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Full Length Research Paper

Cross-border trade and economic growth: An application to Côte d'Ivoire, Ghana, Morocco, and Nigeria

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The objective of this paper is two-fold. On one hand, it seeks to measure the direct effect of cross-border trade on the dynamism of the economies of countries such as Ghana, Côte d'Ivoire, Morocco and Nigeria from 1971 to 2020. On the other hand, it aims to verify the possibility of establishing a link between the volume of cross-border trade, the dynamics of certain variables (currency, population, income) and the dynamics of growth. The results show that cross-border trade between states in the same zone (ECOWAS) and with different currencies can be beneficial if certain constraints are lifted. Second, the structural variables of income and currency have a positive impact on the ability of cross-border trade to generate more growth, while the population variable has a negative impact on this effect. A series of measures should therefore be adopted in the countries in the sample to enable them to make the most of their participation in international trade.

Key words: Growth, cross-border trade, Sub-Saharan Africa, currency, income, population, ECOWAS.

INTRODUCTION

In an international economic context marked by increasing globalization of socio-political, cultural and economic relations, the most advanced phase of which seems to be globalization, there is an increase in trade as well as capital movements. It can therefore be said that cross-border trade plays a central role in economic and social development, especially for poor countries. In West Africa and other parts of the African continent, the trade sector occupies a large proportion of the population and its contribution to national wealth creation and economic growth is significant.

It should also be noted that in this globalized economic framework, countries have different orientations in their trade policies, depending on their geographical, climatic and natural resource development choices. Economists have long noted that economic exchanges within and between countries differ greatly in intensity. Similarly, economic linkages are much closer within national borders than between countries, especially in the context of countries that are linked by strong historical and political relationships and are more likely to have a common currency (Rose, 2000). It would be incorrect, to

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say the least, to conclude that national borders and currencies are important barriers to cross-border or bilateral trade that need to be removed (Helliwell and Schembri, 2005).

Furthermore, the economic structure of the empirical models is not rich enough to determine whether national borders and the existence of separate national currencies constitute a barrier to trade or whether, on the contrary, the results obtained reflect the efficient organization of production, consumption and trade within each country on the one hand and between countries on the other (Cooke, 2016). Over the past 25 years, however, empirical work has shown that African countries are much less involved in the global economy than previously thought. Indeed, the methodology used in this area has often been to compare measures of economic exchange between countries with measures of economic exchange within a country.

As the theoretical observation that economic growth is ultimately the result of exports and/or imports, the debate has always been about testing this hypothesis, as the question of the relationship between economic growth and cross-border trade is central to economic theory.

The divergent views on the appreciation of the link between growth and cross-border trade became important for us to conduct a similar study with reference to some key countries in the West African sub-region in order to shed some light on this debate. In the context of this study, the interest of such analysis is therefore focused on Côte d'Ivoire, Ghana, Morocco and Nigeria. As it can be seen, these are three ECOWAS countries (Côte d'Ivoire, Ghana and Nigeria) and one country which is not yet officially part of this community but which has recently expressed the desire to belong to it (Morocco). Moreover, these different countries do not belong to the same monetary zone. In this respect, several recent studies have sought to assess empirically the appropriateness of a single monetary zone for West Africa (Gong et al., 2016).

The overall results highlighted the sub-optimal nature of the ECOWAS monetary union project and the reasons put forward are related to the non-respect of the classic criteria of the theory of optimal monetary zones, namely: the absence of complementarity between economies (i), the low credibility of institutions and development policies (ii) and more particularly in the monetary domain (iii).

The present study differs from previous ones mainly because of the empirical approach adopted. Indeed, it is based on a two-phase estimation. The first phase seeks to conduct an econometric investigation of the effect of non-membership in a monetary union on cross-border trade on one hand and economic performance on the other hand through an augmented standard gravity model. The second phase uses a panel data model to determine the effect of cross-border trade on the economic growth of the countries in the sample. The main question to be answered is: what is the effect of

cross-border trade on economic growth dynamics in a situation of countries with different currencies?

In this study, the local currencies of each country was not consider, namely the CFA Franc (Côte d'Ivoire), the Naira (Nigeria), the Dirham (Morocco) and the Cedi (Ghana), but focus was on the foreign currencies used mainly by these states to settle their debts arising from trade, on the assumption that Ghana and Nigeria have historically used the Dollar as their international currency and Côte d'Ivoire and Morocco have used the Euro currency. There are several reasons for this approach: firstly, the local currencies of the countries in the study sample are not used in bilateral trade to settle debts and are only used within the national borders of the countries, whereas analysis is concerned with the effect of cross-border or external trade on growth and not the effect of internal trade on growth.

For example, it is note that exports and/or imports between Côte d'Ivoire and Nigeria are not settled in CFAF or Naira, just as trade between Morocco and Ghana is not settled in Dhiram or Cedis. Secondly, a modelling of the factors related to cross-border trade allows a better understanding of the dynamics of growth in a situation of different currencies.

Finally, the understanding of the stakes in terms of economic policy, of the process of forecasting growth in a common economic and monetary area under construction; allusion made to the will to set up in ECOWAS of the common currency called Eco. That said, The rest of the article will be presented as follows: A review of the literature will be the subject of section one. This literature review will be preceded by an econometric analysis of the interactions between cross-border trade and the structural variables that may be complementary to it in its effects on growth. In section two, different models and the estimation methods used were presented. Then, the results obtained on the study sample and the comments will be the subject of section three. Section four will focus on the analysis of the effect of the interaction between cross-border trade and growth through some control variables. Finally, the conclusion and recommendations are presented in the fifth section.

REVIEW OF LITERATURE

In this part of the study, a theoretical and empirical review of the effect of non-membership was presented in the same monetary union of some countries (Côte d'Ivoire, Ghana, Morocco and Nigeria) on cross-border trade and economic performance of these countries.

Theoretical review

If the estimated border effect is partly a consequence of

Table 1. Dictionary of variables.

Type of variables	Name of the variable	Name of the variable	Expected sign
Explained variable	Bilateral exports	Xijt	
Explanatory variables	Common currency	MCijt	+
	Common language	LCijt	+
	Joint independence	INDCijt	+
	Distance between countries i and j	DISTijt	-
	Log of country i's income i	log (log(RNBit)	+
	Log of country's income j	log (log(RNBjt)	+
	Common settler	CCijt	+
	GDP of country i	log(log(GDPit)	+
	GDP of country j	log(log(GDPjt)	+
	Distance-intra national of the country i	log(log(dista-init)	-
	Distance-intra national of the country j	log(log(dista-injt)	-
	Population of country i	log(log(popit))	+
	Population of country j	log(log(popjt)	+

Source: Author.

trade barriers, one such barrier could be the use of separate national currencies. Indeed, the use of different currencies creates an additional barrier to trade since cross-border transactions require currency conversion and, in some cases, hedging of exchange rate risk.

The second criticism is that Rose (2000) concludes that the use of a single currency by two countries has increased bilateral flows, when in most cases trade between them was probably already intense because of an economic or political dependency relationship that may have caused the smaller country to adopt the currency of the larger one in order to facilitate extensive trade (e.g., Bahamas and Bermuda, which use the US dollar; Liechtenstein, which uses the Swiss franc). The trade dependency would probably precede the adoption of a common currency, not the other way around.

The third criticism relates to the statistical significance of the dummy variable on the existence of a common currency, which indicates which countries belong to a monetary union at each point in time and not how the situation of a given country changes over time.

Empirical review

McCallum (1995) uses a widely used empirical model of trade, known as the gravity model, which was first used by Tinbergen (1962) in empirical research on trade flows.

Rose (2000) also uses the gravity model to estimate the effect of adopting a common currency on bilateral trade flows, thereby testing the hypothesis that the use of a common currency reduces the cost of cross-border transactions and thus increases trade. To do this, he essentially uses the empirical gravity model of McCallum (1995), with two important differences: a) the model is

estimated using a dataset of bilateral flows for 186 countries over a given period; b) the indicator variable in the model takes the value 1 if the two countries have a common currency and 0 otherwise. Rose (2000) finds that the use of a common currency by two countries reduces the cost of cross-border transactions and increases trade. Rose finds that the use of a single currency by two countries increases their trade by more than 300%.

In their study on Factors influencing livestock export in Somali land terminal markets, Musa et al. (2020) show that the Hajj season, the number of livestock exporters, the location of the market and the livestock ban imposed by importing countries are the main factors influencing the monthly volume of livestock traded for export. An investigation of cross-border livestock trade across Ethiopia's dryland borders by Angassa and Negassi (2018), reveals that cross-border livestock trade initially improves people's living conditions.

EMPIRICAL EVALUATION

Data source

The data used in this study are taken from the World Bank (WDI) and The United Nations Conference on Trade and Development (UNCTAD) databases and cover the period from 1960 to 2019. This rather long period (59 years) is explained by the requirements of using fish law (the use of long periods).

Variables description

The description of the variables in this study is summarized in the Table 1. Table 1 presents the explanatory variables and the explained variable, which were all mobilized over the study period,

by country and by year. These are therefore variables with two dimensions, namely the individual dimension on the one hand and the temporal dimension on the other. In addition, the expected signs were also indicated in Table 1.

Model specification

Specification of gravity model

The econometric investigation of the effect of non-membership in a monetary union of some countries (Côte d'Ivoire, Ghana, Morocco and Nigeria) on cross-border trade and economic performance of these countries is based on an augmented form of the standard gravity model. The gravity model has been widely used in the literature since the work of Tinbergen (1962) despite the lack of theoretical underpinning of this model at the outset. It was not until the mid-1970s that important theoretical developments of the model emerged. Anderson (1979) was the first researcher to derive the expression of gravity from a model that assumes product differentiation.

Subsequently, the contributions of other works have been not only to strengthen the prior theoretical framework but also to propose further extensions (among others, Anderson and Wincoop, 2001; Evenett and Keller, 2002).

Empirically, it has been mobilized to analyse the impact of regional integration on bilateral trade in West Africa (Anyanwu, 2003; Agbodji, 2007; Bangake and Eggoh, 2009; Coulibaly et al., 2015). After presenting the empirical model (increasing gravity model, explained and explanatory variables), the estimation strategies used was outlined in this research as well as the data and their sources.

Theoretical gravity model

The choice of the model is based on Tinbergen (1962), Anderson (1979) and Mignamissi (2018):

$$COM_{ij} = GY_i^{\alpha}Y_j^{b}\phi_{ij}^{c}RM_{ij} \tag{1}$$

COM_{ij} represents the level of bilateral trade between country i and country j; G is the gravity constant ; $Y_{i(j)}$ the income of country i and country j; ϕ_{ij} the common characteristic of country i and j; $RM_{ij} = RM1_{ij} + RM2_{ij}$ to capture bilateral resistance;

where $RM1_{ij} = \left[\dfrac{\sum Dist_{ij}}{Y_i}\right]$ and $RM2_{ij} = \left[\dfrac{\sum Y_i}{Dist_{ij}}\right]^{-1}$; and

i, j, a, b and c are coefficients.

Empirical gravity model

To address the research question, the researcher introduce in addition to the control variables indicator to capture the different dimensions of cross-border trade between the different countries mentioned above. Thus, the augmented gravity model is as follows:

$$\log(COM_{ijt}) = \beta_0 + \beta_1 \log(GDP_{it}) + \beta_2 \log(GDP_{jt}) + \beta_3 \log(Popu_{it}) + \beta_4 \log(Popu_{jt}) + \beta_5 log(Dstan_{ijt}) + \beta_6 log(Dst - in_{ijt}) + \beta_7 log(Rnb_{it}) + \beta_8 log(Rnb_{jt}) + \beta_9 Mc_{ijt} + \beta_{10} Lc_{ijt} + \beta_{11} Cc_{ijt} + \beta_{10} Ind_{ijt} + \varepsilon_t \tag{2}$$

Where $\log(\text{COM}_{i(j)})$ is the logarithm of the level of border trade captured by the degree of openness of country i to country j ; $\log(\text{Pib}_{i(j)})$ is the logarithm of the nominal GDP of exporting country i and importing country j; $\log(\text{Popu}_{i(j)})$ is the logarithm of the populations of exporting country i and importing country j ; $\log(\text{Rnb}_{i(j)t})$ is the logarithm of the per capita incomes of countries and i and j; $\log(\text{Distan}_{i(j)})$ the log distance between country i and country j. $\log(\text{Dist} - \text{in}_{i(j)})$ intra-national distance of country i and country j captured by the square root of the area of each country; $\text{Mc}_{i(j)}$ is the dummy variable that captures the common currency of countries i and j; Lc_{ij} the dummy variable that captures the common language of countries i and j ; Cc_{ij} the dummy variable that captures the common settler for countries i and j; Ind_{ij} the dummy variable that captures the date of independence common to countries i and j; ε error term. β is a parameter. i represents the exporting country, j the importing country and the time variable. Dummy variables take the value 1 if countries i and j have a common fact and 0 otherwise. The data were from the World Bank database and UNCTAD.

Specification of theoretical growth model

At the end of the 1970s, a major debate began on the effects of cross-border trade on economic growth, with Balassa (1965) being one of the pioneers to address this issue. For him, it was a question of highlighting the hypothesis that countries that practice cross-border trade have all experienced extraordinary economic performance compared to autarkic countries. Based on his work, it is widely accepted that cross-border trade has a positive impact on economic growth (Sachs and Warner, 1995).

Furthermore, in the neoclassical production function, the sources of growth are the accumulation of factors of production and the improvement of total factor productivity. The starting point for modeling is the Cobb-Douglass production function defined as follows:

$$Y_{it} = F(A_{it}, L_{it}, K_{it}) = A_{it}K_{it}^{\alpha}L_{it}^{\beta} \quad \alpha \text{ et } \beta \rangle 0 \tag{3}$$

Y_{it} is the real GDP in country i in year t; A_{it} total factor productivity reflecting the level of technology and efficiency of the economy; k_{it} the physical capital stock; et L_{it} the labor force.

To determine the effect of cross-border trade on economic growth, a panel data model was used from 1971 to 2018.

This approach is in-extensor advantageous because its dual individual and temporal dimension makes it possible not only to estimate the effects of unobserved factors on economic phenomena but also to apprehend the main channels through which aid impacts on economic growth. Also, because of the temporal dimension, they make it possible to analyse the dynamics

of the behavior of the individuals observed. And finally, to test economic theories by developing equation (3), a panel model of the form was obtained:

$$TC_{it} = \partial_0 + \partial_1 Com_{it} + \beta X_{it} + \varepsilon_{it}$$

(4)

TC_{it} measures the economic growth rate of country i in period t; Com_{it} cross-border trade captured by exports and X_{it} the control variables that determine economic growth.

An improvement in the productivity and competitiveness of cross-border trade can be the result of strong growth in a stable macroeconomic framework. The researcher therefore pose:

$$A_{it} = G(Com_{it}, X_{it}) = A_0 e^{\theta Z_{it}}$$

(5)

Where Com_{it} measures the cross-border trade that is captured by exports and X_{it} another variable that controls the determinants of economic growth. With X_{it} The matric X is composed of explanatory variables such as income per capita (Rnb), population (Popu) and the dummy variable that simulates the common currency of the countries (Mc). The dummy variable takes the value 1 if countries i and j have a common fact and 0 otherwise.

To better understand the effect of cross-border trade on the growth of African countries (Côte d'Ivoire, Ghana, Morocco and Nigeria), it is interesting to use an interaction variable for cross-border trade. Thus it was assume that $Z_{it} = G(Com_{it}, Com_{it} \times X_{it})$.

Empirical growth model

Combining it with equation (4) gives the structural form of the panel model as follows:

To better understand the effect of cross-border trade on the growth of African countries (Côte d'Ivoire, Ghana, Morocco and Nigeria), it is interesting to use an interaction variable for cross-border trade. Thus, it was assume that:

$$TC_{it} = \partial_0 + \partial_1 Com_{it} + \partial_2 Rnb_{it} + \partial_3 Popu_{it} + \partial_4 Mc_{it} + \partial_5 Z_{it} + \varepsilon_{it}$$

(6)

With i=1…4 et t=1…49

By replacing Z_{it} by its value in Equation (6):

$$TC_{it} = \partial_0 + \partial_1 Com_{it} + \partial_2 Rnb_{it} + \partial_3 Popu_{it} + \partial_4 Mc_{it}$$
$$+ \partial_5 Com_{it} \times Rnb_{it} + \partial_6 Com_{it} \times Popu_{it} + \partial_7 Com_{it} \times Mc_{it} + \varepsilon_{it}$$

(7)

How cross-border trade affects economic growth was examined. From equation (6), the marginal effect of finance was calculated as follows:

$$\frac{\partial TC_{it}}{\partial Com_{it}} = \partial_1 + \partial_5 Z_{it}$$

(8)

This equation shows that the marginal effect of the GDP growth rate on the growth rate of cross-border trade depends on per capita income, population and the common currency. It is expected that the above variables will improve the marginal effect of growth, which should be reflected in a coefficient ∂_5. The common approach in empirical studies to test for a non-linear effect is to simply examine the sign and statistical significance of the interaction coefficient $\partial_5 \rangle 0$. Thus: If ∂_1 and ∂_5 are all positive (negative), then cross-border trade has a positive (negative) effect on economic growth, and the variables that determine economic growth (worsen) this impact.

If $\partial_1 \rangle 0$ et $\partial_5 \langle 0$, cross-border trade has a positive effect on the economy but the variable controls reduce this positive impact.

If $\partial_1 \langle 0$ et $\partial_5 \rangle 0$, cross-border trade negatively affects the economy and the conditions of the control variables mitigate this negative impact. Under the assumption $\partial_5 \rangle 0$, the threshold level of control variables can be calculated above which cross-border trade accelerates economic growth:

$$\frac{\partial TC}{\partial Com} = \partial_1 + \partial_5 Z \rangle 0 \Rightarrow Z^* \geq -\frac{\partial_1}{\partial_5}$$

(9)

RESULTS

This part of the study deal with the presentation of different results and the economic interpretation that follow them. The investigations started with the results and discussion of the econometric pre-tests before ending with the results of the estimation of different econometric models.

Descriptive statistics

Table 2 shows that the average countries in the study have a growth rate of around 3.8%, and the low standard deviation associated with the growth rate shows that there is no real disparity in growth sample. Moreover, the negative coefficient of the median shows that among the countries studied, the measured value, notably the growth rate, is low.

With regard to exports, it was noted here that the average exports in the sample is around 6.8%. The low standard deviation shows that there are no real major disparities in the export policies implemented by the countries in the sample. The same situation is described in the case of the population and income variables (low mean, low standard deviation and low median).

Unit root tests

The tests used to detect the presence or absence of a unit root are those of IPS, LLC and MW, which are respectively the tests of Im et al. (2003) and Levin et al.

Table 2. Descriptive statistics results.

	Mean	Std. Dev	Median
Growth rate	3.82672	4.552246	-12.43163
Export	6.80	0.894	4.80
Population	16.602	0.472	15.480
Revenue	10.25	1.258	7.340
Common currency	0.5	0.5013	0
Common language	0.5	0.5013	0
Joint independence	0.5	0.5013	0
Common settlers	0.5	0.5013	0

Source: Author Author based on UNCTAD and WDI database

Table 3. Unit root tests.

	LLC	LLC	IPS	IPS
	I(0)	I(1)	I(0)	I(1)
Growth rate	-7.454***	-7.454***	-7.025***	-6.934***
Export	-5.362***	-4.957***	-100692***	-10.439***
Populations	-120292***	-12052***	-9.887***	-9.818***
Revenue	-12.292***	12.52***	-9.887	-9.1818

Source: Authors calculations.

Table 4. Heteroscedasticity and autocorrelation tests results of the equation.

Tests		Equation
Heteroscedasticity	Prob > Chi^2	0.000
Autocorrelation	Prob >F	0.000

Source: Author's calculation.

(2002). The choice of delays is based on the Schwarz information criterion with a max delay = 4. The values in brackets are the p-values * (**) means rejection of the unit root hypothesis at the 1, 5 (10%) threshold respectively. The results of these tests suggest that the GDP growth rate, exports, population and income are stationary in level. When all variables are considered as first differences, they all appear stationary (Table 3).

Heteroscedasticity and autocorrelation tests results

Analysis of Table 4 show that the rejection of the null hypothesis of no heteroscedasticity and the rejection of the null hypothesis of no autocorrelation results in errors at the 1% level for the equation. In other words, the data in the study do not have constant variance errors. Indeed, over the entire study period, the error term corresponding to one period is correlated with the error term of another period.

The correlation matrix between the different variables

The matrix of linear correlation coefficients between different variables indicates that the different estimated values are less than 40% (Table 5). It can therefore be said that collinearity problems are less likely.

The estimation of PPML with dependent variable bilateral exports (Xijt)

The results presented in this study confirm that the Poisson pseudo maximum likelihood estimator generally performs well, even when the conditional variance is far from proportional to the conditional mean. Moreover, as expected, the fact that the dependent variable has a high

Table 5. The correlation matrix between the different variables.

	TC	REV	POP	EXP	MCit	LCit	INDit	CCit
TC	1000							
REVENUE	0.087	1000						
POPULATION	0.150*	0.383*	1000					
EXPORT	0.275*	-0.030	0.251*	1000				
MCit	0.003	0.322*	-0.223*	-0.117	1000			
LCit	0.003	0.322*	-0.223*	-0.117	1000*	1000		
INDit	-0.003	-0.322*	0.223*	0.117	-1000*	-1000*	1000*	
CCit	-0.003	-0.322*	0.223*	0.117	-1000*	-1000*	1000*	1000

Source: Author's calculations.

Table 6. The estimation of PPML with dependent variable bilateral exports (Xijt).

	Coef	t-stat	Prob
Common currency (MCijt)	-0.1474914***	0.0192955	0.000
Common language (LCijt)	-0.0036366	0 .01489	0.807
Joint independence (INDCijt)	0.0515491***	0.0126035	0.000
Distance between countries i and j (DISTijt)	-0.1841253***	0.0497356	0.000
Log of country i's income i (log (log(RNBit))	0.1772452**	0.0727839	0.015
Log of country i's income j (log (log(RNBjt))	-0.0519576	0.0601109	0.387
Common settler (CCijt)	0.0917081***	0.0077864	0.000
GDP of country i (log(log(pibit))	-0.3401837	0.2442387	0.164
GDP of country j (log(log(pibjt))	0.1300318	0.2286635	0.570
Distance-intra national of the country i (log(log(dista-init))	-0.3864331**	0.1706708	0.024
Distance-intra national of the country i log(log(dista-injt))	-1.285914***	0.2822304	0.000
Population of country i (log(log(popit))	0.4229156***	0.1616756	0.000
Population of country j (log(log(popjt))	0.7398307**	0.2311593	0.001
Constant	-14.02814***	0.4666646	0.000

Source: Author, * (**) means respectively the rejection of the unit root hypothesis at the 5 (10%) threshold.

proportion of zeros does not affect the performance of the estimator (Table 6). On the contrary, the presence of zeros is an additional reason to use the pseudo Poisson maximum likelihood because, in this case, all estimators based on the log-linearization of the gravity equation have to use unreasonable solutions to handle these observations. Therefore, as before, it can be concluded that the pseudo Poisson maximum likelihood estimator is a promising tool for estimating constant elasticity models such as the gravity equations (Silva and Tenreyro, 2010).

DISCUSSION

In many empirical studies, the common currency has always had a positive sign coefficient in addition to being significant at varying thresholds relative to the optimal currency area theory. But in the study, it was found that this variable has a negative sign coefficient contrary to

expectations, although it is significant at the 1% level. As pointed out above, the common currency variable is captured here by the currencies of the colonizing countries, used in international transactions for the extinction of the international debts of the countries in our analysis sample, that is, the dollar for Nigeria and Ghana, then the euro for Côte d'Ivoire and Morocco.

The negative sign of the coefficient of this variable can be explained in several ways. For countries such as Côte d'Ivoire and Nigeria, which do not have the same international currency according to the study, the volume of international flows of goods and services will not be dynamic because of the transaction costs linked to the exchange rate between the different currencies involved (the Dollar and the Euro). These are often very high transaction costs that discourage economic operators in the respective countries from exchanging goods and services.

Moreover, for countries sharing the same international

currency, such as Morocco and Côte d'Ivoire for example, the absence of an interest rate differential will not favor a real gain in trade, especially since the absence of an interest rate differential does not appear to be very attractive for economic operators that engage in trade. In other words, one Euro or one Dollar will only bring in one Euro or one Dollar and nothing will be added in terms of substantial gains from the exchange. In short, the fact of having a common currency or not does not, according to the study, favor the dynamism of international trade in goods and services, thus justifying the negative sign of our common currency variable, even though it is significant at the 1% level.

The common independence variable is characterized here by a positive sign in line with the one predicted beforehand and shows a significance at the 1% level. In other words, this variable has a positive influence on the volume of trade or cross-border trade between states that share a common independence or that obtained their independence at the same date. Indeed, among the factors that increasingly bring nations together around the world are sociological and historical factors, among which the acquisition of independence at the same date is in pole position.

Once the rapprochement has been achieved thanks to the sharing of certain historical facts, the divisions and other constraints or obstacles to cross-border trade fall away and thus give free rein to the various economic operators of the countries in question to exchange their goods and services appropriately, thus making trade or cross-border trade between groups of countries dynamic.

Author, such as Bennafla (2002), has demonstrated in her work that cross-border trade constitutes a threat to African countries, because according to her, these are fake and unviable states inherited from colonization.

Although Karine Bennafla's reflection is correct, it is still subject to discussion because, as the results of her work show, cross-border trade is not dangerous for the countries of sub-Saharan Africa as long as they share major sociological and historical facts such as political independence. It is therefore appropriate to put into perspective the words of Bennafla (2002).

The variable distance between countries has a negative sign, in line with expectations, and also has a significance level of 1%. Empirically, when two countries are very distant from each other, the volume of trade between them is very low, and this seems to be the result of estimation. Indeed, when the result of econometric estimation shows, two countries are quite far apart, the economic operators between these two countries bear too many costs linked to trade.

These costs are very regularly linked to road congestion, attacks by armed groups who loot at the borders and the poor quality of communication infrastructures. Moreover, in the sample countries, the land road network, which remains the only means of facilitating the exchange of goods and services, is not dense and is defective in some places.

The variable relating to the income of the importing country shows a positive sign of its coefficient in addition to being significant, and in line with the predicted sign. When several countries are engaged in trade relations, the dynamism of trade between them is quite often based on the level of income of the countries among them that are importing countries. Indeed, importing countries are those that buy from their trading partners the goods and services they need not only to satisfy the well-being of their respective populations but also to invest in activities that create wealth and employment. On this basis, when imports are strong and exporting countries respond appropriately to the demands made of them, the volume of trade can only be dynamic. This is certainly reflected in the result related to the income variable of the importing country.

The variable relating to the populations of the cross-border trade partner countries shows a positive sign in line with the predicted sign and is significant at the 1% threshold. In economic theory, population plays an important role in the dynamism of trade relations between countries. When the population is small in terms of numbers, the demand for products from other partner countries is also small, which does not favor exports and imports of goods and services produced in the different partner countries. But when the population is large in volume, the mutual demand and supply of goods and services that the partner countries trade with each other is large and therefore has a positive impact on cross-border trade. Nigeria alone has a population of over 200 million and when this population is joined by Côte d'Ivoire, Ghana and Morocco, the demand and supply of products to be satisfied increases accordingly, thus making trade between these different states dynamic.

The variable relating to the intra-national distances of the trade partner countries, which is the subject of analysis, has the following form: negative coefficients, significance at the 1% threshold, in line with the predictions. Intra-national distances have a fairly negative effect on the volume of trade between the countries that are supposed to be trade partners. Indeed, when the distances separating the capitals of the nations studied are quite high, this discourages trade. Moreover, when cities within a country are too far apart, the thorny issue of the flow of goods and services from the production sites to the local demand markets arises. This constraint may also be the reason for the drop in exports, since the poor state of the roads will not allow the goods and services requested by the partner countries to be delivered in time to meet the needs of the populations. Such a state of affairs will implicitly reduce the volume of trade and therefore the dynamism of cross-border trade.

Analysis of the interaction effect

In this part of the study, the effect of the interaction

Table 7. The estimates of the effect of bilateral trade on economic growth (generalized least squares) with interaction variables.

Growth rate	Coefficients	P-value
Y1	1.094	0.007
Y2	-1.555	0.184
Y3	0.212	0.787
REVENU	-6.896	0.010
POPULATION	10.030	0.206
EXPORT	16.590	0.314
COMMON CURRENCY	-1.292	0.813
CONSTANT	-105.395	0.353

Source: Author based on WDI data (2020).

between the interactive variables that allow us to understand the conditions that cross-border trade to have an influence on economic growth and to try explain the direction of the nature of the observed influence. As shown in the Table 7, the researcher focused on three interactive variables: Y1=export*income; Y2=export*population and Y3=export*Mcit (Annexes Figures).

Interaction between exports and income

In view of the sign of the coefficient associated with the variable Y1 (positive sign and significance at 1%), exports have a favorable effect on the level of economic growth of the countries in the study sample and the income of the countries amplifies this effect. Indeed, the level of growth of the states is strong when these countries are rich because they have a high income that allows them to import more products from the co-trading countries. The fact is that when countries are rich, they produce a lot, thus creating a large supply of goods and services for the benefit of the population, which thus has a wide range of differentiated products. This high level of production will certainly have a solvent demand due to the high level of income. Cross-border trade will thus have a strong dynamic since the high supply will have a strong demand in front of it.

Interaction between exports and population

The negative sign of the coefficient associated with the Y2 variable and its non-significance at all thresholds show that exports certainly have a positive effect on growth, but the population has a negative impact on this effect, reducing it considerably. In fact, a population is not always a source of growth and well-being. When the population is high in number, it often undermines all the social security mechanisms defined and implemented in the States. Moreover, a high population has a negative

impact on state resources. In addition, it is a source of evils such as theft, delinquency and other anti-social practices, not to mention the destruction of nature and especially the reduction of environmental assets.

Interaction between exports and money

Cross-border trade has a positive effect on the economic growth of the countries in the sample and currency has a positive impact on this effect. This is reflected in the positive sign associated with the variable Y3. In general, when several countries or groups of countries use the same currency, this eliminates or considerably reduces the transaction or conversion costs resulting from their main bilateral or multilateral trade. The use of the same unit of account, the same instrument of exchange, encourages the socioeconomic and political rapprochement of states. Once this rapprochement has been achieved, monetary barriers disappear between these states and they naturally become more willing to trade more. When these bilateral exports, which are assimilated here to cross-border trade, increase in volume, this promotes economic growth.

On analysis, the results are similar to those of Mignamissi (2018), even if in some respects there are notable differences. Indeed, Mignamissi (2018) multilateral and bilateral resistance and then intra-national distance have mixed effects on bilateral trade; the researcher work shows that these variables have a fundamentally negative effect on economic growth via cross-border trade. However, like Mignamissi (2018), the results show that the single currency acts positively on the dynamism of cross-border trade.

It is also worth noting that the results of the present study are similar to those of Musa et al. (2020) as population, intra and inter-regional distance and multilateral resistances are the main factors that influence the dynamism of cross-border trade. Angassa and Negassi (2018) are in line with the present study when

they argue that cross-border trade has a positive impact on the level of growth.

Conclusion

The purpose of this study is to analyse the transmission channels through which cross-border trade impacts on economic growth in selected sub-Saharan African countries such as Nigeria, Ghana, Côte d'Ivoire and Morocco between 1971 and 2020, although these states do not use the same local and international currency to facilitate their trade. This led to the presentation of the literature review through which we were able to have an overview of the existing literature on this topic. From there, the homogeneity, heteroscedasticity and stationarity tests were applied, which prerequisites for the validation of estimates.

In this same dynamic, an econometric approach was preceded using a standard augmented gravity model in a first step; then a panel data model was implemented in a second step in order to reach the confirmation or denial of objectives. The results of these different models show that cross-border trade combined with income and currency positively influence the level of economic growth of the countries in the study sample, unlike population, which acts as an inhibiting factor to the positive influence of cross-border trade on the willingness of states to go for a high economic growth rate. This first observation requires that the countries concerned by this study should work in their preferred zone, which is ECOWAS, to accelerate the implementation of the future single currency called ECO.

In addition, they would also benefit from monitoring the quality of their respective populations. Indeed, almost all the countries of sub-Saharan Africa are subject to a major problem of quality of human capital which does not allow foreign investors to employ them and stimulate economic growth as in Asian countries. Thus, faced with this obstacle of the quality of the local workforce, foreign companies operating in this area very often rely on expatriate engineers and managers, and the local workforce is very regularly employed in labor tasks.

Policy recommendations

It is clear that the countries in the study sample would benefit from diversifying their economies to cross the transformation threshold while working towards greater monetarization. The share of international trade remains relatively low in sub-Saharan Africa, where most countries are not industrial countries. It is therefore important for the African continent to implement a set of measures, including improving the business climate, strengthening the quality of institutions and adopting a common currency, in order to develop.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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ANNEXES

```
. pwcorr TC revenu populations exportations Mcit Lcit INDit Ccit,star (0.01)
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	TC	revenu	popula~s	export~s	Mcit	Lcit	INDit
TC	1.0000						
revenu	0.0872	1.0000					
populations	0.1506	0.3839*	1.0000				
exportations	0.2754*	-0.0303	0.2513*	1.0000			
Mcit	0.0032	0.3226*	-0.2237*	-0.1177	1.0000		
Lcit	0.0032	0.3226*	-0.2237*	-0.1177	1.0000*	1.0000	
INDit	-0.0032	-0.3226*	0.2237*	0.1177	-1.0000*	-1.0000*	1.0000
Ccit	-0.0032	-0.3226*	0.2237*	0.1177	-1.0000*	-1.0000*	1.0000*

	Ccit
Ccit	1.0000

```
. xtreg TC Y1 Y2 Y3 revenu population exportation Mcit
```

Random-effects GLS regression		Number of obs	=	192
Group variable: ID		Number of groups	=	4

R-sq:		Obs per group:		
within = 0.1285		min =		48
between = 0.9939		avg =		48.0
overall = 0.1332		max =		48

		Wald chi2(7)	=	28.27
corr(u_i, X) = 0 (assumed)		Prob > chi2	=	0.0002

TC	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Y1	1.094511	.4060152	2.70	0.007	.298736	1.890287
Y2	-1.555556	1.169641	-1.33	0.184	-3.848009	.7368972
Y3	.2128737	.7886384	0.27	0.787	-1.332829	1.758576
revenu	-6.896732	2.664971	-2.59	0.010	-12.11998	-1.673485
population	10.03092	7.934304	1.26	0.206	-5.52003	25.58187
exportation	16.59088	16.49154	1.01	0.314	-15.73195	48.91371
Mcit	-1.29244	5.463927	-0.24	0.813	-12.00154	9.41666
_cons	-105.3814	113.545	-0.93	0.353	-327.9256	117.1628

sigma_u	0					
sigma_e	4.3393764					
rho	0	(fraction of variance due to u_i)				

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Full Length Research Paper

Assessment of financial system and economic growth: An empirical evidence from Ghana's stock market

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The importance of a country's financial system to its economic well-being cannot be underestimated. This paper seeks to investigate whether causation exists between Ghana's financial system and economic growth. Ghana's financial system was measured using the efficiency, depth, and stability of the stock market, while economic growth was measured as the Gross Domestic Growth (GDP) per capita growth. The measurement variables were purposively sampled from 2008 to 2020, spanning thirteen years of time series data. The granger causality approach was employed to test the financial system's and economic growth's causation. In analysis the data, the study employed the Augmented Fuller Dickey (ADF) and Phillip Perron (PP) to test the stationarity of the series, the Jerque Bera Variable to test the normality of the data and the VAR and Johansen cointegration to test the order of integration among the variables. The statistical test revealed that the variables were not cointegrated at level; there was a unit root in the series. There was no long or short run relationship among the variables. Furthermore, the regressors' depth, efficiency, and stability of the stock market as proxies for the financial system of Ghana do not cause economic growth. It is recommended that regulatory bodies should pursue policies that would improve the effectiveness, efficiency, depth, and stability of other aspects of the country's financial system and focus less on the stock market due to the discovered relationship between the stock market and economic growth.

Keywords: Financial system, economic growth, stock market.

INTRODUCTION

The financial system of every country exists to ensure efficient resource allocation, mobilization of capital for investment, facilitate monetary policy, enable financial stability, and help payment system. The benefits of a well-functional financial system tend to contribute to the fortune of economic growth and development (Guptha and Prabhakar, 2018). A financial system comprises banks, capital stock exchange markets, and insurance companies. In both developed and developing economies, the advancement of the financial system and efficient financial market has been identified as a contributing factor to economic growth (Xu et al., 2021). The efficiency and effectiveness of financial systems and their impacts on economic growth can be assessed using different institutions and parameters. However, academics and policymakers have mainly focused on banks' role in

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the financial stability of economies and their contributions to economic growth, with little emphasis on stock exchange markets (Beck and Cull, 2013; Türsoy and Faisal, 2018). For instance, empirical evidence shows that domestic bank credit, non-performing loans, and bank capital to asset ratio positively affect the economic growth of twenty-eight (28) European Countries (EU) (Prochniak and Wasiak, 2017). The evidence from the developing countries is different. Bank credit negatively affects the economic growth of sixty (60) developing countries (Narayan and Narayan, 2013). The situation is not different with research on Sub-Saharan African (SSA) countries. Most African countries' financial systems are developed, and their structure totally relies on the banking industry with a more significant influence on the countries' economic growth at the total or partial neglect of the stock exchange market (Ouedraogo and Sawadogo, 2022). Notwithstanding the overemphasis literature on the impact of the banking industry as a pivot in the financial system on economic growth, there is strong evidence of the crucial role of an efficient stock exchange market in economic growth (Guptha and Prabhakar, 2018). It is not yet clear if this similarly holds for developing SSA countries. Consequently, this study evaluates Ghana's financial system in the quest to understand whether or not it contributes to economic growth. According to studies, Ghana's financial system is at a growing stage, inefficient, and coupled with challenges that stem from inappropriate dealings and inefficiencies by players in the various industries that make up the sector (Sackey and Nkrumah, 2012; Ofori-Abebrese et al., 2017; Amenu-Tekaa, 2022). The account put forward portrays that the inefficiencies led to the collapse and outright revocation of the license of several banks (Amenu-Tekaa, 2022). However, the Bank of Ghana (BoG) accounts that the country's financial system is robust and resilient to the extent that players are posing high growth potential amidst higher profit due to the recent clean-up of the financial sector (BoG, 2019). Moreover, there is empirical evidence of the impact of the banking industry, one of the blocks in Ghana's financial system, to economic growth (Sackey and Nkrumah, 2012; Ibrahim and Alagidede, 2020). The bank-based financial system is less sensitive to economic growth than the equity-based market (Ergungor, 2008; Liu et al., 2022). This varied fragmented discourse on the financial system calls for more empirical interrogation to establish the relationship between Ghana's financial system and economic growth. In doing so, this paper seeks to assess if Ghana's financial system based on efficiency (EF), stability (ST), and depth (DT) causes economic growth. The study would serve three thematic purposes. First, its findings would inform policymakers; again, practitioners in the financial sector would take a cue in structuring their policies and deals to enhance economic development. Finally, it would enrich the diverse literature on the discourse on the financial system and economic growth.

and policy recommendations.

LITERATURE REVIEW

Theoretical review

No single economic theory explains the relationship between the financial system and economic growth. However, this paper explores three theoretical frameworks that underpin the relationship between the stock market as a proxy for the financial system and economic growth. The three theories are the efficient market theory, asset pricing theory and Fisher's Hypothesis. First and foremost, the efficient market theory has been reconnoitred theoretically and empirically to conclude how security prices behave in an efficient market in different financial systems. The theory of efficient stock assumes that the security prices change fully to reflect the available information about individual stock, the entire stock market, or the economy (Fama, 1970). Although the term "how efficient is the stock market" has received many critiques as limitations to the efficient market theory, many scholars and researchers have tested, proven and added to the evolving of the effectiveness of the theory assumptions (Rayball, 1989; Adam and Tweneboah, 2008; Malkiel, 2003). The hypotheses of the efficient market theory have been used to assess stock market efficiency as either strong, semi-strong or weak form and the extent of such form contributions to the financial system (Ozdemir, 2008; Mubarok and Fadhli, 2020). The contribution of the stock market's efficiency has been linked to security prices and economic growth (Lee and Lee, 2009). The performance of the security prices, which reflects the efficiency of the market, is evident with the market's annual stock turnover as available information (Fama, 1970; Osei, 2002). Most empirical studies of the efficient market theory used the stock turnover to measure market efficiency information (Ozdemir, 2008; Shah et al., 2019; Bouteska and Regaieg, 2020).

Moreover, the asset pricing theory, as propounded (Ross, 1976) and deployed in empirical studies on the stock market (Osei, 2002; Adu et al., 2013), asserts that volatility in the prices of listed stocks on an exchange is affected by systematic factors as well as unsystematic factors. The systematic factors, as proffered by the theory, refer to macroeconomic factors inherent in an economy which influences the mechanism that takes place in determining asset prices, whilst the unsystematic factors are those industry-specific variables that come with the particular industry a firm chooses to invest (Chen et al., 1986). These two distinct factors play an instrumental role in determining the price of listed stocks. As mentioned earlier, the effectiveness and accuracy of the factors reflect the efficiency and stableness of a country's financial market (Borio and Drehmann, 2009).

The effectiveness of the interaction between the asset pricing mechanisms would entice foreign firms to enlist their securities on a country's stock market (Martinez-Jaramillo et al., 2016). The higher the number of expatriate firms listed on the exchange, the higher the depth of the financial market of such country and consequentially higher economic growth with ceteris paribus. The asset price theory does not provide a framework that suggests that macroeconomic factors affect stock price volatility rather than the asset price; the fisher hypothesis proposed that expected nominal annual stock returns are a sum of the real returns and expected rate of inflation (Srivastava, 2010).

Lastly, Fisher's hypothesis, also known as Fisher's theory, is an economic framework brought by Irving Fisher (1930) which asserts that the real interest rate is distinct from monetary mechanisms, precisely the nominal interest rate and the expected rise in the general price of goods and services(Fisher, 1930). The framework describes the linkage between real and nominal interest rates and inflation. According to Fischer (1993), the difference between the real interest rate and the expected level of inflation sum up to the real interest rate. Consequentially a rise in the inflation rate equals a fall in the real interest rate unless a commensurable increment occurs in the nominal interest rate (Fischer, 1993). This volatility necessarily affects the stability of the financial market of every country, however, at different degrees depending on the level of financial advancement and economic growth of the country in question (Borio and Drehmann, 2009). The extent of the volatility of interest rates and inflation influences stock price volatility and thereby determines the financial system's stability. The underpinning assumptions of asset pricing theory and Fisher's hypothesis clearly suggest the interplay of stock prices and macroeconomic factors that determine the stability of a country's financial system and general economic climate. The theoretical framework of Fisher's hypothesis, the efficient market theory and the asset prices theory underpins a country's depth of financial system. Moreover, stock price volatility and stock market turnover are rooted in the assumptions of the efficient market theory and asset prices theory. This study adopts these theoretical frameworks to test the extent of Ghana's financial system's depth, efficiency and stability using the stock market as a proxy.

Emperical review

The existing literature on the financial system and economic growth demonstrates dimensions where possible literature gaps that needs attention in Ghana's financial system. The financial system of a developing financial market is characterized by various factors contributing to market performance and economic growth. The factors identified by existing literature as influencing market efficiency are appropriate legal and regulatory framework, the efficiency of the securities exchange commission, a dynamic stock exchange market, and the extent of available information on a firm's performance (Williams and Hussein, 2018). The stock market is described as efficient when the asset price fully displays all the available information (Eakins and Mishkin, 2012). The level of stock market efficiency has been identified as a key contributing factor to the stock market performance and its contribution to the economic climate of the country of operations (Bodeutsch and Franses, 2015; Jayakumar et al., 2018). For instance, weak stock market efficiency has been significantly linked to different degrees of economic growth (Aktan et al., 2019). The general empirical studies on the Ghana Stock Exchange (GSE) have mainly focused on the performance of the listed firms with few emphases on the efficiency of the market and the possible contribution to economic growth. A corporate financial performance review on GSE-listed banks indicates that the bank's internal variables tend to increase profitability (Oduro et al., 2019) while the unlisted banks' financial performance is inverse with the level of leverage (Gadzo and Asiamah, 2018). With regards to market efficiency, the GSE is not efficient due to high transactional cost, low firm participation, and slow market competition (Ayentimi et al., 2013). The GSE inefficiency is insensitive to firms' returns on the market (Awiagah and Sup Brian Choi, 2018). It has also been established that the GSE is inefficient due to the information release of the annual earnings and the general market climate of the GSE is inconsistent with Efficient Market Hypothesis (EMH) theory (Osei, 2002). The inefficient market of GSE has several implications for domestic and international investors and economic growth (Magnus, 2008). Moreover, the competition in the stock market turns to improve efficiency, thereby impacting the country's economic growth (Cojocaru et al., 2016).

The extent of GSE efficiency, performance, and contribution to economic growth is evident in the market regulations and the enforcement of those regulations (Tagoe, 2019). In Ghana, the level of economic growth and the extent of influence of sectors such as the financial system varies based on the financial market's performance and development. There is evidence of a strong effect of Ghana's capital market performance on economic growth (Acquah-Sam and Salami, 2014). The dynamic shocks in Ghana's financial system development tend to have short-run and long-run effects on the country's economic growth (Ibrahim and Alagidede, 2020). Besides, the government's policy decisions, such as monetary policy, have a significant positive impact on Ghana's stock market and influence economic growth (Antwi et al., 2021). A critical analysis of literature across continents and countries shows that the extent of the financial system's impact on economic growth is determined by the choices of the variables used

in the measurement of economic growth and the proxy of the financial system, thus, resulting in different findings (Adu et al., 2013; Alexiou et al., 2018). As an element that determines economic growth, the financial system has been measured as domestic credit (Mishra and Narayan, 2015; Prochniak and Wasiak, 2017), bank non-performing loans, and market capitalization (Prochniak and Wasiak, 2017; Antwi et al., 2021). In almost all these empirical studies, economic growth is measured by Gross Domestic Product (GDP).

In some studies, GDP is specifically measured in terms of non-oil sectors to evaluate the financial system's effect on economic growth (Ogbonna et al., 2020). In the broader context, using the capital market (Choe and Moosa, 1999) and the banking industry (Jayakumar et al., 2018; Appiah-Otoo and Song, 2022) as proxies shows that the financial system contributes to economic growth because of the crucial role of financial intermediaries. In addition to market efficiency, the varying proxies of the financial system and the financial depth of the chosen financial system influence economic growth (Türsoy and Faisal, 2018). Furthermore, the literature on the context of Ghana's economic growth shows that remittances positively impact economic growth, while external debt and foreign direct investment negatively affect economic growth in the long run. The extent of the domestic financial system's impact on economic growth is hardly being investigated. Even if it is considered, the focus has mainly been on the banking sector in the financial system. A recent study concludes that banks' variables to GDP significantly negatively affect the financial system and economic growth in the long run (Appiah-Otoo and Song, 2022). Although the banking sector plays a major role in Ghana's financial system, the sector has, over the years, experienced challenges leading to amalgamation and revocation license of some banks (Amuakwa-Mensah and Marbuah, 2015; Obuobi et al., 2020); hence using the sector as a proxy of the financial system in addition to the existing literature may not contribute much to the body of knowledge in the field. Also, there are mixed empirical results on the relationship between the financial system and economic growth regarding measurement and proxy of the markets. This paper seeks to add to the literature by using Ghana's stock market measures in terms of financial depth, market efficiency, and stability to establish the influence of the financial system on economic growth.

Conceptual framework and hypothess

The three parameters in the study are fragmented since prolonged stability can lead to greater depth; thus, providing various financial services to the client would lead to efficiency. The depth of the financial system shows how deep or rich services are rendered by players in the financial system (Kim, 2016). Furthermore, the efficiency of financial services can be achieved when
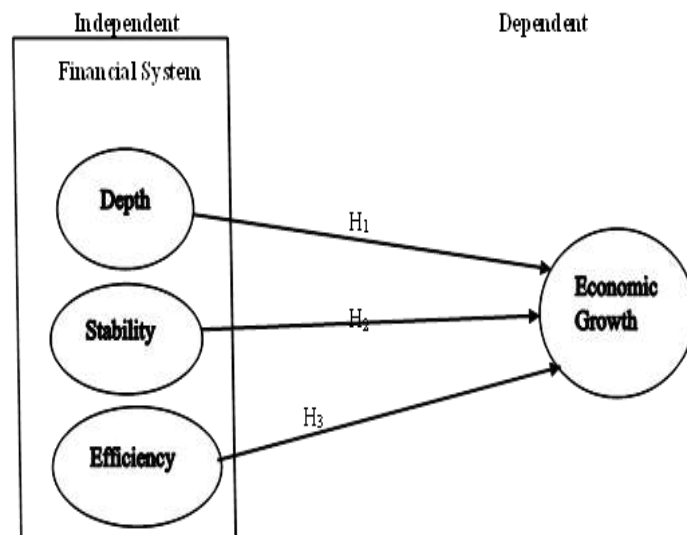

Figure 1. Proposed conceptual framework.
Author's construct (2022).

there is less volatility in the system and, thus, stability. These would jointly impact economic growth. Figure 1 depicts a visual representations of the proposed conceptual framework for the study.

Conceptual framework

Proposed Reserch Hypothess Development:

H_1: Depth of financial system leads to economic growth.
H_2: Stability in the financial system causses economic growth
H_3: Efficiency in the financial system predicts economic growth

METHODOLOGY

The study adopted causal research as the design where the hypothesized individual variables would be regressed on economic growth as the dependent variable. The various variables included in the study are selected based on the indicators employed to assess the financial system. The depth of Ghana's financial system is measured by international debt securities to GDP. The efficiency of the financial system is measured as the stock market turnover ratio. The use of multi-proxies to measure the financial system is motivated by the literature, and studies assert that defining a single appropriate variable for financial system development is a daunting task faced by empirical studies (Türsoy and Faisal, 2018; Koçoğlu and Cihangir, 2021; Kuranchie-Pong and Forson, 2022). In addition, the measuring construct for financial system stability is stock price volatility (Antwi et al., 2021), while the dependent variable, economic growth, is measured by GDP per capita annual growth, as used by Barradas (2020). The multidimensional measure gives a comprehensive and broad assessment of the financial system development encompassing depth, efficiency, and volatility (Beck and Cull, 2013). Yearly data for Ghana's financial system

was assembled from 2008 to 2020, spanning a period of 13 years of time series observations. This period also represents the time frame within which data for all other variables employed in the study were collected. This period was considered for the study since most indicators' data were unavailable before 2008. Moreover, 2008 was the year the global economy experienced a severe financial crisis where the financial systems of emerging economies, including Ghana, were worst hit (Blankenburg and Palma, 2009). Again, data for variables that predate 2008 were not in full. Since then, Ghana's financial structure has witnessed several structural adjustments, including recapitalization and stock market listing requirements (BoG, 2019). The study employed the Granger causality framework as the estimation technique for its analysis (Granger, 1969). The adoption of the method is based on its usage in the empirical literature (Türsoy and Faisal, 2018; Koçoğlu and Cihangir, 2021; Kuranchie-Pong and Forson, 2022). Again, the decision to employ granger causality is premised on the relationship the study intended to test. Moreover, since the data for the studied variables were time series, employing granger causality would serve the purpose of other conventional estimation models. Also, the approach assumes that DT, EF, and ST granger cause economic growth. This condition makes it suitable for the study since it assesses the effect of the regressors on the regressand (Granger, 1969). Since the data used is time series data, the stationarity of the variables needs to be tested; ignoring this would lead to spurious problems (Jayakumar et al., 2018). The Augmented Dickey-Fuller (ADF) tests for unit roots to ensure the variables are integrated in the same order (Harris, 1992).

Where Y_t is a Random Walk and assumes the forms as follows:

$$\Delta Y_t = \partial Y_t - 1 + \alpha_i \sum_{i=1}^{m} \Delta Y_t - 1 + \varepsilon_i$$

Y_t is a Random Walk with an intercept:

$$\Delta Yt = \beta 1 + \partial Y_t - 1 + \alpha_i \sum_{i=1}^{m} \Delta Y_t - 1 + \varepsilon_i$$

Yt is a Random Walk with an intercept and time trend:

$$\Delta Yt = \beta 1 + \beta 2t + \partial Y_t - 1 + \alpha_i \sum_{i=1}^{m} \Delta Y_t - 1 + \varepsilon_i$$

The Philip-Person (PP) statistical test is a different approach to checking the unit root of a dataset. However, the rationale governing this does not differ from the ADF method. Notwithstanding, the PP test adds a non-parametric statistical approach to cater for serial correlation in the residual and does not add the lagged difference into the model. Below is the notation of the PP test.
    Y_t is a random walk and takes the form as follows:

$$\Delta Y_t = \partial Y_t + \varepsilon_i$$

Y_t is a random walk with an intercept.

$$\Delta Y_t = \beta 1 + \partial Y_t + \varepsilon_i$$

Y_t ia a random walk with intercept and time trend

$$\Delta Y_t = \beta 1 + \beta 2 + \partial Y_t + \varepsilon_i$$

$$Y_t = Y_t - 1 + Y_t - 2 + Y_t - n + X_t - 1 + X_t - 2 + X_t - n$$

$$GDP\_G = [DT, EF, ST]$$

Where: Y_t represents economic growth; DT denotes the depth of financial services; EF represents the efficiency of the financial system; ST denotes volatility of the financial system, while t denotes time. GDP_G represents gross domestic product per capita growth.

Descriptive statistics

Beside the above modeling, this research used descriptive statistics to characterize the variables under study. According to Hejase and Hejase (2013), "descriptive statistics deals with describing a collection of data by condensing the amounts of data into simple representative numerical quantities or plots that can provide a better understanding of the collected data" (p. 272). Therefore, this study analyzed data collected with descriptive statistics such as frequencies, percentages, minimum, maximum, and other terms supported with a table for clarity.

RESULTS AND DISCUSSION

The results of various statistical tests and their corresponding discussions and interpretations are presented in this study. For any quantitative inquiry, the data's description and summary are paramount. According to the descriptive statistics in Table 1, financial system stability had a maximum of 13.255, while that of economic growth was 11.315. The maximum efficiency of the financial system was 10.083, while the depth of the financial system recorded 15.214 as the maximum. The mean for economic growth was 3.880, efficiency was 5.675, and that of stability of the financial system was 9.225. In addition, the mean for the depth of the financial system was 7.466. In total, the most divergent data from the center of the distribution was depth, with a standard deviation of 5.036, while the least deviated variable for the average of the distribution was stability which registered a standard deviation of 1.730. Efficiency is highly skewed to the left, notwithstanding the financial system's stability skewed to the right. Jarque's test showed that the dataset is normally distributed. The study begins by adjusting a Vector Error Correction Model (VAR) by identifying the Data Generating Process (DGP) to detect the characteristics of all variables. This VAR requires the study to estimate if the model would incorporate an aspect of intercept and time trend. Thereafter, the sampled indicators being its GDP_G, DT, EF, and ST, would be subjected to unit tests, and only variables that integrate in the same order would be subjected to cointegration analysis. The variables were subject to the stationarity test through the ADF test and PP stationarity test; relying on the automatic level of precision selection by Akaike Information Criterion (AIC) and Schwarzman Information Criterion (SIC), using the PP approach to select the maximum lag length. Since the visual plot is usually the initial step in time series analysis, the study plotted the stationarity of the variables at level specification, as shown in Figure 2. The charts clearly show that the variables have no stationarity at a level, which signifies that their respective means

Table 1. Descriptive statistics.

	ST	GDP_G	EF	DT
Mean	9.225185	3.879667	5.675323	7.462634
Median	9.037324	4.229181	6.729468	6.988401
Maximum	13.25488	11.31541	10.08304	15.21416
Minimum	6.898379	-1.605116	0.353179	1.817259
Std. Dev.	1.729589	3.469663	3.011204	5.305785
Skewness	0.931741	0.340837	-0.351039	0.229973
Kurtosis	3.466984	2.833395	1.854546	1.418631
Jarque-Bera	1.999098	0.266737	0.977697	1.469151
Probability	0.368045	0.875143	0.613332	0.479709
Sum	119.9274	50.43567	73.77920	97.01425
Sum Sq. Dev.	35.89772	144.4627	108.8082	337.8162
Observations	13	13	13	13

Source: Author

Figure 2. Stationarity of variables at Levels (Levels).
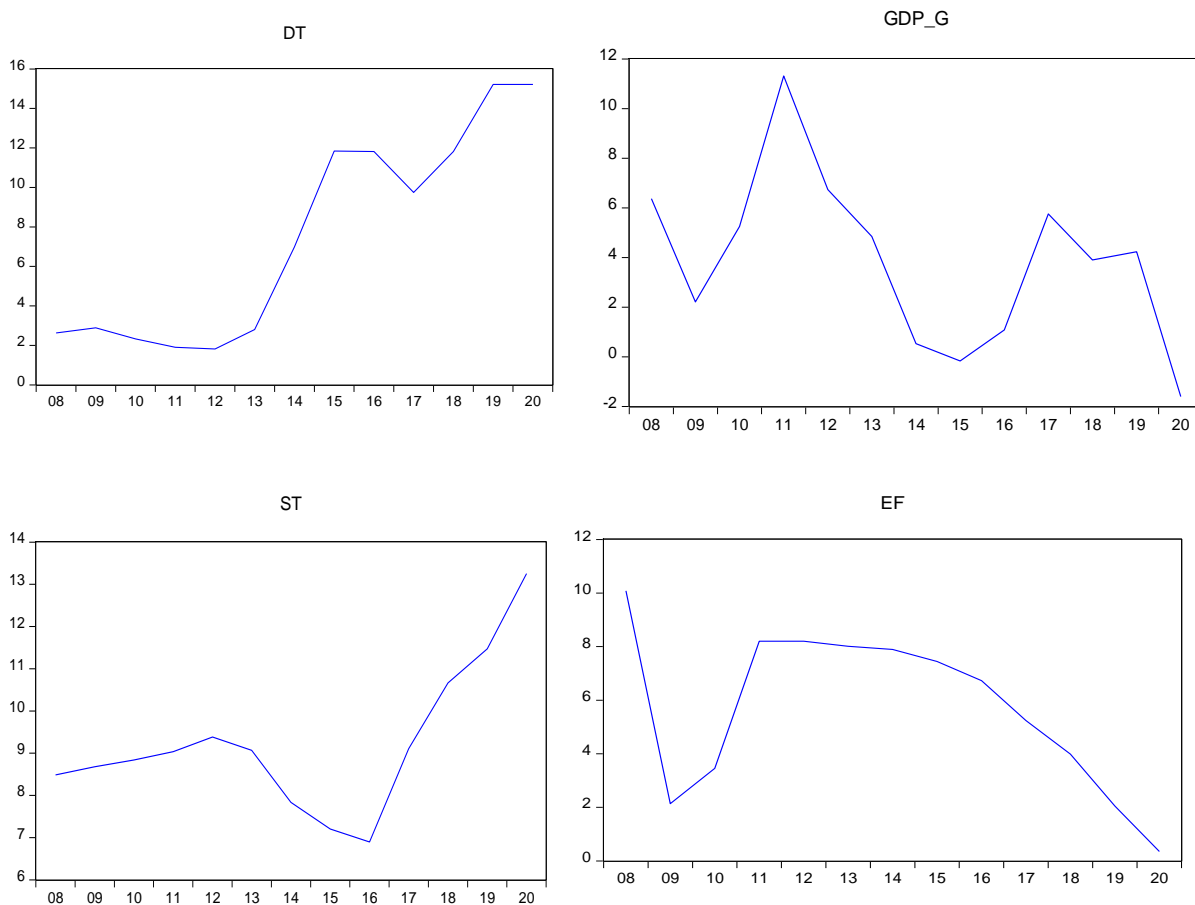Source: Author

and variance are not constant.

This finding agrees with previous studies that found unit roots for variables at level (Forson and Janrattanagul, 2014). For instance, the graphs for GDP_G and DT showed a fluctuating movement throughout the study period. Contrastingly, the graph for ST showed ups and downs, while that of EF demonstrated a decreasing trend

Table 2. Unit root of variables at level specification.

| At level | ADF | | PP | | ADF | | PP | |
| | Intercept | | Intercept | | Intercept and Trend | | Intercept and Trend | |
	t-stats	p-value	Adj-stat	p-value	t-stats	p-value	Adj-stat	p-value
GDP_G	-1.86148	0.3368	-1.97242	0.2931	-3.45439	0.101	-1.88456	0.6009
DT	-0.12536	0.9206	0.132567	0.9539	-3.67873	0.0708	-2.36844	0.3737
EF	0.769242	0.9865	-2.00239	0.2818	-4.21259	0.0386	-1.86648	0.6101
ST	-0.70161	0.8064	-0.00745	0.9396	-0.90475	0.9153	-0.35902	0.9745

Source: Author.

Table 3. Unit root at first difference.

| First Diff | ADF | | PP | | ADF | | PP | |
| | Intercept | | Intercept | | Intercept and Trend | | Intercept and Trend | |
	t-stats	p-value	Adj-stat	p-value	t-stats	p-value	Adj-stat	p-value
GDP_G	-3.3629	0.0432	-3.03911	0.0619	-3.42319	0.113	-2.91293	0.1969
DT	-1.33884	0.5621	-2.218	0.2108	-0.94136	0.8955	-1.72158	0.6719
EF	-2.87613	0.086	-4.23359	0.0095	-7.05397	0.001	-11.0475	0.0001
ST	-1.31959	0.5802	-1.31959	0.5802	-1.85574	0.6104	-1.67595	0.6924

Source: Author

with its peak during the 2008 financial crisis and economic downturn.

Unit Root

In statistical analysis, whenever a time series data exhibits the absence of a unit root, the series is integrated of order 0 or I (0). Nonetheless, if a series is integrated at I (1), I (2), or I (3), it means stationarity can only be achieved at the first difference, second difference, or third difference, respectively. After employing ADF and PP tests which test the null hypothesis that there is unit root and stationarity, the study ascertained mixed results for intercept and intercept with a time trend. Using the ADF for intercept and intercept with time trend, only efficiency was found without a unit root at a 5% level. However, as a confirmatory test, the PP test was employed to ascertain stationarity, but none of the variables was stationarity at a level. This PP test outcome led to testing at the first difference using both approaches. The ADF test found the GDP_G intercept without a unit root at the first difference at a 5% significance level. Again, the intercept and time trend of EF had a p-value of 0.001. Therefore, the null is rejected, concluding that EF does not have a unit root at first difference. PP test found the intercept and time trend of efficiency to be stationary at first difference. The remaining variables were either at the unit root or not stationary. The result means that at a level, only EF had its means and variance constant, which implies that the financial system was efficient at the level while the

efficiency of the system was higher at the first difference (Tables 2 and 3).

Cointegration test

In further analysis, a test was conducted to examine whether the variables are cointegrated. Johansen cointegration test was performed to determine the order in which the variables are integrated. The result revealed that the variables are not cointegrated. Therefore, the VAR approach was used to estimate the short-run relationship among the variables. Since estimating the cointegration between the variables is not enough to assess the robustness of our test. The trace statistic and maximum eigenvalues statistic, and granger causality tests were deployed.

Granger causality test

The presence of a unit root problem due to the rejection of the alternative hypothesis means that the series is non-stationary. This outcome makes it inappropriate and inefficient if the study applies the conventional granger causality test or investigates causality between the independent and dependent tests, making it necessary to select an alternative: Toda Yamamoto granger causality. The Toda and Yamamoto granger causality test was developed to serve as an alternative and more robust approach that tests causality among variables regardless of whether the variables are non-stationary or at the unit

Table 4. Result of Toda andYamamoto Granger Causality test.

Lags: 2 Null Hypothesis:	Obs	F-Statistic	Prob.
GDP_G does not Granger Cause ST	11	1.66111	0.2666
ST does not Granger Cause GDP_G		0.80964	0.4883
EF does not Granger Cause ST	11	0.92775	0.4456
ST does not Granger Cause EF		1.15365	0.3768
DT does not Granger Cause ST	11	14.4889	0.0050
ST does not Granger Cause DT		0.68181	0.5410
EF does not Granger Cause GDP_G	11	0.11027	0.8974
GDP_G does not Granger Cause EF		0.05405	0.9478
DT does not Granger Cause GDP_G	11	3.06114	0.1213
GDP_G does not Granger Cause DT		0.33694	0.7266
DT does not Granger Cause EF	11	6.27841	0.0338
EF does not Granger Cause DT		0.17317	0.8451

Source: Author

root. Therefore, the causality among the variables was tested using the Toda and Yamamoto granger causality, as shown in Table 4. Per the Toda Yamamoto test output, the null hypothesis that ST does not cause GDP_G cannot be rejected; thus, ST does not cause GDP_G. This output implies that the stock market's stability does not lead to economic growth. It violates the study's assumption that the more stable the financial system is, the higher the economic improvement. The result is in line with the findings of previous studies (Alexiou et al., 2018; Ehigiamusoe and Lean, 2018). However, the same contradicts the findings of previous studies (Bodeutsch and Franses, 2015; Min et al., 2018). The efficiency of the financial market was found to be inversely related to economic growth in Ghana. This outcome is based on the failure to reject the null hypothesis that efficiency does not cause economic growth. No long-run or short-run causality is running from efficiency to economic growth. This result means that the past efficient level of the stock market does not lead to economic growth in Ghana, which rejects the study's initial hypothesis. This discovery conforms with the findings of Bhattacharya et al., (2019). However, the result disagrees with the findings of Min et al. (2018) and Antwi et al. (2021), who found the efficiency of a financial market to predict economic growth. Again, the depth of Ghana's stock market does not cause economic growth, and the null hypothesis is accepted due to a p-value of 0.121. The result means that the level of depth of the stock market activities is, the slower the economic growth; thus, there is no causality from depth to economic growth. This outcome confirms the conclusions of Alexiou et al. (2018) and Ehigiamusoe and Lean (2018) that the financial system decelerates economic growth; the same finding contradicts the assertions of Barradas (2020) and Jayakumar et al. (2018).

CONCLUSIONS AND POLICY RECOMMENDATIONS

The financial system's contribution to a country's economic growth has been spearheaded as headlines in previous studies and discussions. Ghana's financial system and its predicting power on economic growth are less researched. This paper explored the causality relationship between the development of Ghana's financial system proxied as depth, efficiency, and stability of the stock market while economic growth was measured as GDP growth per capita. The study employed the ADF and PP tests to examine the stationarity of the series. The Johansen cointegration was employed to test the possibility of the long-run and short-run relationship among the variables through the VAR approach. Again, due to unit root behaviour exhibited by the variables at both level and first difference, the study deployed the Toda and Yamamoto granger causality test as an alternative to the conventional granger causality. The paper concludes that the depth of the stock market in Ghana does not granger cause economic growth. Thus, improving the depth of the stock market operations does not lead to economic growth. A similar result was found in the case of the efficiency and stability of the stock

market, implying that the more efficient and stable the stock market becomes, the slower the country's economic growth. This result deviates from conventional expectations of literature due to challenges that trickled into the study. Just as most empirical apprehensions face, the study was not without limitations. Data unavailability and difficulty in retrieving data were the main limitations. The findings have various policy implications. Regulatory bodies in the financial system should consciously provide data on the stock exchange's operations to facilitate academic and policy apprehension. The regulatory bodies should pursue policies that would improve the effectiveness, efficiency, depth, and stability of other aspects of the country's financial system and focus less on the stock market due to the discovered relationship between the stock market and economic growth. Future research should examine the effect: the long run and the short run, of insurance markets and economic growth. Furthermore, academia can collaborate to use other non-conventional approaches and indicators in exploring the afore-tested relationship

CONFLICT OF INTERESTS

The author has not declared any conflict of interest.

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Full Length Research Paper

Analysis of the impact of renewable energy use on GDP and employment in Angola: An error correction model approach

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This paper explores the impact of renewable energy on Angola's GDP and employment. The study used the Autoregressive Distributed Lag (ARDL) and error correction models with data on renewable energy use, gross domestic product, unemployment rate, industry employment, vulnerable employment, labor force participation rate and gross fixed capital formation. This note contributes to the existing literature by investigating the effects of renewable energy use on vulnerable employment in a single developing country like Angola. All the data gained stationarity at first differentiation. Our analysis revealed that renewable energy use shares a causal long-run relationship with the gross domestic product, unemployment rate, vulnerable employment, and labor force participation rate. The short-term analysis exhibits a causal one-way relationship ranging from renewable energy use to vulnerable employment, labor force participation rate, and gross fixed capital formation. Our findings suggest that renewable energy use will harm vulnerable employment and labor force participation rate but improve gross fixed capital formation in the short run. However, there is no significant relationship ranging from renewable energy use to industries' employment, GDP, and unemployment in the short term. Overcoming the mixed effects of using renewable energy on employment recommends investing in research and development of the renewable energy sector, which could add to the drop in unemployment and the quality of jobs. The country's leaders could draw inspiration from countries like the People's Republic of China, Brazil, and India. Infrastructure development, skills training, and technical support should be the primary emphasis of policy initiatives. In its sustainable development policy, the government must consider that investing in the agriculture sector might add to the country, whether for renewable energy production, agricultural productivity, or jobs creation. The country would benefit from accelerating industrialization while promoting renewable energy use and on-site processing of raw materials.

Key words: Renewable energy, economic growth, employment, Angola, Autoregressive Distributed Lag (ARDL).

INTRODUCTION

Energy plays a crucial role in Angola's economic growth and development, one of the fastest growing and largest economies in sub-Sahara Africa, given that its energy demand has increased. This study aims to determine the

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impact of renewable energy on Angola's economic growth, keeping in mind the need for adequate and sustainable energy to meet the growing annual electricity demand of Angola of 13%, with hydropower power supplying more than two-thirds of Angola's mix (Enerdata, 2023). Therefore, this study contributes to the impact of renewable energy on Angola's employment and GDP and offers policy alternatives regarding renewable energy deployment in Angola to ensure robust economic growth and development. Today, the country's national development plan seeks to increase solar deployment capacity of 100 MW, wind energy of 100 MW, 370 MW of mini and medium hydropower, and 500 MW of biomass in 2025 (International Energy Agency, 2019). Furthermore, the country's economic development has witnessed a recession that mirrored its energy consumption levels from plummeting since 2015. Biomass represents nearly half of its energy mix, but its share is reducing (Alemzero et al., 2021; Enerdata, 2023).

Additionally, Angola plans to reach approximately 60% electricity access from its current 44% access rate by 2025 and increases its installed capacity to 9.9 GW. Since Angola's energy sector faces aging infrastructure and grid constraints to handle variable renewable energy generation, the government predicts investing a total of 23.5 billion US dollars in the energy sector, with a breakdown of 12 billion US dollars in a generation, 4 billion US dollars in transmission and 7.5 billion US dollars in distribution infrastructure (Enerdata, 2023). According to the Africa Energy Outlook's report (International Energy Agency, 2019), Angola is strategizing to reduce greenhouse gas by up to 35% unconditionally to 50% conditionally by 2030 as a business-as-usual approach (BAU).

Even if the shift from burning fossil fuels for energy production to renewable energy sources lowers the total amount of carbon (as CO_2 gases) released into the atmosphere (Adams and Acheampong, 2019; Anwar et al., 2021; Azam et al., 2021), it raises some concerns. Scientists have tried to answer whether renewable energy would be up to that of non-renewable or even better. The results agree with the bewildering effects of using renewable energy on a country's economic growth according to countries (Tuna and Tuna, 2019; Musah et al., 2020; Sharma et al., 2021a; 2021b). It is therefore legitimate to be concerned about the consequences of renewable energy use on the economy of Angola.

According to Alabi et al. (2017), renewable energy consumption experiences outstanding performance in economic development in Angola. This conclusion was reached by applying FMOLS to data on CO_2 emissions, renewable energy consumption, non-renewable energy consumption, and GDP covering the period 1971 to 2011. However, Keshavarzian and Tabatabaienasab (2021) revealed that renewable energy consumption and economic growth do not influence each other in Angola. The analysis was realized using Bootstrap panel

causality on GDP, renewable energy, and non-renewable energy from 1980 to 2018. These studies, which were not explicitly focused on Angola, came to different conclusions, pointing to the importance of conducting analyses with more recent data to learn the effects of renewable energies on growth. Also, the previous findings may no longer remain credible because of the variation in the data.

As the Angolan government plans to reduce poverty by 2030 while reducing carbon emissions, the debate is whether renewable energy could promote growth in Angola.

In 2020, the renewable energy sector employed at least 11.5 million people worldwide, including 4.4 million in China, 1.2 million in Brazil, and 755600 in the United States (IRENA, 2020). Photovoltaic solar industries (P.V.), biopower, hydroelectricity, and wind turbines are the most prominent job providers (renewable energy jobs), whether in the agricultural sector or the production of energy, according to IRENA (2018). From this point of view, renewable energies should consolidate growth. These effects may be due to those countries' energy policies promoting a wide adoption of renewable energies, which is not necessarily the case in Angola.

This paper questions the implications of renewable energy use on vulnerable employment, unemployment rate, industry employment, GDP, and capital in Angola with an ARDL model. This is to consolidate sustainability policies in the country. To the best of our knowledge, there is no study about the impact of renewable energy use on vulnerable employment in Angola. Our paper will address this issue, adding to the vast literature about renewable energy. This could help the authorities when formulating poverty reduction and employment policies. The remainder of the paper is as follows. Section two is the literature, explaining the various studies about renewable energy and growth. Section three describes the study data and the methodology. The results are presented in Section four, while Section five outlines the conclusions and policy implications reached from the findings.

LITERATURE REVIEW

Sustainable economic growth is the main target of economic policy in many countries worldwide (Salari et al., 2021). Policymakers have understood that sound economic policy must be effective over time by ensuring populations' well-being. This has led researchers to conduct investigations according to their economic regions' realities (Xie et al., 2020; Asif et al., 2021; Dimnwobi et al., 2022). Although it has given rise to various conclusions, the impact of renewable energies on growth has been studied according to its relationship with variables such as GDP, employment, and unemployment. This part of the study will present the recent studies on

renewable energy and economic development.

Table 1 outlines some previous studies on the impact of renewable energy on economic growth. The results were classified into positive, negative, and no effects of renewable energy.

The results of the few existing studies about the impact of renewable energy use on economic growth in Africa are mixed. For example, Awodumi and Adewuyi (2020) found that increasing the use of renewable energy contributes to economic growth in Gabon, Egypt but reduces growth in Nigeria. They used data covering 1980-2015 and applied the NARDL method. They recommend exploring avenues to invest in and promote carbon reduction technologies in the production process. Using DCCEMG and data from 1998 to 2018, Musah et al. (2020) demonstrated that renewable energy does not influence gross domestic product in West Africa and encouraged green technology, energy innovation, wind and solar energy, and reduction of fossil energy. Nevertheless, with the NARDL approach and data covering 1990-2015, Namahoro et al. (2021) reported positive and negative impacts of renewable energy on the gross domestic product in Rwanda. Investments in renewable energy consumption and agriculture as prior sectors of development were recommended. Globally, renewable energy's impact on growth is divided into terms of hypotheses: growth, conservative, feedback, and neutrality hypothesis (Somoye et al., 2022). The growth hypothesis refers to the existence of causality ranging from renewable energy use to economic growth; the conservation hypothesis stipulates a unidirectional causality of growth towards the use of renewable energy; the feedback hypothesis reports the existence of causation between the two variables, and the neutrality hypothesis indicates the presence of a relationship between economic growth and the use of renewable energy.

The studies that support the positive impact of renewable energy use on the economic sector include Azam et al. (2021), Salari et al. (2021), Doytch and Narayan (2021), Namahoro et al. (2021), Azretbergenova et al. (2021), Rahman and Velayutham (2020), Awodumi and Adewuyi (2020), Chen et al. (2020) and Bhattacharya et al. (2017). These authors found that using renewable energy contributes to developing economic growth. Salari et al. (2021) used GDP per capita, total energy consumption, non-renewable energy consumption, renewable energy consumption, industrial energy consumption, and residential energy consumption to compare the impact of renewable and non-renewable energy consumption on the economy of the United States. Their result exhibits a growth hypothesis between renewable energy use and economic growth. Likewise, Azretbergenova et al. (2021) investigated the relationship between renewable energy and employment in European Union Countries. They used data on employment, renewable energy, GDP per capita, and fixed capital

formation to finding that renewable energy positively impacts employment.

The negative impact of renewable energy on the economic sector got found by Muazu et al. (2022), Somoye et al. (2022), Namahoro et al. (2021), Awodumi and Adewuyi (2020), Chen et al. (2020), Magazzino (2017) and Bhattacharya et al. (2017). Using a non-linear ARDL approach and data on GDP, renewable energy consumption, gross fixed capital formation, and labor force participation rate from 1990 to 2019, Somoye et al. (2022) show that a positive shock of renewable energy hurts GDP in Nigeria because of the nature and source of the used renewable energy. The authors recommend policies minimizing renewable energy's adverse effect on economic growth while diversifying renewable energy sources. The study of Muazu et al. (2022) established a negative relationship between renewable energy and economic growth in some African countries using threshold regression and data on renewable energy, GDP, capital, and labor. However, they encourage investment in renewable energy and research and development so that renewable energy can support those countries' growth. In West African countries, Maji et al. (2019) assert that renewable energy retards economic growth. They recommend cleaner technology to optimize the benefits of wood biomass while minimizing its adverse effects and increasing the share of solar, wind, and geothermal in the mix of renewable energy.

This conclusion was found with the application of panel dynamic DOLS on a sample of 15 West African countries covering the 1995-2014 period and on data on GDP, renewable energy consumption, labor, and capital.

The findings of Ivanovski et al. (2021), Musah et al. (2020), Toumi and Toumi (2019), Bulut and Muratoglu (2018), Narayan and Doytch (2017), and Alper and Oguz (2016) align with the argument that renewable energy use does not affect growth. Ummalla and Samal (2019) assessed the impact of natural gas and renewable energy consumption on CO_2 emissions and economic growth in China and India. Using the ARDL model and data from 1995 to 2016 on per capita renewable energy consumption, GDP per capita, CO_2 emissions per capita, and natural gas consumption per capita, they found short-run bidirectional causality between renewable energy consumption and economic growth in India but no causality between these two variables in China. Their finding suggests that the feedback hypothesis is established among renewable energy and growth in China. They, therefore, invite Indian policymakers to change the energy structure by increasing the share of clean energy. Based on the use of the NARDL and data on renewable energy, carbon dioxide emissions, and real GDP covering the period 1990-2014, the study outcome of Toumi and Toumi (2019) support that there is no causal relationship between renewable energy and economic growth in the Kingdom of Saudi Arabia. They propose more taxation of non-renewable energy to subsidy clean

Table 1. Summary of some previous studies.

Authors	Period	Method	Country	Result
The negative effect of renewable energy on growth				
Muazu et al. (2022)	1990-2018	threshold regression	54 African countries	A negative effect of renewable energy consumption on economic growth exists
Somoye et al. (2022)	1990Q1–2019Q4	NARDL	Nigeria	An increase in renewable energy decreases economic growth
Namahoro et al. (2021)	1990-2015	NARDL	Rwanda	Renewable energy negatively affects growth in a specific region of Rwanda
Awodumi and Adewuyi (2020)	1980-2015	NARDL	Africa	Renewable energy retards growth in Nigeria
Chen et al. (2020)	1995-2015	threshold model	103 countries	The impact of renewable energy on economic growth is negative if its use does not reach a certain threshold
Magazzino (2017)	1990-2007	Granger	Italy	Renewable energy reduces GDP
Bhattacharya et al. (2017)	1991-2012	GMM, FMOLS	85 countries worldwide	Renewable energy has a significant negative impact on economic output in some countries
Baz et al. (2021)	1990-2017	NARDL	Pakistan	Renewable energy use hurts economic growth
No effect of renewable energy on growth				
İnal et al. (2022)	1990-2014	Bootstrap, ARDL, causality	African oil producer	Neutrality hypothesis
Ivanovski et al. (2021)	1990-2015	LLDVE	OCDE countries	Renewable energy has no significant impact on growth
Musah et al. (2020)	1998-2018	DCCEMG	West Africa	Renewable energy had no vital influence on the GDP
Toumi and Toumi (2018)	1990-2014	NARDL	Saudi Arabia	Neutrality
Bulut and Muratoglu (2018)	1990-2015	Cointegration	Turkey	Neutrality
Narayan and Doytch(2017)	1971-2011	GMM	89 countries worldwide	Renewable energy supports the neutrality hypothesis with GDP in certain countries
Alper and Oguz (2016)	1990-2019	ARDL	European countries	Renewable energy supports the neutrality hypothesis
Dogan (2015)	1990-2012	ARDL, VECM	Turkey	Neutrality
Aneja et al.(2017)	1990–2012	Pedroni Panel cointegration	BRICS countries	No strong relationship ranging from renewable energy to economic growth
The positive effect of renewable energy on growth				
Cheuka and Choga (2022)	1990-2019	Panel ARDL	SADC	Renewable energy generation positively impacts growth over the long term
Azam et al. (,2021)	1990-2015	FMOLS, Granger	Newly industrialized countries	Renewable electricity consumption increases the GDP
Salari et al. (2021)	2000-2016	GMM	The U.S	Renewable energy supports the growth hypothesis
Doytch and Narayan (2021)	1984-2019	Regression	107 countries	Renewable energy enhances growth in high-growth sectors
Namahoro et al. (2021)	1990-2015	NARDL	Rwanda	Renewable energy positively affects growth in certain regions
Azretbergenova et al. (2021)	2006-2019	ARDL	European Union	Renewable energy generation has a positive effect on employment in the long-term
Rahman and Velayutham (2020)	1990-2014	PMOLS, DOLS	South Asia	Renewable energy increases the GDP
Awodumi and Adewuyi (2020)	1980-2015	NARDL	Africa	Renewable energy promotes growth in Gabon and Egypt
Chen et al.(2020)	1995-2015	Threshold model	103 countries	The impact of renewable energy on economic growth is positive when its use exceeds a certain threshold
Bhattacharya et al. (2017)	1991-2012	GMM, FMOLS	85 countries	Renewable energy has a significant positive impact on economic output in some countries

Source: Author

energy and recommend policy in accordance with the SDGs in Saudi Arabia. Alper and Oguz (2016) used ARDL model to investigate the relationship among economic growth, renewable energy consumption, capital and labor for new European Union member countries for the period of 1990–

2009.Their result supports that the neutrality hypothesis between economic growth and renewable energy consumption in Cyprus, Estonia, Hungary, Poland and Slovenia, conservation hypothesis in Czech Republic and growth hypothesis in Bulgaria, Estonia, Poland, and Slovenia. They explained the mixed effect by the fact that some countries have less renewable energy in their energy portfolio than other developed European Union member countries.

Most studies linking renewable energy and employment reported that renewable energy leads to more job creation and decreases unemployment, leading to economic growth (Sari and Akkaya, 2016; Proença and Fortes, 2020). Mu et al. (2018) reported that per 1 TW h expansion of solar PV and wind power would create up to 45.1 and 15.8 thousand, respectively, direct and indirect jobs in China. They used the CGE model and data on renewable energy, agriculture, mining, coal, cooking, and refined petroleum sectors. However, they declared that to have more impact, the renewable energy sector needs more investments. According to Lehr et al. (2016), solar and wind energy generate several jobs in the building sectors in Tunisia. They suggest more local renewable energy production because when the imported renewable energy is extremely lower than 10%, employment may rise to more than 0.6% of the overall employment.

Nasirov et al. (2021) compared the impact of renewable energy (solar PV, wind, hydro) and coal and gas on employment in Chile by using the SWITCH-Chile model, a complex linear programming tool developed at the University of California. The result shows that renewable energy may generate more employment per unit of energy than coal and natural gas, however, they advise that better education, public awareness, reduction of market barriers, and renewable energy subsidies are determinants. Renner (2017) estimates the potential employment generated by renewable energy are among others sales, installation, and reparation of solars lanterns and accessories, manufacturing of improved cook stoves, distribution of fuels, construction of biomass plants and biogas digesters, manufacturing or assembly turbines and other equipment, construction of dam, penstocks and watermills. In 2021, renewable energy jobs were up to 12.7 million, including 4.3 million jobs in solar photovoltaic, 1.3 million jobs in wind power, 2.4 million direct jobs in hydropower, and 2.4 million jobs in bioenergy (IRENA and ILO, 2022).

Those results support the conclusions of the reports of the International Renewable Energy Agency (IRENA, 2013, 2014, 2018, 2020; Ferroukhi et al., 2019) and Arvanitopoulos and Agnolucci (2020). However, very few studies detail the impact of renewable energy use on vulnerable employment.

From the studies mentioned earlier, diverse econometric methodologies were employed to analyze the impact of renewable energy use on economic development. These methods include Granger causality, cointegration,

FMOLS, DOLS, threshold regression, ARDL, NARDL, GMM, DCCEMG, and LLDVE. Most research focused on panel data analysis or only a few African countries, neglecting the study of developing countries like Angola. Also, research on renewable energy use has been little interested in the impact of renewable energy use on vulnerable employment or industry employment. Again, more studies focus on the impact of renewable on one or two variables related to economic growth. This paper fills the gap by using the ARDL method to examine the impact of renewable energy use on GDP, unemployment rate, industry employment, vulnerable employment, gross fixed capital formation, and labor force participation rate. ARDL has the advantage of remaining robust to small sample sizes and being applicable regardless of whether variables are stationary at level or first difference (Mirza and Kanwal, 2017).

MATERIALS AND METHODS

Materials

In the study, annual data was used on renewable energy (RE), gross domestic product (GDP), vulnerable employment (VE), unemployment rate (UEMP), employment in industries (IND), labor force participation rate (LFPR), and gross fixed capital formation (GFCF). Except for GDP data, which is extracted from the International Energy Agency, all other data are from the World Data Bank. Data on gross fixed capital formation covers the period 2000 – 2020, and the other studied data covers the period 1991 – 2020.Table 2 outlines a brief description of our data.

The data of GDP, IND, RE, UEMP, VE, and LFPR are spread over 30 years, while GFCF covers 21 years. Only GFCF is not normal (Probability is significant at 5%). In Figure 1, the curve showing the evolution of renewable energy consumption has a downward trend between 1990 and 2015, then an upward trend between 2015 and 2020. This reflects the decline in the share of renewable energy from 1990 to 2015. Initially, Angolan energy was mainly hydroelectric, but the growth in energy demand has led to more fossil fuel use, reducing the share of renewable energy. But, the government policy to reduce carbon emissions make increased gradually the share of renewable energy after 2015. An increase in vulnerable jobs after 2005, a downward trend of jobs in industries, and a relatively low unemployment rate revealing precariousness and social inequalities reinforcement in Angola were observed. GDP increased between 1994 and 2015, and then commenced to decrease. The civil war mainly affected the labor force, leading to a shrinking workforce. The labor force participation rate began to increase after 2005.

Methods

Data on RE, GDP, VE, and IND are on their logarithm form. We first determined the optimal lag of the variables and employed stationarity tests (Dickey and Fuller, 1979; Phillips and Perron, 1988). The unit root test shows that all the variables gained stationarity at first differentiation. The autoregressive distributive lag model was then executed. Some diagnostics tests were finally applied to assess our models.

The Autoregressive distributive lag (ARDL) cointegration is a test method proposed by Charemza and Deadman (1994), gradually improved by Pesaran and Shin (1997) and Pesaran et al. (2001)

Table 2. Data summary.

Variable	GDP	IND	RE	UEMP	VE	LFPR	GFCF
Mean	3198.32	8.16	62.26	5.15	65.52	78.08	26.96
Median	3216.93	8.46	62.02	3.87	64.45	78.06	27.48
Maximum	4272.46	9.10	76.82	9.43	73.71	78.66	42.79
Minimum	1927.50	6.80	47.82	3.63	59.77	77.66	16.76
Std. Dev	760.61	0.65	10.15	0.74	0.50	0.29	5.21
Skewness	-0.08	-0.69	-0.11	0.74	0.54	0.44	0.83
Kurtosis	1.57	2.43	1.43	1.93	1.93	2.32	5.63
Jarque-Bera	2.57	2.79	3.15	4.17	2.66	1.54	8.43
Probability	0.28	0.25	0.21	0.12	0.26	0.46	0.01***
Observations	30	30	30	30	30	30	21

Source: Author

and acknowledged as one of the most flexible methods when the study variables are integrated order zero or one, tolerating different lags in different variables and providing unbiased estimates and valid t-statistics independently of the endogeneity of some regressors (Harris and Sollis, 2003; Jalil and Ma, 2008). The ARDL cointegration approach or ARDL bound tests is based on the F-statistic value under the null hypothesis of no cointegration among the tested variables (Sun et al., 2017). If F-statistic exceeds the upper bound of the critical value, the null hypothesis is rejected. If F-statistic falls below the lower band of the critical value, the null hypothesis is accepted. If F-statistic falls inside the critical value band, then the outcome becomes inconclusive (Tang, 2016). When the ARDL bounds test confirms the existence of cointegration, long and short-run models are estimated and ARDL-ECM is performed, where ECM designed the Error Correction Model.

Contrariwise, the ardl model cannot apply to variables of integration order exceeding 2 (Jalil and Ma, 2008; Nkoro and Uko, 2016; Deka and Dube, 2021).

Bivariate models are used to investigate the impact of renewable energy use on each of the other variables. The ARDL model applied to renewable energy use, economic growth, unemployment rate, employment in industries, vulnerable employment, labor force participation rate, and gross fixed capital formation is specified as follows:

Model 1: Renewable Energy and Gross Domestic Product

$$\Delta LNGDP = \mu + \sum \beta_i \Delta LNGDP_{t-i} + \sum \beta_j \Delta LNRE_{t-j} + \alpha_1 LNGDP_{t-1} + \alpha_2 LNRE_{t-1} + \epsilon_{1,t} \tag{1}$$

Model 2: Renewable Energy and Vulnerable Employment

$$\Delta LNVE = \mu + \sum \beta_i \Delta LNVE_{t-i} + \sum \beta_j \Delta LNRE_{t-j} + \alpha_1 LNVE_{t-1} + \alpha_2 LNRE_{t-1} + \epsilon_{1,t} \tag{2}$$

Model 3: Renewable Energy and Unemployment Rate

$$\Delta UEMP = \mu + \sum \beta_i \Delta UEMP_{t-i} + \sum \beta_j \Delta LNRE_{t-j} + \alpha_1 UEMP_{t-1} + \alpha_2 LNRE_{t-1} + \epsilon_{1,t} \tag{3}$$

Model 4: Renewable Energy and Employment in Industries

$$\Delta LNIND = \mu + \sum \beta_i \Delta LNIND_{t-i} + \sum \beta_j \Delta LNRE_{t-j} + \alpha_1 LNIND_{t-1} + \alpha_2 LNRE_{t-1} + \epsilon_{1,t} \tag{4}$$

Model 5: Renewable Energy and Labor Force Participation Rate

$$\Delta LFPR = \mu + \sum \beta_i \Delta LFPR_{t-j} + \sum \beta_j \Delta LNRE_{t-j} + \alpha_1 LFPR_{t-1} + \alpha_2 LNRE_{t-1} + \epsilon_{1,t} \tag{5}$$

Model 6: Renewable Energy and Gross Fixed Capital Formation

$$\Delta GFCF = \mu + \sum \beta_i \Delta GFCF_{t-i} + \sum \beta_j \Delta LNRE_{t-j} + \alpha_1 GFCF_{t-1} + \alpha_2 LNRE_{t-1} + \epsilon_{1,t} \tag{6}$$

Since ARDL bounds tests show long-run relationship for models including LNGDP, LNVE, UEMP, and LFPR (Table 5), then the Error correction models studying those long-run elasticities relationship are described as follow:

Model 7: Renewable Energy and Gross Domestic Product

$$\Delta LNGDP = \mu + \sum \beta_i \Delta LNGDP_{t-i} + \sum \beta_j \Delta LNRE_{t-j} + \alpha_1 ETC_{t-1} + \epsilon_{1,t} \tag{7}$$

Model 8: Renewable Energy and Vulnerable Employment

$$\Delta LNVE = \mu + \sum \beta_i \Delta LNVE_{t-i} + \sum \beta_j \Delta LNRE_{t-j} + \alpha_1 ETC_{t-1} + \epsilon_{1,t} \tag{8}$$

Model 9: Renewable Energy and Unemployment Rate

$$\Delta UEMP = \mu + \sum \beta_i \Delta UEMP_{t-i} + \sum \beta_j \Delta LNRE_{t-j} + \alpha_1 ETC_{t-1} + \epsilon_{1,t} \tag{9}$$

Model 10: Renewable Energy and Labor Force Participation Rate
$$\Delta LFPR = \mu + \beta_i \Delta LFPR_{t-i} + \beta_j \Delta LNRE_{t-j} + \alpha_1 ETC_{t-1} + \epsilon_1, \tag{10}$$

ETC represents the error correction term. A negative and significant value of ECT represents the existence of long-run causal relationship.

RESULTS

In this part, the authors provide the short-term and long-term analysis results and the diagnostics of the applied models.
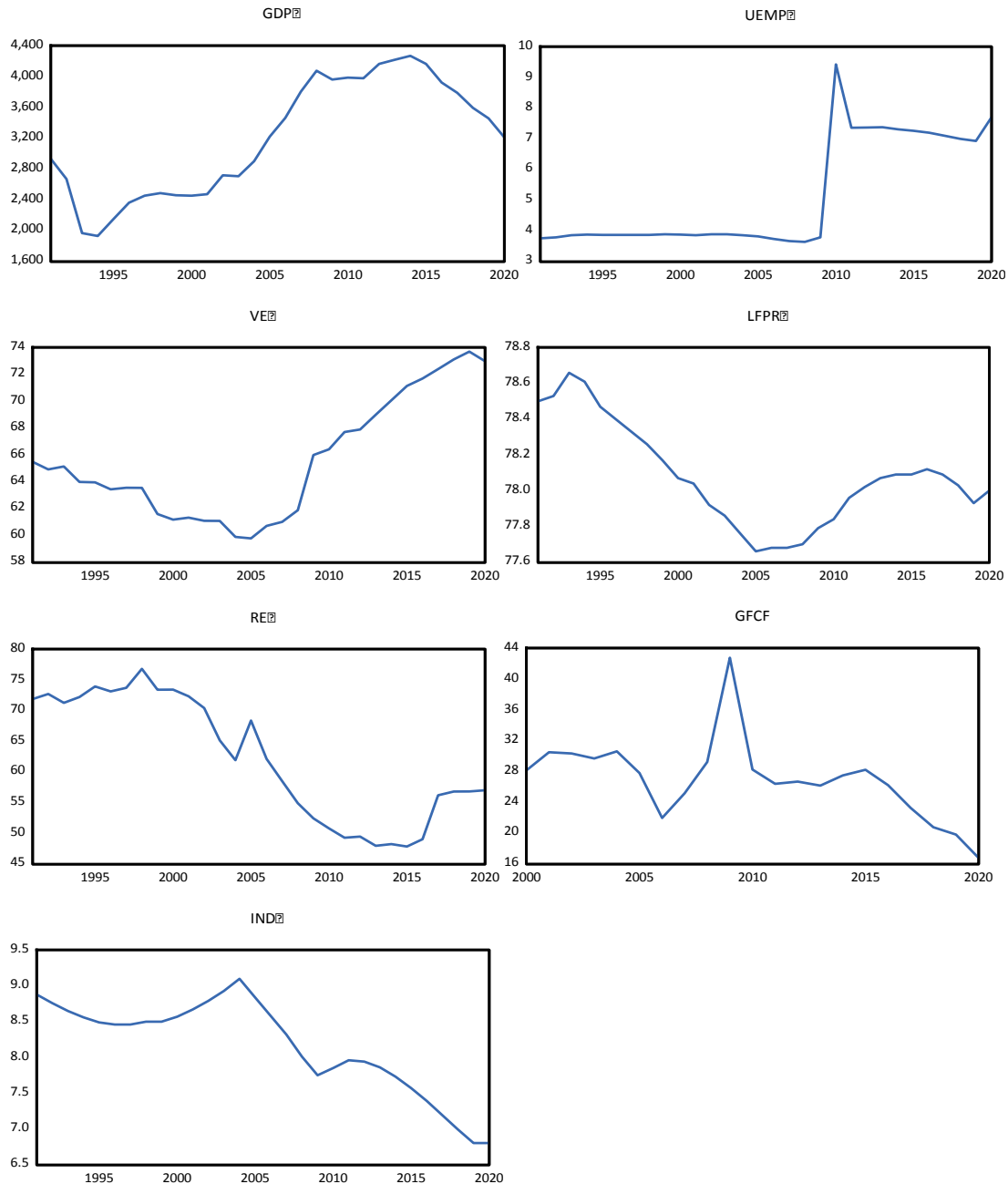
Figure 1. Data evolution.
Source: Author.

Stationarity tests

The first step of analyzing time series data is checking its stationarity. We performed Augmented Dickey-Fuller, and Phillip Perron tests to investigate the unit root tests of variables. The following equation describes the equation used for stationarity analysis.

$$\Delta y_t = \alpha_0 + \theta y_{t-1} + \gamma_1 \Delta y_{t-1} + \gamma_2 \Delta y_{t-2} + \cdots + \gamma_v \Delta y_{t-v} + \eta_1 trend + \varepsilon_t \tag{11}$$

Table 3 shows the performed stationarity tests under Augmented Dickey-Fuller and Phillip-Perron. Estimates indicate that none of the variables are stationary at level, but all the variables gained stationarity at first difference. Thus, our variables are integrated of order one. ARDL models suit variables of order zero or one when studying their relationships. The ARDL bounds test will specify whether the studied variables share a long-run relationship.

Table 3. Unit root test.

Level	Variable	ADF	P-value	P.P	P-value
At level	LNRE	-0.9780	0.7476	-1.0686	0.7143
	LNGDP	-1.5186	0.5097	-1.0375	0.7261
	LNIND	-0.9834	0.2835	-1.8809	0.0582
	UEMP	0.4597	0.8074	0.6630	0.8536
	GFCF	-0.8047	0.3547	-0.9489	0.2940
	LFPR	-3.3952	0.0205**	-1.5352	0.5020
At first difference	ΔLNRE	-4.5850	0.001***	-4.6252	0.001***
	ΔLNGDP	-3.1644	0.033**	-2.8790	0.034**
	ΔLNIND	-2.1237	0.035**	-2.1237	0.035**
	ΔUEMP	-7.0178	0.000***	-7.2324	0.000***
	ΔGFCF	-5.0907	0.000***	-5.9648	0.000***
	ΔLFPR	-2.2916	0.0237**	-2.6064	0.011**

Source: Author

Table 4 presents the optimal lags of the equations (1-6). The choice for the optimal lags is essential since it avoids models' overfitting. Models 1 to 6 have respectively as optimal lags 2; 1; 1; 2; 1 and 1.

ARDL approach

The error correction term (ECT) of Model 7, Model 8, Model 9, and Model 10 are negative and significant at a 1% level, indicating long-run relationship ranging from renewable energy use to economic growth, from renewable energy use to vulnerable employment, from renewable energy to unemployment rate and from renewable energy use to labor force participation rate.

However, the error correction terms of models containing ΔLNIND and ΔGFCF are either positive (0.01) or insignificant at the 5% level, and their F-statistic (3.71 and 1.84) do not exceed the upper bound (4.16) at the 5% significance level. We conclude that renewable energy use and industry employment do not share a long-run relationship as well as renewable energy use and gross fixed capital formation. When LNGDP or UEMP is the dependent variable, the error correction is (-0.54) or (-0.60), indicating that the rate of adjustment to equilibrium will be fast (as the speeds rate 54 and 60% exceeds 50%). Nevertheless, when LNVE or LNFPR is the dependent variable, the speed rate is 8 or 0.7% lower than 50%, revealing that the adjustment to equilibrium will be really slow.

Short-run results

Here, we provide the different results of the short-run analysis in separate tables (Tables 6 to 11). Tables 6 to 11 present the results of models [1-6] for short-run causality.

No significant causal relationship was found between renewable energy use and economic development. This finding aligns with Narayan and Doytch (2017) and Musah et al. (2020), who reported that renewable energy use does not influence economic growth. Differently, Magazzino (2017) and Anwar et al. (2021) found that renewable energy use decreased economic growth, and Azam et al. (2021) stipulated that renewable energy increased economic growth. Our finding puts in evidence the underutilization of renewable energy in Angola's economic activities and insists that by maintaining this proportion of renewable energy consumption, economic development will not depend on renewable energy consumption. Economic policies must be shaped so that renewable energy valiantly replaces fossil fuels. Indeed, the potential of renewable energy is not sufficiently exploited; solar energy is used only for domestic needs, namely for electrification. Renewable energies have not got fully integrated as alternative sources to non-renewable energies. Lags in GDP have mixed effects on GDP, indicating that investments may often not be profit-making. A 1% increase in lag 1 in LNGDP increases the current LNGDP by 1.18 units while a 1% increase in lag 2 in LNGDP reduces the current LNGDP by 72.29%.

Table 7 indicates that renewable energy use negatively affects vulnerable employment. A 1% increase in renewable energy use weakens vulnerable employment by 7.26%. This result highlights the difficulties faced by the authorities in improving the vulnerable employment sector. It was noted that the use of renewable energies is harmful to employment policy. Thus, a transition to renewable energy will only further expose disadvantaged people because they are typically in vulnerable jobs. Therefore, it is logical that people are wary of using renewable energy. Lag 1 in VE supports VE. This result

Table 4. Optimal lag selection.

Model	Lag	Lags selection criteria		
		AIC	SBIC	LR
Model 1	0	-3.0935	-2.9967	-
	1	-6.5716	-62813	8.0746
	2s	-6.7785*	-6.2946*	10.8051*
	3	-6.5775	-5.9000	2.0270
	4	-6.6839	-5.8129	7.0405
Model 2	0	-3.6680	-3.5712	-
	1s	-8.7805*	-8.4902*	124.665*
	2	-8.7198	-8.2360	5.1877
	3	-8.5418	-7.8643	2.4628
	4	-8.3700	-7.4990	2..3100
Model 3	0	2.5521	2.6489	-
	1s	0.0546*	0.2357*	67.0317*
	2	0.1367	0.6206	2.4443
	3	0.4096	1.0870	0.6621
	4	0.5933	1.4642	21078
Model 4	0	-3.2783	-3.1815	-
	1	-3.2783	-7.8985	120.02
	2s	-8.8493*	-8.3654*	20.331*
	3	-8.6600	-7.9826	2.2497
	4	-8.6104	-7.7394	4.3840
Model 5	0	-0.9745	-0.8777	-
	1s	-6.5789*	-6.2885*	135.98*
	2	-6.3652	-5.8813	1.9750
	3	-6.3343	-5.6568	5.2576
	4	-6.3827	-5.5117	6.0537
Model 6	0	4.7223	4.8204	-
	1s	3.5067	3.8008*	23.6074*
	2	3.6514	4.1415	3.9107
	3	3.9220	4.6081	2
	4	3.0712*	3.9534	0.0940

shows the selected lag.
Source: Author

shows that vulnerable jobs will reinforce job insecurity, contributing more to poverty and intermittent unemployment, hence the necessity of policies improving the employment sector.

Renewable energy use has no significant direct impact on the overall unemployment rate in Angola. This finding aligns with those of Bulut and Muratoglu (2018) and Dogan (2015) but contrasts with the study outcome of Sari and Akkaya (2016) and Proença and Fortes (2020), who indicated that renewable energy, contributes to employment. Lag 1 in UEMP positively affects UEMP.

Table 5. Long- run relationship.

Models	F-statistics	ECT	Cointegration
ΔLNGDP	3.90	-0.54 (0.00***)	Yes
ΔLNVE	6.47	-0.08 (0.00***)	Yes
ΔUEMP	4.44	-0.60 (0.00***)	Yes
ΔLNIND	3.71	0.01 (0.00***)	No
ΔLFPR	7.56	-0.007 (0.00***)	Yes
ΔGFCF	1.84	-0.45 (0.13)	No
	Lower bound	Upper bound	
5%	3.62	4.16	
2.5%	4.18	4.79	
1%	4.98	5.58	

Source: Author

These findings indicate that unemployment increases social inequality and poverty, hence the need to raise policies against unemployment issues.

Renewable energy does not affect employment in industries in Angola. The Lag in LNIND positively affects LNIND, revealing that industrial growth may contribute to industry employment, and reinforce economic growth. More precisely, a 1 unit increase in the lag 1 of LNIND increases current LNIND by 1.01 units.

Table 10 ascertains that renewable energy use reduces the labor force participation rate. A one percent increase in renewable energy use leads to a decrease in the labor force participation rate by 66%, reinforcing the overall unemployment and threatening the country's growth. This result differs from the findings of Sari and Akkaya (2016), Bulut and Muratoglu (2018), and Bibi and Li (2022). However, our findings align with Maji (2015) in Nigeria and Namahoro et al. (2021) in Rwanda. Lag 1 of LFPR positively influences LFPR. A 1 unit increase in lag 1 of LFPR increases LFPR by 1.05 unit.

Table 11 outlines the positive effect of renewable energy use on Gross fixed capital formation (GFCF). This impact is significant at 10% and indicates that a 1-unit increase in renewable energy use increases gross fixed capital formation by 2.88 units. This result is consistent with the findings of Awodumi and Adewuyi (2020), Chen et al. (Chen et al. 2020), and Bhattacharya et al. (2017). The lag 1 of GFCF has a positive effect on GFCF. A 1 percent increase in lag 1 of GFCF increases GFCF by 56%.

Residual diagnostic test results

Table 11 summarizes the diagnostics test results of the models. Breusch-Godfrey was used for the serial correlation test, Jarque Bera for the normality test,

Table 6. Renewable energy use and GDP.

| Variable | LNGDP (dependent variable) | | | | | |
| | Lag 0 | | Lag 1 | | Lag 2 | |
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
LNGDP			1.1827	0.00***	-0.7229	0.00***
LNRE	-0.3289	0.3028	-0.4025	0.1634		

Source: Author

Table 7. Renewable energy and vulnerable employment.

| Variable | LNVE (dependent variable) | | | |
| | Lag 0 | | Lag 1 | |
	Coef.	t-stat	Coef.	t-stat
LNVE			0.9234	0.00***
LNRE	-0.0726	0.00***		

Source: Author

Table 8. Renewable energy use and unemployment rate.

| Variable | UEMP (dependent variable) | | | |
| | Lag 0 | | Lag 1 | |
	Coef.	t-stat	Coef.	t-stat
UEMP			0.3905	0.0327**
LNRE	0.6952	0.8634	-6.4394	0.1602

Source: Author

Table 9. Renewable energy use and employment in industries.

| Variables | LNIND (dependent variable) | | | |
| | Lag 0 | | Lag 1 | |
	Coef.	t-stat	Coef.	t-stat
LNIND			1.0139	0.00***
LNRE	0.0275	0.2797		

Source: Author.

Table 10. Renewable energy use and labor force participation rate.

| Variable | LFPR (dependent variable) | | | |
| | Lag 0 | | Lag1 | |
	Coef.	t-stat	Coef.	t-stat
LFPR			1.0508	0.00***
LNRE	-0.6636	0.0301**	0.3634	0.1798

Source: Author

Breusch-Pagan-Godfrey for the heteroskedasticity test, and CUSUM graph for the stability test. Table 12 indicates that in the models, the residuals have no serial correlation and are homogenous at a 1% significance level. However, when the unemployment rate is the dependent variable, the model suffers from normality

Table 11. Renewable energy use and gross fixed capital formation.

Variable	GFCF (dependent variable)			
	Lag 0		Lag 1	
	Coef.	t-stat	Coef.	t-stat
GFCF			0.56	0.02**
LNRE	2.88	0.08*		

Source: Author

Table 12. Residual diagnostic test results.

Models	Breusch–Godfrey: Serial correlation L.M. test		Jarque-Bera normality test		Heteroskedasticity test: Breusch–Pagan–Godfrey	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
ΔLNGDP	0.112	0.895	73.86	0.27	1.848	0.154
ΔLNVE	0.545	0.587	68.17	0.17	1.431	0.257
ΔUEMP	0.709	0.503	112.86	0.02**	4.713	0.09*
ΔLNIND	8.505	0.121	1.46	0.48	3.232	0.151
ΔLFPR	0.650	0.531	7.72	0.13	0.368	0.777
ΔGFCF	0.028	0.972	18.68	0.11	0.358	0.704

Source: Author

issues.

The CUSUM graph lies within the 5% significance bounds indicating that all our models are stable. Thus, Figure 2 shows that the results of the models are robust.

CONCLUSIONS AND POLICY IMPLICATIONS

This paper investigates the impact of renewable energy consumption on Angola's economic development. For this, we employed data covering the period 2001 – 2020 for gross fixed capital formation and data from 1990 to 2020 for renewable energy use, unemployment rate, and vulnerable employment, employment in industries, gross domestic product, and labor force participation rate. The effects of renewable energy use was analyzed on the unemployment rate, vulnerable employment, employment in industries, gross domestic product, the labor force participation rate, and gross fixed capital formation. Unit root tests indicate that all the study data are stationary at first difference. Bivariate autoregressive distributive lag (ARDL) and error correction model (ECM) framework were used to conduct the analysis. The residual diagnostics tests confirmed the robustness of results.

This paper highlighted the need to establish economic policies considering the transition to renewable energy use and the employment issue in Angola. The results exhibit the presence of short and long-term elasticities relationships.

The long-run relationship directing from renewable energy use to gross domestic product, unemployment rate, vulnerable employment, and labor force participation rate asserts that using renewable energy may have mixed effects on Angola's economic development. These findings call on the authorities to strengthen economic policies and optimize renewable energy use. Thus, investing in research and development is necessary to find a pathway to minimize the adverse effects of renewable energy use. The risk that the use of renewable energies may cause unemployment can be minimized by improving citizens' skills. This may make it possible to take advantage of renewable energy jobs such as the sale, installation, and maintenance of solar panels and equipment and facilitate the electrification of remote areas.

However educational training for skills development can take time, discouraging citizens in a hurry to lift themselves out of poverty. Skill development in rural areas should be taught in local languages, with respect and frankness to avoid quarrels within the population. The deployment of renewable energies could come up against the refusal of the rural citizen who prefers firewood and charcoal which they can have almost for free in forests. It would therefore be difficult to convince them to spend money on alternative energy sources.

The short-run analysis reveals that using renewable energies reduces the labor force participation rate and weakens vulnerable jobs but contributes to gross fixed capital formation. Therefore, renewable energies facilitate the disappearance of vulnerable jobs, further exposing citizens. These results indicate that renewable energy is not enough to improve the quality of jobs. In this regard,
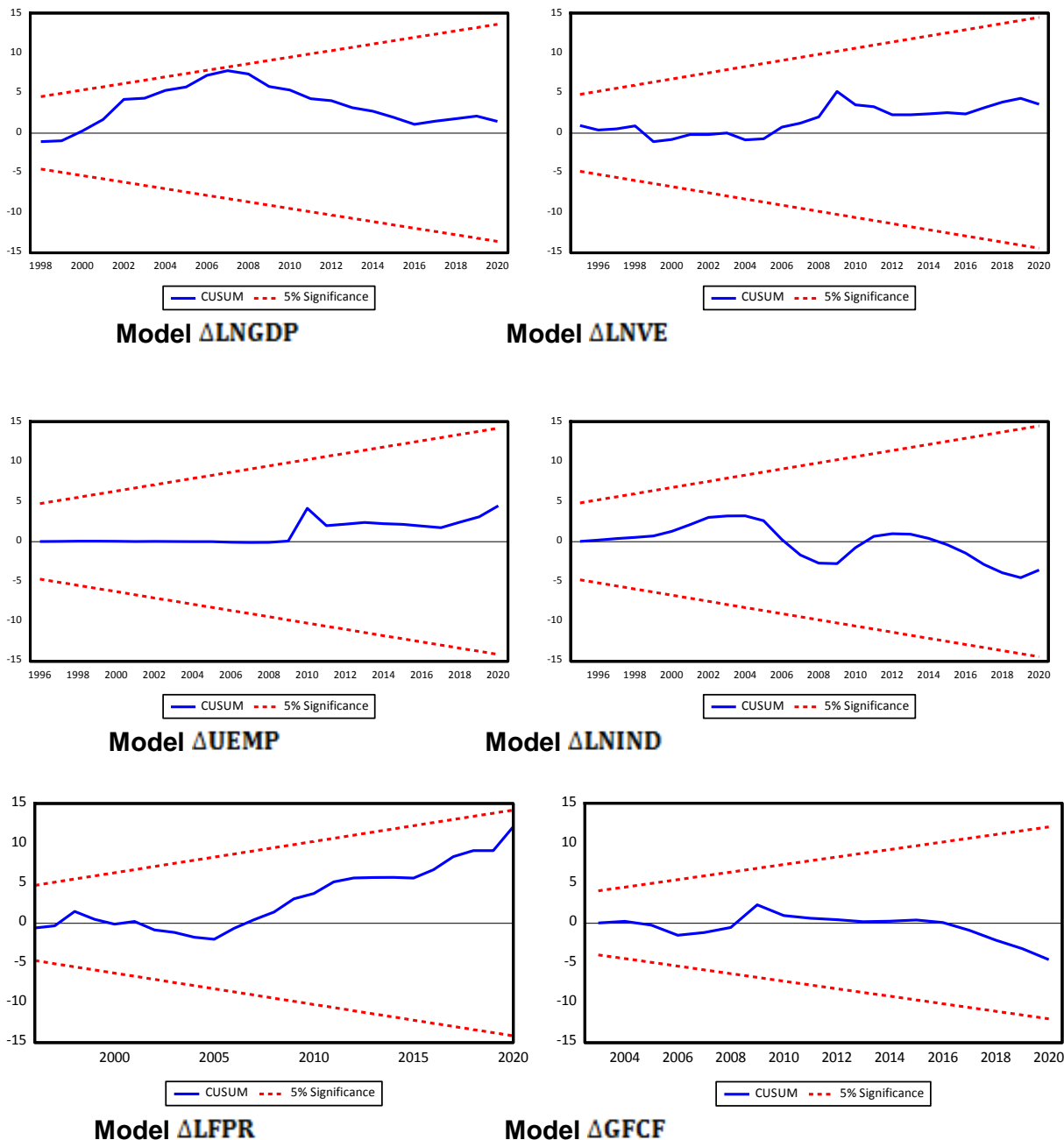
Figure 2. Different models.
Source: Author

Angola's Government must improve its policy relating to the employment sector and devote itself to job creation. The renewable energy sector is an untapped reservoir of jobs in Angola. The country's authorities could draw inspiration for job creation policies from the renewable energy sector of countries such as the People's Republic of China, India, and Brazil. These countries devote a large part of their budget to research and development, and education. To the default for Angola to be able to strictly imitate them (lack of funds, researchers,

laboratories), the country should be active in clean energy technology development. The fact that the country has no specific policy for population growth calls on the Angolan authorities to consider the consequences of that growth, namely economic need unemployment, energy needs, and environmental protection. The authors recommended implementing policies favoring infrastructure development, skills training, and technical support. Solar and wind energy remain the most easily deployable renewable energies and renewable energy

jobs providers in Angola, facilitating the electrification of remote areas. This aligns with the authorities' vision. However, renewable energy integration requires the subsidization of materials and equipment and qualified personnel for maintenance.

Also, our results found that renewable energy use does not significantly impact industry employment, indicating that renewable energy does not have a vital influence on industry employment in Angola. The non-significant positive effect implies that renewable energy use is not generalized in the industrial sector. To solve this, we suggest incentivizing industries to use renewable energy more. Authorities can encourage industries to use renewable energy by taxing fossil fuels and subsidizing renewable energy to reduce potential losses. Also, the impact of renewable energy use on industry employment should be considered in the discussion of policies about sustainable development.

The lag in GFCF positively impacts GFCF, lags in GDP have mixed effects on GDP, and lag in LNIND has a positive impact on LNIND, meaning that some investments may not be profit-making while industrial growth is determinant to reduce unemployment. One of these reasons is that Angola is a country in reconstruction, whose several economic sectors (agriculture, fishing, livestock, commerce, hotels, tourism, and industries) need reforms. However, it is important to set up funds supporting entrepreneurship and the gradual transition to renewable energy. Development policy requires huge human and financial investments. The immediate action from the country's leaders should be investing in sustainable policies supporting agriculture and animal husbandry, the main economic activities in rural areas where the poverty rate is high. The country would benefit from accelerating industrialization while encouraging clean energy. For this, it will be preferable to process raw materials inside the country. This may reduce social inequalities, reinforce the employment sector and promote growth. Also, convenient investments in agriculture could help in producing biofuels.

Vulnerable employment and unemployment reinforce respectively vulnerable employment and unemployment. This finding explains the importance of reducing unemployment and vulnerable jobs. Unemployment is often caused by the refusal for certain jobs deemed poorly paid or not decent. It is therefore imperative to create a craze for such jobs, by valuing wages. Importing high-quality materials and equipment and making them accessible to workers may help to reduce vulnerable jobs.

The mixed effects of using renewable energy in the economic sector led us to think that renewable energy will not spur economic development. The renewable energy transition will be realized at the expense of economic development.

However, funding for research to develop the renewable energy sector could lessen the negative impact of renewable energy and thus boost the economic sector.

Also, we suggest that decision-makers formulate energy and economic policies per the country's development programs, taking inspiration from China, Brazil, and India. The country possesses large agricultural land areas where cassava and sugar cane grow. In its sustainable development policy, the government must consider that the development of the agriculture sector could bring more to the country, whether for the development of renewable energies, agricultural productivity, or job creation.

Future studies should focus on minimizing the negative impact of renewable energy on Angola's economy. It will also be interesting to conduct further studies about optimizing renewable energy production in Angola. The authors think such studies could reinforce the low-carbon policy. It is important to specify that the major limitation of this paper is the unavailability of data. This placed a limit on the choice of time horizon as we would have preferred to extend the study time horizon.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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