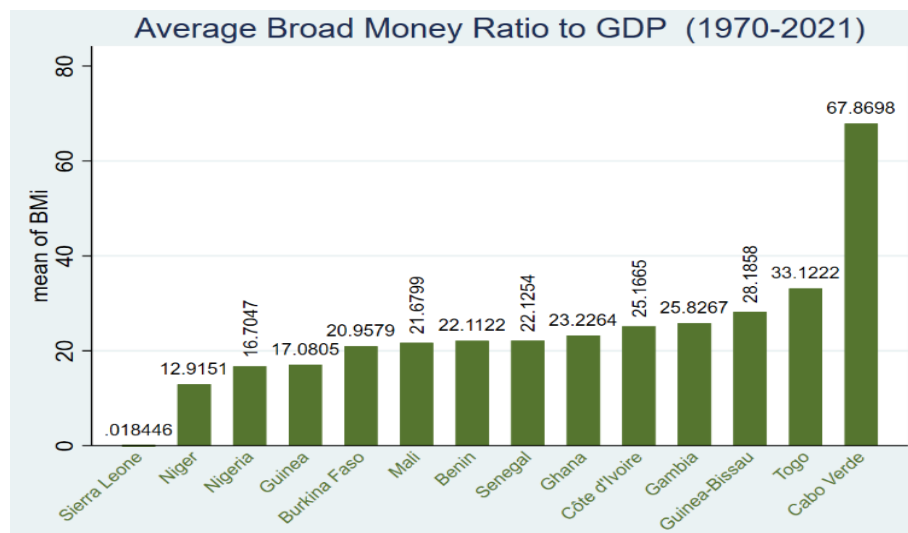
Graphic 6. Average Money Supply

5.3. Correlation Matrix

The correlation matrix (Table 3) indicates a statistically significant relationship at a 5% level (shown by the ∗ symbol) between pairs of variables. Therefore, all the variables are found to be interrelated apart from those pairs of variables: no statistically significant relationship between inflation and domestic credit (CPI10–DCP), inflation and pupils–teacher ratio (PTR–

CPI10), per capita government expenditure and pupils–teacher ratio (PCGE – PTR) and per capita government expenditure and Oil prices (PCGE–OPr).

Table 3. Correlation Matrix

	GDP	DCP	BMi	PTR	LE	TRD	CPI10	GGEPCPC	OPr
GDP	1,00								
DCP	0,50*	1,00							
BMi	0,45*	0,79*	1,00						
PTR	–0,28*	–0,12*	–0,21*	1,00					
LE	0,34*	0,45*	0,69*	–0,13*	1,00*				
TRD	0,15*	0,49*	0,52*	–0,18*	0,42*	1,00			
CPI10	0,11*	0,04	0,19*	0,06	0,54*	0,09*	1,00		
PCGE	–0,14*	0,40*	0,29*	0,09	0,26*	0,32*	0,12*	1,00	
OPr	0,15*	0,17*	0,25*	–0,10*	0,50*	0,18*	0,52*	0,05	1,00

5.4. Cross–Sectional Dependence and Unit Root Checks

Table 4 provides evidence of cross–sectional dependence among individual countries, and as such, traditional unit root tests may not be robust when applied. Instead, 2nd generation unit root tests have been implemented.

Table 4. Cross–sectional Dependence CD–test

Ho (Null hypothesis): There is cross–sectional independence			
Variable	**CD–test**	**p–value**	**Conclusion**
lnGDP	9,53	0,000	There is cross–sectional dependence (Ho rejected at 1% level)
lnDCP	11,91	0,000	There is cross–sectional dependence (Ho rejected at 1% level)
lnBM	18,06	0,000	There is cross–sectional dependence (Ho rejected at 1% level)
lnPTR	3,25	0,001	There is cross–sectional dependence (Ho rejected at 1% level)
lnLE	53,78	0,000	There is cross–sectional dependence (Ho rejected at 1% level)
lnPCGE	5,35	0,000	There is cross–sectional dependence (Ho rejected at 1% level)
lnCPI10	40,28	0,000	There is cross–sectional dependence (Ho rejected at 1% level)
lnTRD	5,30	0,000	There is cross–sectional dependence (Ho rejected at 1% level)
lnOPr	42,25	0,000	There is cross–sectional dependence (Ho rejected at 1% level)

According to all the test statistics in Table 5, all the variables, which are in log form, are integrated of order one (I (1)): e.g., lnGDP is I (1); thus, d_lnGDP is I (0).

Table 5. Second Generation Panel Unit Root Tests

Unit Root Tests	Pesaran's CADF test. constant & trend	Pesaran's CADF test. constant	IPS Test Demean option. Time trend: Included	2nd gen. Breitung Test (Time Trend Included)	2nd gen. Breitung test (No time trend)	Pesaran CIPS Test	
Statistics:	Z[T–bar] (P–value)	Z[T–bar] (P–value)	W–T–bar (P–value)	Lambda (P–value)	Lambda (P–value)	CIPS value	Critical values
lnLE	5,160 (1,000)	0,644 (0,740)	3,8858 (0,9999)	5,2174 (1,0000)	5,9478 (1,0000)	–1,8	–2,43* –2,25** –2,15***
d_lnLE	–5,263 *** (0,000)	–4,998*** (0,000)	–4,4728 *** (0,0000)	–5,0146 *** (0,000)	–7,128*** (0,0000)	–3,583***	–2,43* –2,25** –2,15***
lnOPr				–0,3863 (0,3496)	0,1786 (0,5709)		
d_lnOPr				–2,7857 *** (0,0027)	–4,722*** (0,0000)		
lnGDP	–0,192 (0,424)	1,438 (0,925)	1,3603 (0,9131)				
d_lnGDP	–11,173*** (0,000)	–12,178*** (0,000)	–13,1317 *** (0,000)				
lnDCP	0,755 (0,775)	–0,363 (0,358)	–0,7860 (0,2159)				
d_lnDCP	–9,086*** (0,000)	–10,737 *** (0,000)	–12,6909*** (0,0000)				
lnBM	–1,609 (0,054)	–1,352 (0,088)	–0,3269 (0,3719)				
d_lnBM	–12,690*** (0,000)	–14,052*** (0,000)	–15,0945*** (0,0000)				
lnPTR	–1,571 (0,058)	–1,215 (0,112)	–1,7525** (0,0398)				
d_lnPTR	–11,263*** (0,000)	–12,627 *** (0,000)	–12,2980*** (0,0000)				
lnPCGE	–0,246 (0,403)	–0,904 (0,183)	–1,0413 (0,1489)				
d_lnPCGE	–7,126*** (0,000)	–8,354*** (0,000)	–9,9782*** (0,0000)				
lnCPI10	–0,884 (0,188)	–1,200 (0,115)	0,6549 (0,7437)				
d_lnCPI10	–7,505*** (0,000)	–10,886*** (0,000)	–8,1805*** (0,0000)				
lnTRD	–1,314 (0,094)	–1,496 (0,067)	–1,9936 (0,0231)				
d_lnTRD	–12,224*** (0,000)	–13,547*** (0,000)	–15,2576 *** (0,0000)				

Note: *, **, *** indicate 1%, 5%, and 10% probability, respectively.

5.5. Consistent Moment and Model Selection Criteria

Lag selection results are presented in the Table 6. Based on the results in Table 6, a PVARX of lag order 1 is the best model.

Table 6. Lag Selection

Lags of Endogenous Variables	BIC/SIC	AIC	HQIC
1*	–881,8173	–195,9638	–471,5919
2	–594,3608	–137,125	–320,8772
3	–305,4612	–76,84336	–168,7194

Note: *: With 1 to 3 lags, the HQIC (Hannan-Quinn information criterion), AIC (Akaike Information Criterion), and BIC/SIC (Bayesian / Schwarz information criterion) values are minimized at lag 1 without exception, all indicating a PVARX of lag order 1.

5.6. Model Estimation Results and Interpretation.

Based on Table 7 output, past realizations of GDP, Trade openness, and per capita government expenditure are associated with an increase of about 27%, 6%, and 5% in GDP on average ceteris paribus. Also, past realizations of broad money, pupils–teacher ratio, and consumer price index are associated with a decrease of about 3,5%, 5%, and 5%, respectively, in GDP on average ceteris paribus. Thus, the expected and actual sign of PTR being negative, when PTR decreases, GDP increases. Life expectancy and domestic credit have positive but no statistically significant impacts on GDP. The evidence that trade, general government expenditure, and education (PTR) boost GDP in ECOWAS while money supply and inflation hinder its growth, is largely in line with established macroeconomic theory. These results support the works of Dada et al. (2021), Muhammad et al. (2024), Ndongo and Diop (2021), Oloke et al. (2022), Orji et al. (2022), and West African Monetary Agency (2009) on ECOWAS sub-region.

GDP, per capita government expenditure, and Life expectancy positively impact domestic credit (the rest of the variables do not significantly affect domestic credit). In fact, GDP growth may create more demand for and/or supply of credit for new projects/investments; public spending (on infrastructure, education, health, ...) may stimulate credit intermediation; and better life expectancy (health-based human capital) may be an indicator of sustained politico-socio-economic stability, encouraging long-term investments (thus, more demand/supply of domestic credit). These findings are backed by multiple theoretical and empirical works like Abu-Bader and Abu-Qarn (2003), Adegbite and Moffatt (2022), and Beck et al. (2000).

A percentage increase in domestic credit and consumer price index is associated with a 9% and 31% decrease in Broad money, respectively, and on average, ceteris paribus. However, life expectancy at birth and per capita government expenditure positively affect the money supply (the other variables have no significant impact on the money supply). In economic theory, public spending can lead to new investments and more cash in the economy, while higher life expectancy can be a signal of economic stability, attracting more FDI (Foreign Direct Investment), which means more foreign currencies (money supply) in the economy. When inflation rises monetary authorities tend to decrease money supply to contain inflation and this relationship is illustrated in the Quantity Theory of Money (QTM) using the equation of exchange (MV=PY): When V (Velocity of money) and Y (GDP) are hold constant, any increase

in M (Money supply) leads directly to an increase in P (Price level) (Fisher, 1911; Friedman, 1956).

Table 7. Model Estimations

	d_lnGDP	d_lnDCP	d_lnBM	d_lnPTR	d_lnLE	d_lnTRD	d_lnCPI10	d_lnPCGE
L1.d_lnGDP	0,2751*** (,0589)	,4019*** (,1524)	,2219 (,1495)	–,1104 (,0812)	,0029 (,0045)	,2852 * (,1491)	–,2773*** (,0663)	–,3207* (,1829)
L1.d_lnDCP	0,0095 (,0066)	–,0461 (,0314)	–,0916 ** (,0354)	,0091 (,0099)	,00006 (,0009)	,0116 (,0231)	,0055 (,0124)	,0587 ** (,0260)
L1.d_lnBM	–,0355*** (,0134)	,0624 (,0551)	–,0875 (,0590)	–,0006 (,0216)	–,0037*** (,0012)	,1270 *** (,0397)	–,0158 (,0170)	,0575 (,0412)
L1.d_lnPTR	–,0516* (,0303)	0,0999 (,1126)	–,1164 (,0980)	,0801 (,0624)	,0010 (,0028)	–,0391 (,0761)	–,0213*** (,0396)	–,1529* (,0905)
L1.d_lnLE	,1391 (,3459)	8,015*** (1,4500)	13,066*** (1,830)	–,7309 (,5416)	,8977*** (,0449)	4,1216*** (1,4715)	1,6277*** (,5594)	–4,704*** (1,2644)
L1.d_lnTRD	,0569*** (,0123)	,0651 (,0491)	,0577 (,0419)	–,0376** (,0189)	–,0028** (,0011)	–,1304*** (,0393)	,0228 (,0255)	,0330 (,0456)
L1.d_lnCPI10	–,0505** (,0233)	–,1356 (,1025)	–,3158*** (,1085)	,0289 (,0397)	–,0034 (,0022)	,2707** (,1094)	,4095*** (,0609)	–,3471 *** (,0848)
L1.d_lnPCGE	,0537*** (,0145)	,1846*** (,0534)	,1206** (,0587)	–,0367 ** (,0167)	,0022** (,0008)	,0349 (,0344)	,0026 (,0123)	–,1820*** (,0603)
L1.d_lnOPr	,0020 (,0069)	–,0310 (,0256)	–,0290 (,0260)	–,0031 (,0102)	,0009 (,0007)	,0748*** (,0231)	,0180 ** (,0071)	–,0079 (,0192)

Note: ***p < 0,01, **p < 0,05, *p < 0,1. Standard deviations are in parentheses. Test of overidentifying restriction: Hansen's J chi2(128) = 140,28234 (p = 0,216). Instruments: I (1/3).(d_lnGDP d_lnDCP d_lnBM d_lnPTR d_lnLE d_lnTRD d_lnCPI10 d_lnPCGE) d_lnOPr. Final GMM Criterion Q(b) = 0,46 Initial weight matrix: Identity GMM weight matrix: Robust

Only a percentage change in trade and per capita government expenditure has a statistically significant and negative impact of about 3,8% and 3,7% on the pupils–teacher ratio. In line with established theoretical and empirical literature, government spending (building more schools/universities, government subsidies for school supplies, public student scholarships) can boost education. Trade can also favor education through an increase in income, allowing more private and public spending on education and educational infrastructure.

Almost 90% of the change in life expectancy (health-based human capital) is due to past realization of life expectancy itself. Per capita government expenditure has a positive, even though negligible, impact (0,02%) on life expectancy. However, a percentage increase in broad money and trade is found to exert a negative, even though small, effect (0,04% and 0,03% respectively) on life expectancy. These findings may be a resulting effect of very poor public investments in health care services and infrastructure in the ECOWAS region.

"No West African country beats the cutoff of a minimum of 15% health priority index. Ghana (8,43%), Carbo Verde (8,29%), and Burkina Faso (7,60%) were the top three countries with the highest average health priority index, while Guinea (3,05%), Liberia (3,46%), and Guinea-Bissau (3,56%) had the lowest average health priority in the West African region within the period of our analysis (2010 to 2018)" stated Adebisi et al. (2021: 1).

While GDP, money supply, life expectancy, consumer price index, and crude oil price positively impact trade openness, the past realization of trade negatively affects current trade openness. This negative effect or constraint on trade openness in ECOWAS may be due to several structural and institutional factors (such as trade focused on raw materials, persistence of tariff and non-tariff barriers, transport/logistics networks often more oriented toward ports for trade with Asia or Europe, member states protectionist policies) that have historically hindered regional integration (Kanu et al, 2022).

The consumer price index is affected positively by itself, life expectancy, and crude oil price; it is impacted negatively by real GDP and pupil–teacher ratio. In line with the standard economic theory, higher oil prices raise the costs of goods and services, due to higher costs in transportation, electricity supply, and industrial production. According to Samson (2010), oil price increases accelerated inflation in seven ECOWAS member countries.

Finally, domestic credit affects per capita government expenditure positively, but PCGE is negatively affected by itself, real GDP, pupil–teacher ratio, life expectancy, and consumer price index. Households' access to domestic credit increases demand for goods and services, leading to more production of goods and services and investment. This raises government revenue, allowing it to spend more. The negative link between PCGE and PTR is expected: better education-based human capital (smaller PTR) can cause output to increase, leading to more government revenue generation, and, thus, more public expenditure. In standard economic literature, economic prosperity (rising real GDP) causes unemployment to decrease and life expectancy to rise. Under some circumstances, this may lead the government to lower its spending on social safety nets or to cut off various subsidies, resulting in a decrease in public expenditure.

5.7. Model Stability Check

The estimated model is stable based on all the eigenvalues, which lie inside the unit circle, and on the fact that all the moduli are less than 1(see Figure 4 and Table 8).
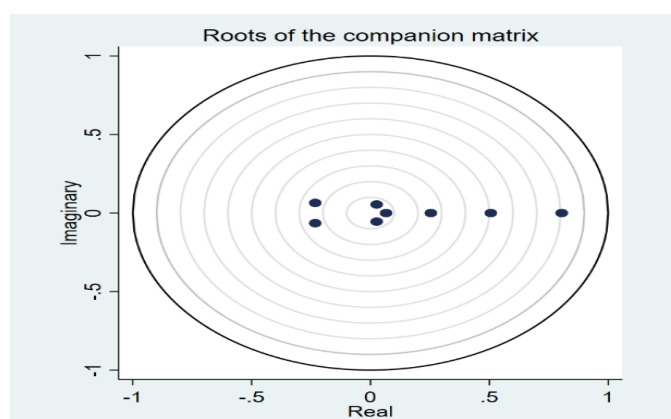

Figure 4. Roots of the Companion Matrix

Table 8. Eigenvalue Stability Condition

Real	Imaginary	Modulus
0,804	0	0,804
0,506	0	0,506
0,253	0	0,253
–0,232	–0,064	0,241
–0,232	0,064	0,241
0,065	0	0,065
0,025	0,054	0,060
0,025	–0,054	0,060

5.8. Granger Causality

According to the Granger causality test results in Table 9;

GDP is granger–caused by BM, PTR, TRD, CPI, and PCGE.

DCP is Granger–caused by GDP, LE, and PCGE.

BM is granger–caused by DCP, LE, CPI, and PCGE

PTR is granger–caused by TRD and PCGE.

LE is granger–caused by BM, TRD, and PCGE.

TRD is granger–caused by GDP, BM, LE, and CPI.

PCGE is granger–caused by GDP, DCP, PTR, LE, and CPI.

CPI is Granger–caused by GDP and LE.

Table 9. Panel VAR–Granger Causality Wald Test

Equation Variable➡	d_lnGDP	d_lnDCP	d_lnBM	d_lnPTR	d_lnLE	d_lnTRD	d_lnCPI	d_lnPCGE
d_lnGDP		6,955***	2,202	1,85	0,418	3,66*	17,485***	3,073 *
d_lnDCP	2,046		6,696 **	0,84	0,004	0,251	0,197	5,089**
d_lnBM	7,001***	1,283		0,001	9,003***	10,228***	0,862	1,945
d_lnPTR	2,886*	0,787	1,41		0,13	0,265	0,289	2,855*
d_lnLE	0,162	30,554***	50,966 ***	1,821		7,845***	8,464***	13,846***
d_lnTRD	21,137***	1,756	1,896	3,938**	6,225**		0,798	0,525
d_lnCPI	4,674**	1,75	8,460***	0,53	2,378	6,118**		16,729***
d_lnPCGE	13,721***	11,954***	4,218**	4,793**	6,249**	1,032	0,045	
Overall	61,740***	82,959***	98,921***	17,693**	30,420***	32,363***	33,476***	49,092***

Note: ***p < 0,01, **p < 0,05, *p < 0,1. Ho: The excluded variable does not Granger–cause equation variable. Ha: Excluded variable Granger–causes equation variable.

Thus, there is evidence of bidirectional causality between health-based human capital and trade openness (LE↔TRD); education-based human capital and government expenditures (PTR ↔ PCGE); government expenditures and health-based human capital (PCGE↔LE); income and trade (GDP↔TRD); income and government expenditures (GDP↔PCGE); income and

inflation (GDP↔CPI); domestic credit and government expenditures (DCP↔PCGE); money supply and health-based human capital (BM ↔ LE)[4]   .

Furthermore, there is also evidence of unidirectional causality running from money supply to trade openness (BM→TRD); education to income (PTR→ GDP); trade to education (TRD→ PTR); health to domestic credit (LE→DCP); health to inflation (LE→CPI); income to domestic credit (GDP→DCP); domestic credit to money supply (DCP→BM) and money supply to income (BM→GDP)[5].

5.9. Orthogonalized IRFs

5.9.1. Response of GDP (see IRF 1)

The response of GDP to an impulse to DCP and LE is statistically not different from zero, given that the 95% confidence intervals are around the zero line throughout the periods ahead. The response of GDP to itself is positive in the first period but then declines and converges to zero after almost four periods. The responses to an impulse to PCGE or TRD are positive, causing GDP to increase up to the first period and then decrease and converge towards zero after the 5th period.
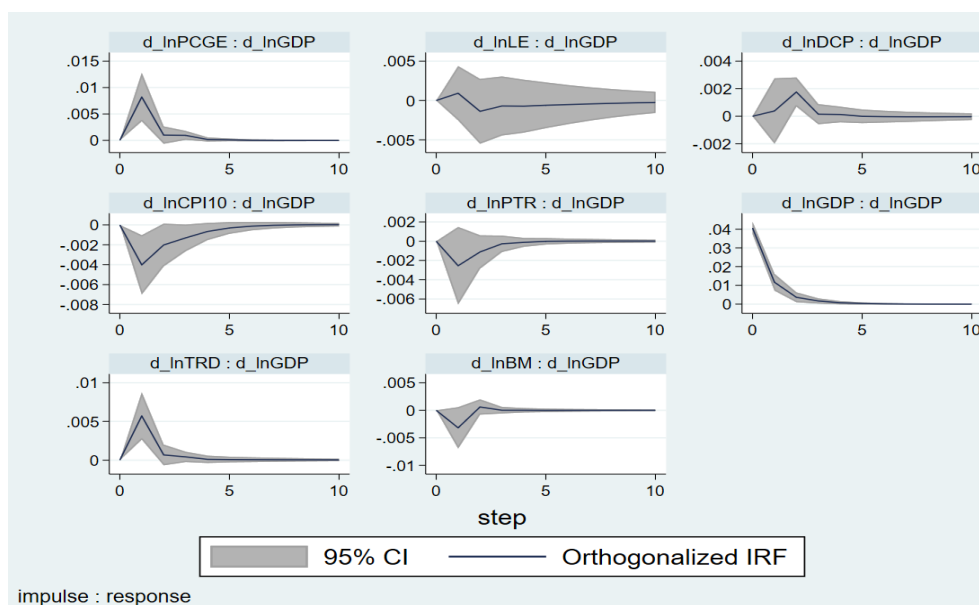

Figure 5. IRF 1

The responses to CPI, PTR, and BM shocks are all negative but cause GDP to decrease in period 1, then increase and reach its steady state at around period 6 for CPI, period 5 for PTR, and 4th period for BM. It can be noticed that a positive impact of BM on GDP at around period 2 before declining towards its stable state.

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[4] ↔: bidirectional causality among the variables.
[5] →: unidirectional causality running from left to right variable.

5.9.2. Response of DCP (see IRF 2)

The responses to a shock in CPI, PTR, BM, and TRD are statistically equal to zero. Although their responses are positive, there is no first-period impact of a one-standard-deviation shock to PCGE and LE. In fact, for PCGE, the response increases between periods 0 and 1, then decreases until period 2 before slightly increasing again until period 3, from which the effect declines and converges towards zero. For LE, there is an increase between periods 0 and 1and then the impact decreases very slowly and converges to zero after almost ten periods.

There is a first-period impact of a shock on itself and GDP. However, the response to the shock to itself is positive but decreases between periods 0 to 1, from where it converges to the steady state; the response to the shock to GDP is negative but increases from period 0 and becomes even positive after period 1, and then decreases from 1,5 periods until the 5th period, where it converges to the steady state.
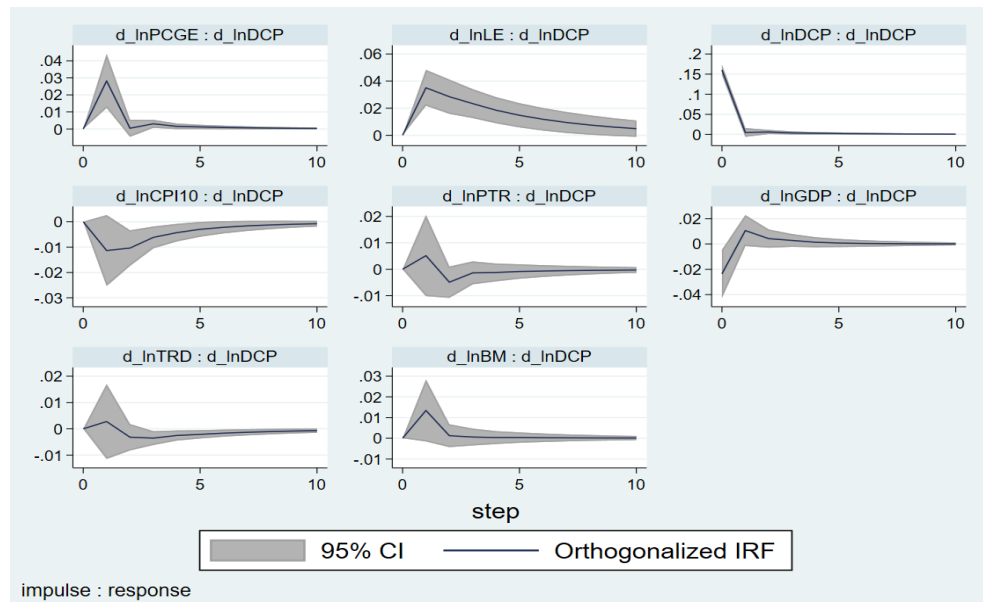

Figure 6. IRF 2

5.9.3. Response of BM (see IRF 3)

The responses to shocks to PTR, GDP, and TRD are statistically equal to zero. The response to shocks to PCGE and LE has no first-period impact (starting from zero), but from period 0, there is a positive increase with a peak around 1,5 periods. The effect of a shock to PCGE is positive, then decreases up to period 2 before slightly increasing again between periods 2 and 3, declines from period 3, and reverses to a stable state at the 4th period. The impact of a shock to LE decreases quite slowly after the pick at period 1,5 and converges to zero only after 10 periods. The effect of a shock to DCP is a positive decrease in BM up to period 1; when it becomes negative, it increases and reaches a positive value between periods 1 and 2. From period 2, it decreases and reaches its steady state in period 3. A shock to CPI results, overall, in a negative response of BM. Between periods 0 and 1, there is a decrease in BM. From period 2, there is an increase up to the 10th period, when the steady state is reached.
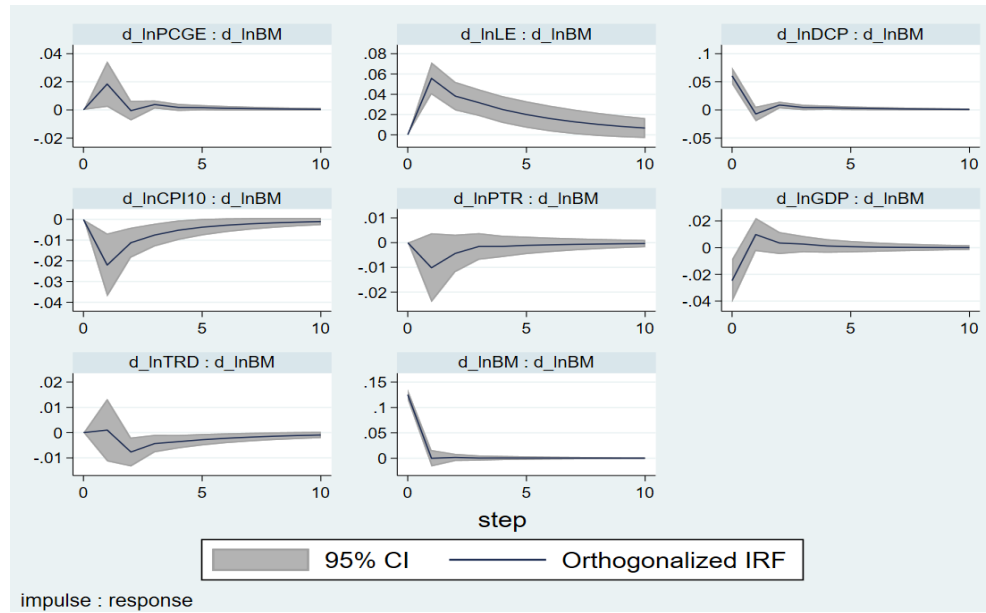
Figure 7. IRF 3

5.9.4. Response of PTR (see IRF 4)

The response of PTR to innovations in LE, DCP, CPI, GDP, and BM is statistically insignificant. However, the response to a one standard deviation shock to PCGE and TRD is overall negative. A decrease in PTR means more teachers for the same number of students, indicating better education-based human capital. Innovation to PCGE or TRD causes PTR to decrease between periods 0 to 1 and then to increase till period 2. Between periods 2 and 3, PTR decreases slightly; from the 3rd period, PTR increases and reaches its steady state around the 5th period.
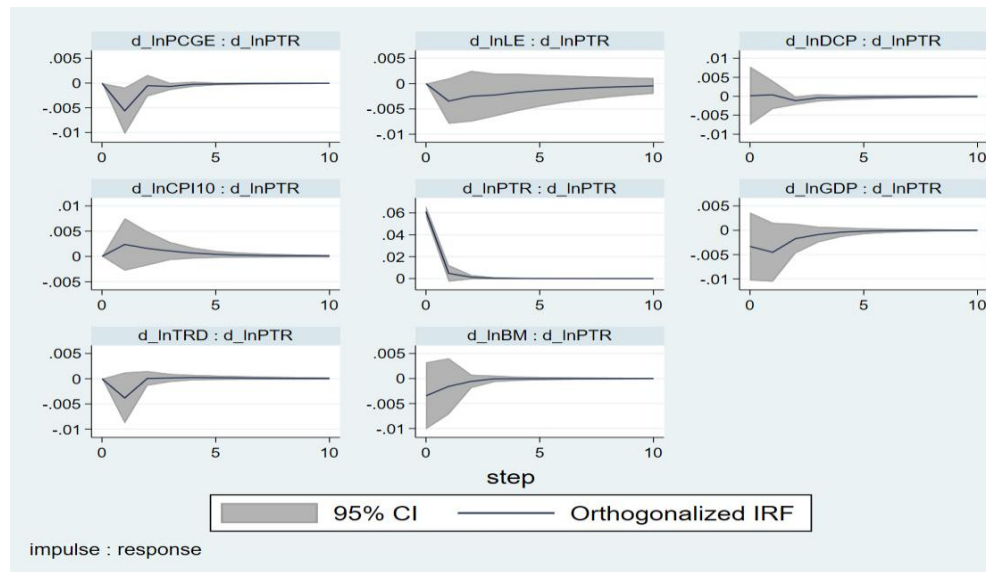

Figure 8. IRF 4

5.9.5. Response of LE (see IRF 5)

The response of LE to a one standard deviation innovation in DCP, CPI, PTR, and GDP is statistically insignificant. The response to innovations in BM is positive. It decreases between periods 0 and 1 and converges to the steady state. The response to innovations in TRD is negative. It decreases between periods 0 and 1, then increases and tends to converge to a steady state beyond period 10. The response to innovations in PCGE is positive. The impact increases between periods 0 and 1 and decreases between periods 1 and 2. It slightly increases between periods 2 to 3, then declines and converges to a steady state after 10 periods.
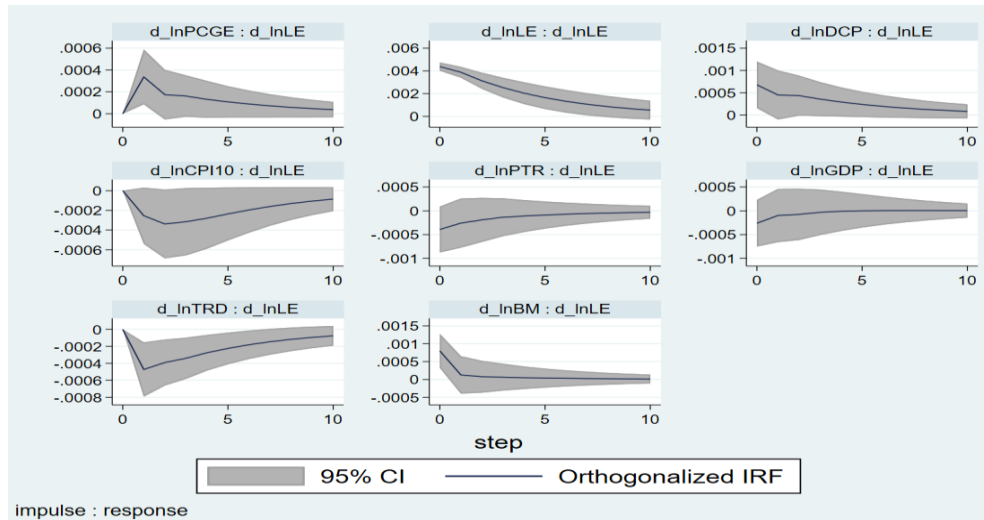

Figure 9. IRF 5

5.10. Analysis of Forecast Error Variance (FEV)

In the first year, one hundred percent of the FEV in real GDP is explained by the variable itself (GDP). This implies that other variables do not significantly influence GDP, meaning they are strongly exogenous in the initial year. From the short to the long run, GDP still predicts itself (more than 92%). Trade, consumer price index, and per capita government expenditure account for only 1,7%, 1,1%, and 3,5% of FEV in real GDP, respectively. Money supply and pupils-teacher ratio jointly do not account for even 1% of FEV in GDP (Table 10).

Table 10. FEVD1 (for GDP)

Response Variable and Forecast Horizon	Impulse Variable							
	d_lnGDP	d_lnDCP	d_lnBM	d_lnPTR	d_lnLE	d_lnTRD	d_lnCPI10	d_lnPCGE
d_lnGDP								
0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	0	0
2	0,930	0,000	0,005	0,003	0,000	0,017	0,008	0,035
3	0,925	0,002	0,005	0,004	0,001	0,017	0,010	0,035
4	0,924	0,002	0,005	0,004	0,002	0,017	0,011	0,035
5	0,923	0,002	0,005	0,004	0,002	0,017	0,011	0,035
6	0,923	0,002	0,005	0,004	0,002	0,017	0,011	0,035
7	0,923	0,002	0,005	0,004	0,002	0,017	0,011	0,035
8	0,923	0,002	0,005	0,004	0,002	0,017	0,011	0,035
9	0,923	0,002	0,005	0,004	0,002	0,017	0,011	0,035
10	0,923	0,002	0,005	0,004	0,002	0,017	0,011	0,035

In year 1, almost 98% of FEV in domestic credit is explained by the variable itself (DCP), while the remaining 2% is explained by real GDP. In the short run (first four years), about 85 % of error variance in domestic credit is explained by the variable itself, and in the long run (years 5 to 10), it is about 82%. When moving forward into the future, GDP still explains about 2% of error variance in domestic credit, while life expectancy explains up to 8% in the short run and up to 11% in the long run. Per capita government expenditure explains 2,8% (of error variance in domestic credit) in year 2, which drops to 2,6% in year 10 (see Table 11).

Table 11. FEVD2 (for Domestic Credit)

Response Variable and Forecast Horizon	Impulse Variable							
	d_lnGDP	d_lnDCP	d_lnBM	d_lnPTR	d_lnLE	d_lnTRD	d_lnCPI10	d_lnPCGE
d_lnDCP								
0	0	0	0	0	0	0	0	0
1	0,021	0,979	0	0	0	0	0	0
2	0,023	0,894	0,006	0,001	0,043	0,000	0,004	0,028
3	0,023	0,865	0,006	0,002	0,069	0,001	0,008	0,027
4	0,023	0,848	0,006	0,002	0,085	0,010	0,009	0,026
5	0,023	0,838	0,006	0,002	0,095	0,001	0,010	0,026
6	0,022	0,831	0,006	0,002	0,102	0,001	0,010	0,026
7	0,022	0,827	0,006	0,002	0,106	0,001	0,010	0,026
8	0,022	0,825	0,006	0,002	0,108	0,001	0,010	0,026
9	0,022	0,823	0,006	0,002	0,110	0,001	0,010	0,026
10	0,022	0,822	0,006	0,002	0,111	0,002	0,010	0,026

From year 1 through year 10, from 78,5% to 54,5% of FEV in broad money is explained by the variable itself (BM), while GDP and domestic credit explain, respectively, about 3% to 2,5% and 18,5% to 13,5% of FEV in broad money. The contribution of life expectancy to changes in broad money has increased from about 13% in year 2 to about 25% in year 10. The consumer price index increases from 2% in year 2 to 2,5% in year 10, while per capita government expenditure decreases slightly from 1,4% to 1,3% (see Table 12).

Table 12. FEVD3 (for Money Supply)

Response Variable and Forecast Horizon	Impulse Variable							
	d_lnGDP	d_lnDCP	d_lnBM	d_lnPTR	d_lnLE	d_lnTRD	d_lnCPI10	d_lnPCGE
d_lnBM								
0	0	0	0	0	0	0	0	0
1	0,030	0,185	0,785	0	0	0	0	0
2	0,029	0,155	0,649	0,004	0,128	0,000	0,020	0,014
3	0,028	0,147	0,606	0,005	0,176	0,002	0,024	0,013
4	0,027	0,142	0,580	0,005	0,205	0,003	0,025	0,013
5	0,026	0,139	0,566	0,005	0,223	0,003	0,025	0,013
6	0,026	0,137	0,557	0,005	0,234	0,004	0,025	0,013
7	0,026	0,136	0,552	0,005	0,240	0,004	0,025	0,013
8	0,025	0,135	0,549	0,005	0,245	0,004	0,025	0,013
9	0,025	0,135	0,546	0,004	0,247	0,004	0,025	0,013
10	0,025	0,135	0,545	0,004	0,249	0,004	0,025	0,013

Based on Table 13, in year 1, the pupil-teacher ratio strongly predicts itself by 99% and 96% in year 10. The contribution of trade and per capita government expenditure has remained

around only 1% in the error variance of the pupil-teacher ratio. Income alone contributes to about 0,9% in the long run.

Table 13. FEVD4 (for Education-based Human Capital)

Response Variable and Forecast Horizon	Impulse Variable							
	d_lnGDP	d_lnDCP	d_lnBM	d_lnPTR	d_lnLE	d_lnTRD	d_lnCPI10	d_lnPCGE
d_lnPTR								
0	0	0	0	0	0	0	0	0
1	0,003	0,000	0,003	0,994	0	0	0	0
2	0,008	0,000	0,004	0,972	0,003	0,004	0,001	0,008
3	0,009	0,000	0,004	0,968	0,005	0,004	0,002	0,008
4	0,009	0,000	0,004	0,966	0,006	0,004	0,002	0,008
5	0,009	0,000	0,004	0,965	0,007	0,004	0,003	0,008
6	0,009	0,000	0,004	0,965	0,007	0,004	0,003	0,008
7	0,009	0,000	0,004	0,964	0,008	0,004	0,003	0,008
8	0,009	0,000	0,004	0,964	0,008	0,004	0,003	0,008
9	0,009	0,000	0,004	0,964	0,008	0,004	0,003	0,008
10	0,009	0,000	0,004	0,964	0,008	0,004	0,003	0,008

Finally, according to Table 14, life expectancy remains a strong influencer in predicting itself, with around 94% in the short and long run. Per capita government expenditure accounts for only 0,3% of FEV in LE, trade accounts for around 1%, and money supply contribution to changes in LE drops from 3% in year 1 to 1% in year 10.

Table 14. FEVD5 (for Health-based Human Capital)

Response Variable and Forecast Horizon	Impulse Variable							
	d_lnGDP	d_lnDCP	d_lnBM	d_lnPTR	d_lnLE	d_lnTRD	d_lnCPI10	d_lnPCGE
d_lnLE								
0	0	0	0	0	0	0	0	0
1	0,003	0,022	0,031	0,007	0,936	0	0	0
2	0,002	0,018	0,018	0,006	0,944	0,006	0,002	0,003
3	0,002	0,018	0,014	0,006	0,945	0,008	0,004	0,003
4	0,002	0,018	0,012	0,005	0,945	0,009	0,005	0,003
5	0,001	0,018	0,012	0,005	0,945	0,010	0,006	0,003
6	0,001	0,018	0,011	0,005	0,944	0,010	0,007	0,003
7	0,001	0,018	0,011	0,005	0,944	0,010	0,007	0,003
8	0,001	0,018	0,011	0,005	0,944	0,011	0,007	0,003
9	0,001	0,018	0,010	0,005	0,944	0,011	0,008	0,003
10	0,001	0,018	0,010	0,005	0,944	0,011	0,008	0,003

6. Conclusion and Policy Implications

The general aim of this study was to analyze the interactions between financial development, human capital, and economic growth in the ECOWAS zone during the period 1970-2021 using the panel VARX econometric technique. Economic growth was proxied by real GDP (GDP). Besides, financial development was proxied by BM and DCP), both as a ratio of GDP. Human capital was proxied by LE as a measure of health-based human capital, and PTR as a measure of education-based human capital. Moreover, some control variables were used (TRD, PCGE, CPI10, and OPr). The study found that trade openness and per capita government expenditure positively impact economic growth, while broad money, pupil-teacher ratio, and consumer price index affect growth negatively. Here, the study suggests that the

money supply may cause inflation, which hinders growth. Life expectancy and domestic credit have a positive but not statistically significant impact on GDP. Real GDP, per capita government expenditure, and Life expectancy positively impact domestic credit. Domestic credit and consumer price index negatively affect the money supply. At the same time, life expectancy at birth and per capita government expenditure positively impact broad money. Trade and per capita government expenditure have a negative impact on the pupil-teacher ratio. Per capita government expenditure has a positive effect on life expectancy, but broad money and trade are found to exert a negative impact on health-based human capital.

Consequently, there was evidence of bidirectional causality between money supply and life expectancy at birth (BM $\leftrightarrow$ LE) and unidirectional causality running from real GDP to domestic credit (GDP$\rightarrow$DCP), education-based human capital to GDP (PTR$\rightarrow$ GDP), money supply to GDP (BM$\rightarrow$GDP), health-based human capital to domestic credit (LE$\rightarrow$DCP) and domestic credit to broad money (DCP$\rightarrow$BM).

Overall, financial development, as measured by broad money, has a negative impact on economic growth, confirming the findings of Forouheshfar (2017). In contrast, when measured by domestic credit, it has a positive but statistically insignificant effect on growth, which is similar to Hakeem (2010) reporting no strong impact of Financial Development in the SSA region. Education-based human capital does have a significant positive impact on income (in line with the findings of Ali et al. (2021)), while the impact of health-based human capital on GDP is also positive (like the findings of Oyinlola and Adedeji (2019)), but statistically insignificant. Moreover, health-based human capital interacts positively with financial development irrespective of the proxy used, but human capital as measured by education-based human capital had no statistically significant interaction with both financial development measures.

Economic growth was found to positively impact financial development through domestic credit. Also, economic growth positively but not significantly impacts money supply (confirming partially the results of Abubakar et al. (2015)) and human capital, irrespective of the proxy used. Moreover, overall, computed FEVDs and IRFs support these findings. Thus, the monetary and political authorities and policymakers should spur economic growth by facilitating access to private sector credit, increasing health and education investments considerably, and avoiding expansionary monetary policies.

Declaration of Research and Publication Ethics
This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement
The authors declare that they have contributed equally to the article.

Declaration of Researcher's Conflict of Interest
There is no potential conflict of interest in this study.

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