

The influence of Information Technology, Foreign Direct Investment and Carbon Emissions on Economic Growth of Franc Zone Countries

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Abstract

This paper examines the influence of information technology, foreign direct investment, and environmental regulations on economic growth in 13 African countries in the Franc zone during the period 1990-2020. It contributes to the literature on the information technology, foreign direct investment and environmental regulations. In this research, results have confirmed theoretical and empirical arguments for a linear growth relationship for both the West African and Central African monetary union countries. The results indicate a positive and significant influence of information technology, foreign direct investment, and environmental regulations on economic growth. These findings could have policy implications for the Franc zone countries' development prospects, particularly in terms of post-COVID-19 recovery plans. The findings of this study emphasize the financial assistance and role of information technology adoption in assisting economic recovery while meeting its objectives on domestic and external stability and incorporation of environmental policies in the post-COVID-19 era.

Key words: Information technology, foreign direct investment, environment regulations, Economic growth, Franc zone

1.0.Introduction

Over the last two decades, information technology has advanced at a breakneck pace. Various countries are interested in learning how to use information technology to cut energy use and avoid environmental degradation. In previous empirical investigations, using information technology to drive economic growth was seen as one feasible strategy to increase efficiency while reducing energy consumption. The intricate relationships between IT, energy consumption, foreign direct investment, and economic growth are investigated in this study. A lot of studies have looked into the relationship between economic growth, pollution, and foreign direct investment. Fewer studies, on the other hand, looked at the impact of IT on the link between pollution, foreign direct investment, and economic growth.

The rapid rise of the internet in Africa has been hailed as a vital source of income and a proof of the continent's technological maturity. At least a quarter of the population now has internet connection, reflecting a nearly fifty-fold increase in usage since the turn of the century. By 2030, three-quarters of Africans are expected to have access to the internet, bringing the continent closer to parity with the rest of the globe. Mobile technology alone have created 1.7 million jobs and contributed \$144 billion to the economy of the continent, or about 8.5 percent of GDP.

Some African countries have used quick growth in internet penetration to produce tangible changes in citizens' lives. Africa has jumped ahead of other regions to become a center of mobile, peer-to-peer finance, thanks to networks like Kenya's M-PESA. Nearly half of the world's mobile money accounts are registered on the continent. Sierra Leone, one of the world's poorest countries, has recently formed a Science, Innovation, and Technology Directorate (DST). A "national financial data architecture with embedded automated financial instruments" is one of its projects, which aims to improve service delivery and minimize corruption. These are only two instances of how digitalization can help those in need by providing a low-cost, secure source of funding and improving government transparency in nations where official bribery is a widespread problem. Both IT and energy policy must consider the influence of information technology on carbon dioxide (CO₂) emissions. There are two sorts of study strands in linked empirical investigations. The first strand investigates the link between IT adoption, energy consumption, and economic growth. Various perspectives on IT-energy concerns have been taken based on real studies. IT spending is expected to increase productivity, increase

economic growth, and decrease energy use (Coroama et al. 2013; Moyer and Hughes 2012; Erdmann and Hilty 2010). These studies claimed that information and communication technology (ICT) is not harmful to the environment, and that it can even help to mitigate global climate change. IT increases industrial technology and reduces energy intensity, according to Shahiduzzaman and Alam (2014), Coroama et al. (2013), and Ishida (2015), among others. These studies illustrate that using and investing in information technology saves energy and reduces CO₂ emissions. This type of research backs policies encouraging governments to invest in information technology. Several studies, however, have found that IT puts a major burden on electricity consumption and energy utilization. For the IT–energy nexus, the opposite findings can be found (Sadorsky 2012; Hamdi et al. 2014).

The second line of research looks into information technology, energy consumption, economic growth, CO₂ emissions, and other relevant explanatory variables. Furthermore, IT use has the potential to raise both energy consumption and economic growth at the same time (Lee and Brahmasrene 2014; Sadorsky 2012).

The second strand focuses on the challenges and constraints of utilizing information technology. More IT usage, according to this viewpoint, may reduce labor demand and boost labor productivity while simultaneously raising energy demand and consumption. The prior empirical results were mixed because they came from different countries (regions), time periods, and econometric techniques. Although time-series techniques like as the error correction model (ECM), autoregressive distributed lag (ARDL), panel integration, and Granger causality can be used to evaluate if a hypothesis holds, traditional econometric methods are based on the Kuznets hypothesis. In their econometric model, Salahuddin et al. (2016b) looked at financial development and trade. The results of the above correlations are inconclusive.

The aim of this research is to look into the effects of information technology, energy consumption, and foreign direct investment on economic growth using panel data from 13 Franc zone countries from 1990 to 2020. This study adds to the current literature in two ways: first, previous research has primarily focused on industrialized countries/regions. The Western African Monetary Union (WAMU) and the Central African Monetary Union (CAMU) are still being researched. Second, the results of a panel data research of IT, energy consumption, foreign direct investment, and economic growth are presented in this work. The majority of previous studies used a panel or time-series approach to quantify their correlations. In comparison to previous studies, we provide our findings by taking into account and managing cross-sectional reliance among countries. Third, if it is discovered that information technology and foreign direct investment boost energy consumption or economic growth, this relationship may have an impact on energy policy and CO₂ emission mitigation methods. As a result, carbon emissions play a moderating influence in the relationship between foreign direct investment, information and communication technology, and economic growth.

2.0. Theoretical Background, Literature Review and Hypothesis Development

2.1 Information Technology and Economic Growth

Economic growth is defined as an increase in a country's output per person per unit of time. The manufacturing sector is the key driver of increased output. IT increases industrial efficiency, and its impact on production factors and sectors is the most important economic growth mechanism. Economic growth theory is based on the impact of production factors on capital, labor, and technology, for example (Czernich, Falck, Kretschmer, & Woessmann, 2011; Jin & Jin, 2014; Terzi, 2011). The ICT (information and communication technologies) industry, in terms of the production sector, promotes the national economy through scale expansion, industrial correlation, and diffusion effect. IT helps to alter the industrial structure by optimizing resource allocation while also promoting economic growth. Production is also aided by demand-side factors. Demand-driven production is the norm. If demand rises, production capacity will adapt in response, resulting in an increase in output.

The expansion of cross-border e-commerce is becoming increasingly noticeable in encouraging international trade, which is driving up overall production (Asosheh, Shahid-Nejad, & Khodkari, 2012; Choi, 2010; Kurihara & Fukushima, 2013; Meijers, 2014). As a result, demand-side factors such as international commerce play a critical part in the process. This process relies heavily on economic progress. The more a

country's economic development, the more resources it has to increase its IT development. The greater the impact of IT on economic growth, the higher the level of its input in diverse domains of production and consumption. The value of a network increases by the square of the number of users, according to Metcalfe's law of network economics. When the number of users N is infinite, $V=N(N-1)$ and the network value V is N^2 . As information technology brings more people together in the Western and Central African Monetary Region, the amount of data collected will expand exponentially, creating a positive feedback loop that will compound the effect, propelling the rate of economic growth to continue to improve. This is the allure of information technology. The mechanism is likewise inextricably linked to the outside world (Qu & Chen, 2014). Natural resources, societal stability, the economy, market openness, and the international situation all have a role. Thus, it is hypothesized:

H1: Information Technology has positive and significant influence on economic growth.

2.2 Foreign Direct Investment and Economic Growth

The relationship between FDI and economic growth has piqued the interest of academics all around the world (Basu et al. 2003; Vo et al. 2019a). It is commonly known that this link has been thoroughly explored using data from a single country or a sample of many countries. Regrettably, there has been no consensus among academics about empirical findings. Koojaroenprasit (2012) conducted a single-country study on the impact of foreign direct investment on Korean economic growth from 1980 to 2009. The author discovered that foreign direct investment, as well as the positive effects of human capital, exports, and employment on following growth, had a considerable positive impact on Korea's economic growth. In Pakistan, the similar observation was made, with foreign capital influx having a beneficial long-term influence on economic growth. (Shahbaz and Rahman 2010).

The evidence offered in the FDI-growth nexus also backs up the notion that FDI is harmful to economic growth. Konings (2001) found little evidence of FDI having a positive impact on substantial growth in Poland between 1993 and 1997. The author also claimed that FDI harmed Romanian and Bulgarian economies since these nations were vulnerable to trade imbalances, monopolies, and reverse knowledge and technology transfers. A number of cross-country studies were done in addition to research focusing on single-country data. Between 1986 and 2008, Tiwari and Mutascu (2011) found that both FDI and foreign commercial activities boosted economic growth in 23 Asian nations. They also discovered that FDI has a significant impact on economic growth. Borensztein et al. (1998) investigated the influence of FDI on developing country economic growth. Their findings suggest that foreign direct investment (FDI) had an important role in bridging the gap between technological advancement and economic growth. They also felt that if a country had a high level of human capital, FDI would have a greater impact on its economy. Using a Causality test using an OLS model, Omran and Bolbol (2003) discovered a high correlation and significant causation between FDI and economic growth for Arab countries. Local economic and political factors, as well as FDI-attractive policies, were also found to be important determinants of FDI inflows. Foreign direct investment (FDI) was one of the most important factors of economic growth for 20 OECD nations, according to Alfaro et al. (2004). Furthermore, their empirical findings showed that the development of financial markets in those nations altered the link between FDI and economic growth. From 1978 to 1996, Basu et al. (2003) looked at a two-way link between FDI and economic growth in 23 developing nations. They discovered that FDI and economic growth were cointegrated in the long run after accounting for a range of nation characteristics.

Furthermore, their empirical findings demonstrated that there was a bidirectional association between these two variables for countries with a higher level of economic openness, whereas for closed economies, there was a unidirectional causality moving from GDP to FDI. In contradiction to earlier assumptions, a negative link between FDI and economic growth was discovered for cross-country data, further confounding the (unsolved) conundrum. For the period 1975–2000, Jyun-Yi and Chih-Chiang (2008) found no link between FDI and economic growth for 62 nations. Similarly, Lyrouti et al. (2004) found no influence of FDI on emerging market economic development from 1995 to 1998.

A new body of study has recently emerged emphasizing the link between FDI and output/consumption instability (Backus et al. 1992; Bodenstein 2008; Caporale et al. 2015; Levchenko 2005). From 1960 to 1999, Kose et al. (2003) found that increasing financial openness has a positive relationship with rising consumption volatility in developing nations. Kose et al. (2009) looked into how financial globalization had benefitted countries. During the globalization period, they discovered that industrial countries had achieved greater risk sharing than emerging markets. Thus, it is hypothesized:

H2: Foreign Direct Investment has positive and significant influence on economic growth.

2.3 Environmental Regulations and Economic Growth

The relationship between energy consumption and economic growth can be easily explained using growth theory such as the Cobb–Douglas production function, which includes energy as a factor in the production function that can either constrain or enable economic growth. Energy consumption plays a critical role in the economic growth process. Because renewable energy is less harmful than fossil energy, energy and renewable energy are significant drivers of global output growth. As a result, countries strive to replace fossil energy with renewable energy. For example, renewable energy can be used by both labor and capital to produce commodities and services, which are the primary drivers of economic growth. Capital, labor, technical innovation, and energy are the basic economic growth ingredients in both developed and developing countries, according to contemporary economic growth literature. The importance of energy, particularly renewable energy, to economic growth has been highlighted in recent research. This section contains research that look at the short and long-term relationship between energy use and economic growth in the literature. The vast majority of studies on energy consumption and economic growth focuses on energy, electricity, and oil consumption characteristics (Al-Mulali U et al.,2013; Hosseini et al.,2019; Aperigs and Payne,2011).

On the other hand, renewable energy research is still scarce. Numerous correlations have been found in the literature between renewable energy consumption, economic growth, CO2 emissions, and other factors. The Autoregressive Distributed Lag (ARDL) model, Vector Error Correction Model (VECM), Vector Autoregressive (VAR) model, cointegration, and Granger causality tests were all utilized to demonstrate capabilities for emerging and developed countries. When the literature is analyzed, the bulk of studies explain a causal association between renewable energy and economic growth.

The following are a few of these studies. Soytas and Sari (2003) investigate the relationship between energy use and GDP causation. In Argentina, a two-way causation link was discovered, while in Italy and Korea, a causality from GDP to energy use was discovered. The correlation between energy use and GDP has been established for Turkey, France, Germany, and Japan. As a result, it's been proposed that energy saving in the final four countries may be detrimental to economic progress. Arbex and Perobelli (2010) studied the relationship between renewable energy and production in six Central American nations between 1980 and 2006. Their research showed that renewable energy and economic growth have a bidirectional causal relationship in the short and long run.

From 1985 to 2007, Mahmoodi et al. (2011) investigated the association between renewable energy utilization and GDP development in seven Asian nations. Unidirectional causality was observed in Pakistan, India, Iran, and Syria, according to their research. There was a bidirectional causation between Jordan and Bangladesh, but none between Jordan and Sri Lanka, unlike the prior discovery. From 1980 to 2010, Joyeux and Ripple (2011) investigated the causal relationship between renewable energy and GDP in China. According to the findings of a multivariate labor and capital model, renewable energy has a positive impact on GDP.

Using particular regional economies in Italy from 1997 to 2007, Marjanovi et al. (2016) attempted to demonstrate a causal association between renewable energy and economic growth. Renewable energy generation has a significant influence on reducing existing balance of payments constraints in the regions studied, according to the findings of this study. When using VECM to investigate the relationship between

renewable and non-renewable energy consumption and economic growth, Payne (2009) found that the results point to a feedback hypothesis for the relationship between GDP and renewable energy consumption, as well as a conservation hypothesis for the GDP-energy relationship. From 1980 to 2009, Apergise and Danuletiu (2014) assessed the long-run bidirectional link between high-income renewable energy consumption and GDP growth in upper-middle-income and lower-middle-income nations using the Fully Modified Ordinary Least Square (FMOLS) technique. The findings, for the most part, reveal a direct link.

In 154 nations, Keynes (1936) looked at how renewable electricity production could promote economic development rather than expansion. The findings of this study revealed that renewable energy generation is associated with long-term economic growth, but bidirectional correlations are only evident in the short term. Apergis and Danuletiu (2014) examined the long-term relationship between renewable energy and economic growth in 80 countries across four continents using the ARDL panel and Granger causality. Over time, they discovered a bidirectional relationship between renewable energy and GDP in all categories. Ouedraogo (2013) used panel cointegration and the panel causality process to study the nexus in 15 European nations from 1990 to 2011, finding evidence for the growth hypothesis. Fang (2011) examined the link for 19 OECD countries from 1980 to 2008 using a panel causality model and found evidence for the conservation hypothesis. In OECD economies, Salim et al. (2014) looked at the unidirectional relationship between GDP and renewable energy consumption. As a result, a one-way causation link has been demonstrated between renewable energy and GDP.

The growth hypothesis was proven to be valid by Inglesi-Lotz (2016), who utilized panel cointegration methods to examine the relationship between renewable energy use and economic development in all OECD countries. Lee (2005) looked at the relationship between energy consumption, OECD economic growth, and the Middle East and North Africa (MENA) region between 1975 and 2011. They discovered that economic expansion had a favorable impact on energy consumption in the Middle East and North Africa (MENA), while no such association exists in OECD countries. Between 1971 and 2011, Ozdeveciolu (2013) investigated the association between renewable energy utilization and economic growth in newly developed countries. Negative shocks in renewable energy consumption induced positive shocks in real GDP in South Africa and Mexico, according to the statistics. Negative shocks in renewable energy consumption in India are accompanied by negative real GDP shocks. Thus, it is hypothesized:

H3: Carbon emissions has positive and significant influence on economic growth in developing countries.

3. Econometric Model, Data and Methodology

3.1 Econometric Model Specifications

This study primarily aims to determine the influence of information technology, foreign direct investment and environmental regulations on economic growth of Franc Zone countries while determining the linear effects. This study has extended the research model proposed by Shahbaz and Rahman (2010). The proposed model for this study is as follows:

Linear Effect Model

$$\text{LogGDP}_{it} = \alpha_0 + \alpha_1 \text{IT}_{it} + \alpha_2 \text{FDI}_{it} + \alpha_3 \text{CO2E}_{it} + \alpha_4 \text{POP}_{it} + \alpha_5 \text{URBAN}_{it} + \alpha_6 \text{IND}_{it} + \varepsilon_{it} \quad (1)$$

Where α_0 is the intercept α_1 till α_{10} respectively are the estimation coefficients to be estimated under linear effect model, non-linear effect model and synergy model and ε_{it} is the error term. Subscripts i and t represents country and year ($i=1, 2, \dots, 10$; $t=1, 2, 3, \dots, 30$). The gross domestic product per capita is converted into natural logarithm (Log GDP) to lower the potential heteroscedasticity.

3.2 Data Sources and Variables

This study is based on time series panel data. The panel data is from 13 countries both from the Western African monetary union and Central African monetary union. Central African Monetary Union countries include Cameroon, Central African Republic, Chad, Congo Republic, Equatorial Guinea, Gabon, Senegal and Togo. Western African Monetary Union countries include: Benin, Burkina Faso, Guinea-Bissau, Mali and Niger. The time period for data ranges from 1990-2020. The Table 1 provides more details about the variables taken into consideration.

The variable gross domestic product divided by midyear population equals GDP per capita. GDP is calculated as the total gross value added by all resident producers in the economy, plus any product taxes, minus any subsidies not included in the product value. It is estimated without taking into account depreciation of manufactured assets or natural resource depletion and degradation.

The variable Information Technology (IT) refers to individuals who have utilized the internet in the last three months (from any location) are considered Internet users. The internet can be accessed by a computer, a mobile phone, a personal digital assistant, a gaming machine, or a digital television, among other devices.

Foreign direct investment (FDI) refers to net inflows of funds used to acquire a long-term managerial stake (10% or more of voting shares) in a company that operates in a country other than the investors. As represented in the balance of payments, it is the sum of equity capital, earnings reinvestment, other long-term capital, and short-term capital. This data is segmented by GDP and displays net inflows (new investment inflows less disinvestment) from foreign investors in the reporting economy.

This study has taken carbon emissions to determine the relationship between environmental pollution and economic growth. Carbon dioxide emissions (CO₂E) are those caused by the combustion of fossil fuels and the production of cement. Carbon dioxide is created by the combustion of solid, liquid, and gas fuels, as well as gas flaring.

Moreover, the control variables are also taken into model specification other than the independent variables. The population size, urbanization and industrialization are taken as control variables. The population size (POP) counts all residents regardless of legal status or citizenship, is used to calculate total population. The figures indicated are estimates for the middle of the year. Urbanization (URBAN) refers to people who live in urban regions, as defined by national statistical offices, are referred to as urban population. The industrialization (IND) is measured through summing all outputs and deducting intermediate inputs, value added is a sector's net output. It is estimated without taking into account depreciation of manufactured assets or natural resource depletion and degradation.

Table 1: Variable Selection

Variable	Symbol	Source	Expected Sign	Measurement
Dependent Variable				
Gross Domestic Product	LogGDP	World Development Indicators		US dollars
Independent Variables				
Information Technology	IT	World Development Indicators	+	Percent of Population
Foreign Direct Investment	FDI	World Development Indicators	+	Percent of GDP
Carbon Dioxide Emission Per Capita	CO ₂ E	World Development Indicators	+	Per Capita
Control Variables				
Population Size	POP	World Development Indicators	+	Millions
Urbanization	URBAN	United Nations Population Division	+	Millions
Industrialization	IND	World Development Indicators	+	Percent of GDP

Source: Authors own calculation

3.3 Econometric Techniques

Panel (data) method is a measurement tool used in social science, epidemiology, and econometrics to analyze two-dimensional (usually cross-sectional and longitudinal) panel data (Maddala and Lahiri, 1992). Data is often collected over time and from the same persons, and then a regression on these two aspects is conducted. Multidimensional analysis is an econometric technique for gathering data in multiple dimensions (typically, time, individuals, and some third dimension).

The random-effects model, also known as the variance components model, is a mathematical model that uses random variables as model parameters. It's a hierarchical linear model in which the data being investigated comes from a hierarchy of different populations, the differences between which are related to the hierarchy. In econometrics, where no fixed effects are assumed, random effects models are employed in panel analysis of hierarchical or panel data (it allows for individual effects). The random-effects model is a variant of the fixed-effects model.

When unobserved heterogeneity is constant over time and not associated with independent variables, random effect models may help account for it. This constant can be extracted from longitudinal data using differencing, as the first difference would exclude all time-invariant model components. The random effects assumption and the fixed effects assumption are two common assumptions about the individual specific effect. Person unobserved heterogeneity is uncorrelated with the independent variables, according to the random-effects assumption. The individual-specific effect is associated with the independent variables, according to the fixed effect assumption.

A fixed-effects model, on the other hand, is a mathematical model in which the model parameters are fixed or non-random quantities. This differs from random-effects and mixed models which consider all or some of the model parameters to be random variables. When the heterogeneity is constant over time, such models can help account for omitted variable bias due to unobserved heterogeneity. This heterogeneity can be extracted from the data using difference, such as subtracting the group-level average over time or using a first difference to exclude any time-invariant model components (J. Wooldridge, 2005). The random effects assumption and the fixed effects assumption are two common assumptions made about the individual specific effect. Individual-specific results are uncorrelated with the independent variables, according to the random-effects assumption. Individual-specific effects are associated with the independent variables, according to the fixed effect assumption. The random effects estimator is more efficient than the fixed effects estimator if the random effects statement is true. The random effects estimator, on the other hand, is inconsistent if this assumption is not met (J. M. Wooldridge, 2016).

In this study to check the influence of information technology, foreign direct investment, environmental regulations on economic growth. The proposed study hypothesis used static panel models (Pooled OLS, RE, and FE) to provide empirical evidence based on the concrete theoretical basis. This study tested for their respective post-model estimation and validity checks after the static panel model estimations.

The White test is applied to check for heteroscedasticity in the pooled OLS model. One of the most critical assumptions in regressions is that the error term's variance is constant across observations. Homoscedastic errors have a fixed variance, whereas heteroscedastic errors have a variable variance. The traditional analysis techniques become inefficient in the case of heteroscedastic errors (non-constant variance). A typical econometric test for heteroscedasticity is the White test, which begins by allowing the heteroscedasticity process to be a function of one or more of your independent variables. The White test is similar to the Breusch-Pagan test, but it allows for the independent variable's nonlinear and interacting effect on the error variance. Breusch-Pagan suggested a test that is very similar to the White test (White, 1980). The null hypothesis is homoscedasticity (or constant variance), and if the likelihood for chi-square is large, we reject the null hypothesis and infer that heteroscedasticity exists in the model.

To check for autocorrelation the Cumby-Huizinga test is applied on pooled OLS model. Autocorrelation is a mathematical representation of the degree of similarity between a particular time series and a lagged version of itself over subsequent time intervals. A generic specification test of serial correlation in a time series was proposed by Cumby and Huizinga (Baum and Schaffer, 2013). It can be used to estimate a single-variable time series or as a post-estimation command after OLS or IV estimation. The test's null hypothesis is that the time series is a moving average of known order q , which can be zero or positive. The test considers the possibility that the time series' autocorrelations are nonzero at lags greater than q . The test is general enough to test the null hypothesis that serial correlation in the time series exists but dies out at a known finite lag ($q > 0$) or the null hypothesis that serial correlation exists but dies out at a known finite lag ($q = 0$). If the likelihood is large in this test, we reject the null hypothesis and conclude that autocorrelation exists in the model.

In contrast to check for intergroup heteroscedasticity using random and fixed effect model the Wald test is applied. The Wald test investigates potential measurements restrictions using a weighted gap between the unrestricted estimate and its hypothesized value under the null hypothesis, where the weight is the precision of the estimate. The greater the apparent weighted gap, the less probable the restriction is valid. In this case, the null is homoscedasticity (or constant variance). If the chi-square likelihood is large, we reject the null hypothesis and conclude that intergroup heteroscedasticity exists in the model.

Moreover, to check for serial correlation in random and fixed effect model Wooldridge serial correlation F-test is used. Wooldridge (2002) proposes a new test that is appealing because it needs few assumptions and is simple to implement. Since this test is so versatile, simulations can be run for a variety of scenarios, including random and fixed effect designs, conditional homoscedasticity in the idiosyncratic error word, balanced and unbalanced results, and individual series with and without gaps. The standard errors of the coefficients are smaller and the R-squared is higher when there is serial correlation. The null hypothesis is that there is no serial association. If the likelihood for f values is large, we reject the null hypothesis and conclude that serial correlation exists in the model.

Significant cross-sectional dependence in the errors is likely in panel-data models, which may arise due to the presence of common shocks and unobserved components that eventually become part of the error term, spatial dependence, and idiosyncratic pairwise dependence in disturbances with no particular pattern of idiosyncratic pairwise dependence in disturbances with no particular pattern of idiosyncratic pairwise dependence in disturbance. The effect of cross-sectional dependence in estimation is naturally influenced by a number of factors, including the magnitude of cross-sectional correlations and the existence of cross-sectional dependence. The standard fixed-effects (FE) and random-effects (RE) estimators are reliable, but not effective, and the estimated standard errors are biased, if we assume that cross-sectional dependence is caused by the existence of common factors that are unobserved (and thus felt through the disturbance term) but uncorrelated with the included regressors. Tests for cross-sectional dependency in fixed effects and random effects panel data models are suggested to assess the presence of a cross-sectional association in the data. The null hypothesis is that there is no cross-sectional correlation. If the likelihood of chi-square values is large, we reject the null hypothesis and conclude that cross-sectional correlation exists in the model.

4. Results and Discussion

Based on the above econometric model specifications and justification to apply the pooled ordinary least square analysis, fixed and random effect modeling the following empirical evidences are in align with study proposed hypothesis. Table 2 provides the descriptive summary of the key variables. The Table 3 shows the pairwise correlation matrix that is in accordance to the economic rationale. There is positive association among IT, FDI, CO2E and GDP. The Table 4 provides the empirical evidence based on the econometric model specifications. The information technology has positive and significant influence on economic growth of the

Franc zone countries under OLS, RE and FE models. The greater the impact of IT on economic growth, the higher the level of its input in diverse domains of production and consumption. As information technology brings more people together in the Western and Central African Monetary Region, the amount of data collected will expand exponentially, creating a positive feedback loop that will compound the effect, propelling the rate of economic growth to continue to improve. This is the allure of information technology (Asosheh, Shahid-Nejad, & Khodkari, 2012; Choi, 2010; Kurihara & Fukushima, 2013; Meijers, 2014). Moreover, foreign direct investment also has positive and significant influence on economic growth under all the static panel models. The relationship between FDI and economic growth has piqued the interest of academics all around the world (Basu et al. 2003; Vo et al. 2019a). This relationship has been extensively studied using data from a single nation or a sample of many countries, it is universally acknowledged. Unfortunately, no consensus has been achieved among academics on empirical findings. In terms of single-country research, Koojaroenprasit (2012) looked at the impact of FDI on economic growth in Korea from 1980 to 2009. In Pakistan, the similar observation was made, with foreign capital influx having a beneficial long-term influence on economic growth. (Shahbaz and Rahman 2010). Furthermore, the carbon emissions have positive and significant influence on economic growth under all static panel models. The panel data used for this study includes the developing countries which explains the rationale that there are fewer environmental regulations. In the developing countries, the aim for more industrialization and therefore produce more environmental pollution. Therefore, the higher level of carbon emissions refers to more industrial growth in an economy and thus economic growth. Keynes (1936) looked at how renewable electricity production could promote economic development rather than expansion. The findings of this study revealed that renewable energy generation is associated with long-term economic growth, but bidirectional correlations are only evident in the short term. Apergis and Danuletiu (2014) used the ARDL panel and Granger causality to look at the long-term relationship between renewable energy and economic growth in 80 nations across four continents. They discovered bidirectional correlation between renewable energy and GDP across all categories in the long run. Ouedraogo (2013) used panel cointegration and the panel causality process to examine the nexus in 15 European nations from 1990 to 2011, finding evidence of the growth hypothesis. In OECD economies, Salim et al. (2014) looked at the unidirectional relationship between GDP and renewable energy consumption. As a result, a one-way causation relationship between renewable energy and GDP has been established. All the post estimation test performed validates the empirical model and explains there is no presence of autocorrelation, serial correlation and heteroscedasticity.

Table 2: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LogGDP	403	.682	.543	-1	1.702
IT	403	5.096	9.736	0	61
FDI	403	-3.637	11.251	-161.82	5.01
CO2E	403	.873	1.935	.02	11.68
POP	403	12.415	15.121	.42	89.56
URBAN	403	45.593	18.566	13.81	90.09
IND	403	1.2	1.582	0	10.42

Source: Authors own calculations

Table 3: Pairwise correlations matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) LogGDP	1.000						
(2) IT	0.413*	1.000					
(3) FDI	0.212*	-0.001	1.000				
(4) CO2E	0.151*	0.161*	-0.182*	1.000			
(5) POP	0.513*	-0.001	0.066	-0.276*	1.000		
(6) URBAN	0.285*	0.461*	0.003	0.465*	-0.167*	1.000	
(7) IND	0.653*	0.526*	-0.015	0.188*	0.558*	0.366*	1.000

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source: Authors own calculations

Table 4: The influence of Information Technology, Foreign Direct Investment, Carbon Emissions on Economic Growth using Static Linear Panel Modelling

VARIABLES	(1) OLS	(2) RE	(3) FE
IT	0.0126*** (0.0025)	0.0169*** (0.0016)	0.0170*** (0.0016)
FDI	0.0107*** (0.0016)	0.0041*** (0.0011)	0.0038*** (0.0011)
CO2E	0.0554*** (0.0115)	0.1745*** (0.0112)	0.1797*** (0.0114)
POP	0.0158*** (0.0019)	0.0255*** (0.0031)	0.0256*** (0.0034)
URBAN	0.0023* (0.0013)	0.0019 (0.0012)	0.0020 (0.0012)
IND	0.0773*** (0.0202)	0.0115 (0.0175)	0.0125 (0.0180)
Constant	0.2120*** (0.0590)	0.0665 (0.1136)	0.0588 (0.0619)
Observations	403	403	403
R-squared	0.5668		0.6900
Number of countries	13	13	13
Post Estimation Tests			
F-stats	10.25		
White Test (Heteroscedasticity)	5.59		
Cumby-Huizinga Test (Autocorrelation)	340.123		
Wald Test (Inter-group Heteroscedasticity)		851.26	851.26
Woolridge F-Test (Serial Correlation)		68.52	68.52
Pesaran's Test (Cross-Sectional Dependence)		0.541	0.539

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
Source: Authors own calculations

5. Conclusion, Implications and Future Research Direction

This paper examines the influence of information technology, foreign direct investment, environmental regulations on economic growth in 13 African countries in the Franc zone during the period 1990-2020. It contributes to the literature on the information technology, foreign direct investment and environmental regulations. In this research, results have confirmed theoretical and empirical arguments for a linear growth relationship for both the West African and Central African monetary union countries. The results indicate a positive and significant influence of information technology, foreign direct investment, environmental regulations on economic growth.

These findings could have policy implications for the Franc zone countries' development prospects, particularly in terms of post-COVID-19 recovery plans and monetary agreement revisions. The findings of this study emphasize the central bank's role in assisting economic recovery while meeting its objectives on domestic and external price stability in the post-COVID-19 era.

Such improvements, however, should not be made at the expense of fundamental structural reforms that would encourage productivity growth, greater financial intermediation, and improved monetary policy transmission. For example, it is vital to understand that utilizing information technology (in the long run) would be ineffective without a strong reform programme that encourages innovation and productivity gains. Furthermore, there is a need to enact changes that would reduce carbon emissions because increasing

environmental pollution could lead to health and environmental hazards, thereby balancing the potential growth benefits of this strategy.

In the face of restricted fiscal space, countries in the franc zone would benefit from the opportunities provided by information technology and foreign direct investment. In reality, the COVID-19 issue is projected to have a significant impact on African countries, who lack the fiscal space to implement big economic stimulus projects. Countries that rely on mining and oil exports are projected to see significant drops in growth, maybe as low as 7% for oil exporting countries and as low as 8% for metal exporting countries (Calderon et al, 2020). The anticipated loss of already low tax revenues owing to economic disruption, commodities revenue collapse, and increased public health spending are expected to undermine fiscal positions in several Franc zone nations, leading in limited room to implement economic stimulus initiatives. It should be highlighted, however, that the underlying static panel model equation in this research has several drawbacks. In fact, we put various models to the test and reported on the ones that were the most economically and theoretically sound. Although applying fundamental environmental regulations could have enhanced the studies, there are significant data restrictions.

Conflicts of Interest

The authors declare that they have no competing interests in the research's publication.

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