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Effect of Foreign Direct Investment on Energy consumption: Does Institutional Quality matter? Evidence from Cote d'Ivoire

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ABSTRACT

This paper examines the role played by institutional quality in the relationship between foreign direct investment and energy consumption in Côte d'Ivoire. Using data from the World Bank and International Country Risk Guid over the period 1984-2014 and the Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS) methods, we account for the joint effects of institutional quality and foreign direct investment on energy consumption. The results reveal that a high level of democracy attenuates the negative effects of FDI flows on energy consumption. This result shows that improving and strengthening democratic institutions has a positive influence on energy efficiency incentive policies by changing the composition of FDI towards clean technology sectors, such as the service sector.

Keywords: FDI, Energy Consumption, Institutional Quality, Cote d'Ivoire
JEL Classifications: E02, F21, O13, C32

1. INTRODUCTION

Energy consumption or use which means, "the use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport" (World Bank, 2020), is considered crucial in the development process (Kraft and Kraft, 1978; Ozturk and Acaravci, 2010). The underlying reason is that energy is central to the process of producing goods and services. It appears to be the key source of economic growth, industrialization and urbanization. It is widely accepted that the availability of efficient energy services is an essential driver of economic growth and development in that access to enhanced health, education and better economic opportunities are dependent on efficient energy supply (Pokharel, 2007; Augutis et al., 2011). Therefore, energy demand and consumption are integral to people's daily lives as they are linked to improved well-being and better lives (Nkalu et al., 2020). Moreover, ensuring a stable and cost-effective energy supply is crucial for the economic and political stability of countries (Salim et al., 2017). For this reason, energy security has been considered a national security issue for centuries in order to reduce countries' energy dependence (Desket, 2018).

Given the crucial role of energy in economic growth and development, much of the theoretical and empirical literature in recent years has focused on identifying and analysing the drivers and constraints to energy consumption. Thus, among the many factors identified[1], foreign direct investment flows are prominent. FDI is understood as the export of capital from one country to another to acquire or establish a business or to acquire a stake in it.

1 Among others, we can cite the work of Shahbaz and Lean (2012), Destek (2018), Coban and Topcu (2013), Nkalu et al. (2020), who emphasised the role of financial development as a factor stimulating energy consumption; Li and Lin (2015), Pan et al. (2019) highlighted the role of urbanization and industrialization in energy consumption; Koengkan (2018), Pan et al. (2019) focused on the effect of trade openness on energy consumption; others such as Becken and Patterson (2006) and Katircioglu et al. (2014) focused on the influence of tourism on CO2 emission, etc.

Theoretically, there are divergent views on the impact of FDI on energy consumption. Indeed, Grossman and Krueger (1995) decomposed the effect of FDI on energy consumption into three effects: scale, technique and decomposition effects. The scale effect refers to an increase in energy consumption caused by a booming economic activity. In contrast, the technical effect describes a negative association between FDI flows and energy consumption from foreign investors who introduce energy efficiency not only in their own facilities, but also disseminate it to the wider community. Finally, the decomposition effect is uncertain, as it depends on the sectorial distribution of FDI and the level of economic development of the host country (Salim et al., 2017). For example, increasing the share of FDI in the tertiary sector may reduce energy consumption while concentrating FDI in secondary sectors may produce opposite effects.

Given these contrasting theoretical views on the role of FDI in energy consumption, many empirical studies have sought to investigate the relationship. Looking at the empirical literature, we also find a near lack of consensus among the majority of existing studies on the subject. Some studies have succeeded in proving the growth effect of FDI, while others have not been able to show this positive relationship. Among the studies that have found a positive and significant relationship between FDI and energy consumption is the pioneering work of Mielnik and Goldemberg (2002) who, in examining the relationship between FDI and energy, found that FDI flows lead to an improvement in environmental quality through increased energy efficiency. Following this work, we can quote those of Zaman et al. (2012) who found a positive relationship between FDI and energy consumption in Pakistan; Lau et al. (2014) found a positive relationship between FDI and CO2 emission in Malaysia over the period 1970-2008. Omri and Kahouli (2014) by splitting the countries in their sample according to their level of development (low-income, middle-income, high-income countries) came to the conclusion that increasing FDI increases energy consumption in all groups of countries regardless of the level of development. Leitao (2015) finds a positive relationship between FDI and energy consumption in Portugal.

In contrast to these studies that found a positive correlation between FDI and energy consumption, others found a non-significant or negative effect. For instance, we can cite the studies by Hubler and Keller (2010) and Sadorsky (2010) who, by examining the relationship between FDI and energy intensity in samples of developing countries, found no statistically significant relationship between the variables. On the other hand, Salim et al. (2017) analysing the interaction between FDI and energy consumption in China found a negative relationship between the variables. The results show that in the long run, a 1% increase in FDI decreased energy consumption by 0.21%.

Among the arguments put forward to explain these ambiguous results, an interesting literature suggests that certain host country characteristics could help explain energy consumption (Saud et al., 2018; Danish and Ulucak, 2021)[2].

Rather than analysing a wide range of heterogeneous factors that could explain such a discrepancy between theoretical predictions and empirical results, this study focuses on institutional quality to identify the role played by the institutional environment in the transmission chain of the effects of foreign direct investment on energy consumption in Cote d'Ivoire. In this sense that various studies have shown that democracy, considered as a meta-institution, has an impact on the environment and environmental policy-making. The environmental quality of a country is closely linked to the environmental policy and governmental decision-making mechanism (Bernauer and Koubi, 2009; Libman, 2013; Fankhauser et al., 2015).

The choice of this country is particularly interesting in several respects. First, in recent years, the country has shown impressive economic growth performance. Indeed, before the global shock of the Covid-19 pandemic, the country had one of the highest economic growth rates in Africa and the world, with an average annual growth rate of 8% since 2012 (World Bank, 2021). Moreover, its Gross Domestic Product (GDP) represents about 40% of that of Francophone West Africa. Consequently, this country occupies a strategic place in the economic and social development of the sub-region. Accelerating economic growth requires the use of large amounts of energy. Thus, its energy consumption has increased especially since 2012 with the expansion of economic activities. For this reason, Côte d'Ivoire has become the country with the highest energy demand in West Africa after Nigeria.[3]

Another reason for choosing this country is that, like most developing countries, it gives pride of place to foreign capital flows in its economic growth strategy. For instance, net foreign direct investment flows have increased on average from US $64.36 million between 1984 and 1994 to US $306.55 million between 1995 and 2005 and US $465.71 million between 2006 and 2018, reaching US $1.008 billion in 2019 (Gakpa and Kouadio, 2021), i.e. an increase of 2753% over the 1984 and 2018 period.

The choice of this country is also motivated by the fact that governance indicators in the country are poor (IMF, 2016). Indeed, for more than two decades, the country has been marked by repeated socio-political crises, armed conflicts and unconstitutional changes. These worrying situations have greatly weakened the country's institutions. These institutional weaknesses could help explain the direction of the relationship between FDI and energy consumption. Indeed, the literature shows that institutions play an important role in FDI inflows and energy consumption (Dash et al., 2020; Bhattacharya et al., 2017).

Finally, from an economic policy-making perspective, assessing the role of institutions in the relationship between FDI and energy consumption would allow quantifying the risk that poor quality institutions pose to the achievement of sustainable development goals. The results of the study would thus provide a documented source of information on the real burden of the institutional

2 Their work highlights the role of globalisation in the relationship between financial development and energy consumption.

3 Our calculations based on World Bank data show that over the period 1980-2014, energy consumption per capita in Côte d'Ivoire rose from 444.86 kg of oil equivalent in 1980 to 612.64. This represents an increase of almost 38%.

environment on development efforts, and thus allow for a better consideration of this parameter in designing strategies for efficient energy use. This study is the first to explore the role of institutions in the relationship between FDI and energy consumption in Côte d'Ivoire.

The remainder of the paper is arranged as follows: Section 2 introduces the methodology and data, section 3 presents the empirical results, section 4 addresses the estimation results and section 5 concludes this paper and outlines policy implications.

2. EMPIRICAL MODEL AND DATA

To assess the influence of institutional environment on the relationship between FDI and energy consumption, we build from the empirical model of Uzar and Eyuboglu (2019), Salim et al. (2017) and Leitao (2015), to which we have made some modifications to adapt it to the objective of this study. The econometric model is then specified as follows:

$$EC_t = \beta_0 + \beta_1 FDI_t + \beta_2 INSQ_t + \beta_3 (FDI_t * INSQ_t) + \beta_4 X_t + \varepsilon_t \quad (1)$$

Where *EC*, refers to energy consumption measured in per capita kg of oil equivalent; *FDI*, represents Foreign direct investment, net inflows (% of GDP); *INSQ*, the institutional quality variable which is approximated by democracy. Indeed, in the literature, democracy is considered as a meta-institution, i.e. an institution from which other institutions in a country are born or strengthened (Rodrik, 2000; Acemoglu et al., 2005). It is also recognised that the level of democracy affects the quality of governance. According to the ICRG's definition, democratic institutions measure how the government responds to its people. This indicator is rated on a scale of 0 to 6, with a high score indicating better quality of democratic institutions. Democracy gives the different actors in society the possibility to exert pressure on the state, or even to sanction the state in case of failure. The principle of democratic accountability makes the state answerable to its citizens for its actions. It has an obligation to be accountable to its citizens for the management of its affairs. *X*, the vector of control variables that are supposed to influence energy consumption. Following the literature on the determinants of energy consumption, we select as control variables trade openness (measured by the ratio of exports plus imports divided by GDP); financial development (measured by domestic credit to the private sector relative to GDP)[4]; urbanization (measured by urban population [% of total population]); the level of industrialization is captured by industrial value added as a percentage of GDP and economic growth measured by the first difference of the logarithm of real GDP per capita. ε, the error term of the model and *t*, the time or period.

The annual data used in this study cover the 1984-2014 sample period. The choice of this period is linked to the availability of data on institutional variable and on per capita energy consumption data over this period. Data on the control variables and energy consumption are gathered from the World Bank database. Data on institutional variable are sourced from the International Country Risk Guid (ICRG) database. The main advantage of this database over other institutional database is that data are available over a relatively longer period. This makes it possible to analyse the dynamics of institutional variables.

3. EMPIRICAL RESULTS AND DISCUSSIONS

3.1. Descriptive Statistics

In Table 1, CV measures the coefficient of variation (std.dev/mean). Table 1 reports the descriptive statistics for all the variables. For comparison purposes, the coefficient of variation is used to interpret the relative magnitude of standard deviation.

The results reveal strong variations in the variables of interest. Overall, FDI has a high coefficient of variation, followed by the institutional quality variable and the energy consumption variable.

3.2. Analysis of Multicollinearity

The analysis of multicollinearity is useful in that it allows one to verify that a model does not incorporate explanatory series that are related to each other. Multicollinearity creates numerical and statistical problems that result in potentially serious estimation difficulties (Erkel-Rousse, 1995). Table A-2 present the matrix of correlation coefficients between the different explanatory variables. As can be seen, overall, the correlation coefficients between the different explanatory variables do not exceed 0.8[5]. Therefore, the study decides to use all variables in the empirical model.

3.3. Unit Root Tests

To ensure robustness in our estimates, it is important that the time series properties of the data are evaluated. We examined the unit root process of the data by using the Augmented Dickey Fuller (ADF) and Phillips-Perron tests. These tests are well documented in the literature[6]. The results of the tests are reported in the Table 2 below.

The results show that the variables are stationary in first difference I (1). The results of the unit root tests therefore show that none of the variables are integrated of an order higher than 1, which according to Pesaran et al. (2001) presages the existence of a long-term relationship between the variables. In the next section, we test the existence of cointegration among the variables.

3.4. Co-integration Analysis

We use the technique developed by Pesaran et al. (2001) to test the existence of a long-term relationship between the variables

4 Several indicators of financial development have been used in empirical analyses to explain energy consumption. In this study, we focus on domestic credit to the private sector as a percentage of GDP. It has a clear advantage over other real interest rate measures or monetary aggregates (such as M1; M2; or M3) because it more clearly represents the actual volume of funds channelled to the private sector. It also appears to be the most appropriate indicator for developing countries like ours, because most financial development takes place in the banking sector unlike in industrialised countries where a significant part of financial development occurs beyond the banking system. For these reasons, credit to the private sector represents a better proxy for financial development in a broad sense (Jimborean, 2004).

5 Multicollinearity only becomes a concern if the correlation coefficient between the variables is greater than 0.8 (Keho, 2016).

6 See Damodar N. Gujarati, Basic Econometrics, Fourth edition.

Table 1: Descriptive statistics of variables

Variables	Obs.	Mean	Std. Dev.	Min	Max	CV
EC	31	439.859	80.8144	361.578	612.640	18.372
FDI	31	1.554	1.130	0.176	6.026	72.715
TRADE	31	76.364	12.015	55.348	95.069	15.733
URB	31	42.938	3.542	37.693	49.014	8.249
IND	31	22.775	1.909	19.548	27.410	8.381
LogGDP	31	1370.773	159.4384	1132.548	1691.933	11.631
CREDSP	31	22.369	9.112	12.452	37.939	40.734
DEMO	31	2.556	0.586	1	3	22.926

Table 2: Unit root test results

Series	Level		First Difference	
	ADF	PP	ADF	PP
EC	−0.070	−0.252	−4.674***	−6.113***
FDI	−2.269	−2.668	−5.215***	−6.795***
TRADE	−1.462	−1.407	−3.111**	−4.646***
URB	0.336	4.746	−3.568***	−2.861**
IND	−1.741	−1.900	−−3.601***	−6.297***
LogGDP	−1.986	−1.986	−2.994**	−2.994**
CREDSP	−1.566	−1.566	−4.158***	−4.257***
DEMO	−2.303	−1.876	−4.772***	−3.994***

(***), (**), indicate the rejection of the null hypothesis at the 1% and 5% threshold

because it has several advantages. It is more appropriate for testing the existence of long-term relationships in small samples and, unlike the approach of Johansen and Juselius (1990), it allows us to test them between variables with different orders of integration (I (1) an I(0). The ARDL form of the equations to be estimated is as follows:

$$\Delta EC_t = \mu_1 + \sum_{i=1}^{m} \beta_{1i}\Delta EC_{t-i} + \sum_{i=0}^{P} \beta_{2i}\Delta FDI_{t-i} + \sum_{i=0}^{p} \beta_{3i}\Delta INSQ_{t-i} + \sum_{i=0}^{p} \beta_{4i}\Delta FDI * \Delta INSQ_{t-i} + c\sum_{i=0}^{p} \beta_{7i}\Delta IND_{t-i} + \sum_{i=0}^{p} \beta_{8i}\Delta logGDP_{t-i} + \sum_{i=0}^{p} \beta_{9i}DEMO_{t-i} + \gamma_1\Delta EC_{t-1} + \gamma_2 FDI_{t-1} + \gamma_3 INSQ_{t-1} + \gamma_4 FDI * INSQ_{t-1} + \gamma_5 TRADE_{t-1} + \gamma_6 URB_{t-1} + \gamma_7 IND_{t-1} + \gamma_8 LOGgdp_{t-1} + \gamma_9 DEMO_{t-1} + \varepsilon_t \quad (2)$$

According to the ARDL approach, a long-term relationship between the variables of the model exists when the null hypothesis of absence of cointegration ($\gamma_1=\gamma_2=\gamma_3=\gamma_4=\gamma_5=\gamma_6=\gamma_7=\gamma_8=\gamma_9=0$) is rejected. This hypothesis is tested through a Fisher test where the calculated value of the statistic is compared to the critical values simulated by Pesaran et al. (2001). These authors provide two sets of values representing upper and lower bounds respectively. The hypothesis of absence of cointegration is rejected when the calculated value of the Fisher F-statistic is higher than the upper bound. It is not rejected if it is lower than the lower bound, and it is not possible to conclude if it is between the two bounds.

The results of the « *bounds test* » procedure are presented in Appendix A-2. The results from the table show that the Fisher statistic is above the 1% upper bound for the specification. Therefore, we reject the null of no long-term relationship and conclude that a long-term relationship exists between the different variables in the model.

The next step is to estimate the long-term relationship between FDI, institutional quality and energy consumption.

4. ESTIMATION RESULTS AND DISCUSSIONS

To assess the sensitivity of the results, we estimate the long-term relationship using the Fully Modified Ordinary Least Square (FMOLS) and Dynamic Ordinary Least Square (DOLS) methods[7]. These two methods take into account potential endogeneity of regressors and have good properties on small samples. Furthermore, to ensure the robustness and stability of the effect of institutional quality in the FDI-energy consumption relation, we gradually added the control variables to the regression.

The results are disclosed in Tables 3 and 4.

In all models, the results show that FDI flows and the democracy indicator positively affect energy consumption. This positive sign of the FDI coefficient is consistent with those found by Uzar and Kemal Eyuboglu (2019), Omri and Kahouli (2014) and Lau et al. (2014) but contrary to those found by Salim et al. (2017). These results show that FDI to Côte d'Ivoire is directed towards sectors that are highly polluting and consume more energy than in energy efficient sectors. Thus, our results confirm that FDI inflows are concentrated in polluting sectors rather than clean sectors. This is especially true since, according to BCEAO[8] (2018) data, the largest share of net FDI inflows into Côte d'Ivoire in 2017, i.e. 39.2%, was directed towards extractive industries. This result is also supported by the positive sign of the coefficient of the variable measuring the level of industrialisation in our different specifications.

An unexpected result is the sign of the democracy variable. This does not necessarily mean that it negatively influences energy use. It indicates that improved democratic institutions have not had an impact on the environment and environmental policy making. This result suggests a threshold effect for democracy. This is understandable since the level of the democracy indicator

7 DOLS is a parametric procedure proposed by Saikkonen (1991) and Stock and Watson (1993) in the case of time series. It consists in including leads and lags of the explanatory variables in the cointegration relationship, to deal with endogeneity and serial correlation of residuals. FMOLS is a semi-parametric procedure, initially proposed by Phillips and Hansen (1990) and developed by Phillips (1995). It consists of applying the OLS to a transformed model to orthogonalize the residual of the cointegration relationship with respect to the innovations of the non-stationary variables. Among them, DOLS is considered more reliable as it contains both leads and lags and corrects heteroskedasticity and autocorrelations (Chen et al., 2017).

8 Central Bank of West African States.

Table 3: DOLS estimation results

	(1)	(2)	(3)	(4)	(5)	(6)
FDI	3.099***	3.143***	1.947***	1.876***	0.313*	0.424*
DEMO	2.049***	2.079***	1.507***	1.417***	0.268**	0.351**
FDI*DEMO	−1.038***	−1.066***	−0.679***	−0.649***	−0.122**	−0.154**
DLogGDP	---	3.780	0.507	0.561	0.686	0.308
TRADE	---	----	0.023***	0.025***	0.008***	0.006*
CREDSP	---	---	---	0.005	−0.006	−0.0004
IND	---	----	---	----	1.550***	1.099***
URB	---	----	---	----	----	0.027

*, **, and *** indicates the statistical significance and 10, 5, and 1% level, respectively

Table 4: FMOLS estimation results

	(1)	(2)	(3)	(4)	(5)	(6)
FDI	3.287***	3.317***	2.065***	2.055***	0.404**	0.488**
DEMO	2.028***	2.069***	1.549***	1.531***	0.325**	0.382**
FDI*DEMO	−1.089***	−1.120***	−0.723***	−0.718***	−0.155**	−0.180**
DLogGDP	---	4.810**	0.849	0.855	0.820	0.601
TRADE	---	----	0.022***	0.022***	0.009***	0.008**
CREDSP	---	---	---	0.0002	−0.005	−0.001
IND	---	----	---	----	1.485***	1.215***
URB	---	----	---	----	----	0.014

in the country is low. Indeed, over the study period, the value of the democracy variable oscillated between 1 and 3 on a scale of 0-6, with a high score indicating better quality of democratic institutions. Thus, the results seem to indicate that the country needs to reach a certain level of quality of democracy for an energy efficiency. These explanations support the economic implications of the empirical work of Chou and Zhang (2020), according to which a high level of democracy has a significant positive impact on improving national energy efficiency. Therefore, our results highlight the need for institutions and policies that promote the establishment and strengthening of democracy in the country.

The cross product of FDI and democracy (FDI*INSQ), has a negative and statistically significant sign in all specifications. This result confirms the threshold effect of democracy. That is, the country needs to reach a certain level of democratic quality to implement policies that will direct FDI flows towards cleaner, energy-efficient sectors. Deepening democracy by affecting the legal system will affect energy use and improve energy efficiency. Studies on the environment and the economy have shown that the development of the democratic system has a substantial impact on national environmental policies or can even bring about significant changes in the environmental state of a country (Cirone and Urpelainen, 2013; Barrett and Graddy, 2000; Torras and Boyce, 1998; Didia, 1997; Congleton, 1992).

Regarding the control variables, the results show that trade openness and the level of industrialisation positively and significantly affect energy consumption. These results are consistent with those obtained by Ma and Fu (2020).

5. CONCLUSION AND POLICY IMPLICATIONS

In this paper, we examine the influence of institutional quality in the relationship between foreign direct investment and energy consumption over the period 1984-2014. To do so, in the specification of our model, we consider the joint effects of institutional quality and FDI flows. The univariate and multivariate analysis of the data leads to three important conclusions. First, the examination of the level of democracy reveals that it is still low in Côte d'Ivoire. Second, foreign direct investment flows and energy consumption have varied significantly over the period. Third, the implementation of the econometric model reveals that it is in the interest of Côte d'Ivoire to choose an economic development strategy based on the reform of its democratic institutions. Indeed, the results from the econometric estimations show that the interaction between FDI and democracy reduces energy consumption. Such results indicate that improving democratic institutions by promoting transparency and better governance could channel FDI into less polluting sectors and thus help improve energy efficiency. In addition, deepening democracy by promoting the institutionalisation of law could help attract FDI that includes green technologies and renewable energy sources to promote energy efficiency. These results suggest that improving and deepening democratic institutions is paramount for energy efficiency in Côte d'Ivoire.

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APPENDICES

Table A-1: Correlation matrix between variables

	EC	FDI	TRADE	URB	IND	LogGDP	DEMO	CREDSP
EC	1.000							
FDI	0.0443	1.000						
TRADE	0.6648*	0.3160	1.000					
URB	0.8680*	0.2761	0.7371*	1.000				
IND	0.5594*	−0.0244	0.0318	0.5011*	1.000			
LogGDP	−0.585*	−0.3002	−0.6191*	−0.8356*	−0.3283	1.000		
DEMO	−0.2834	−0.1814	−0.4676*	−0.5300*	0.0230	0.5637*	1.000	
CREDSP	−0.4408*	−0.6264*	−0.6869*	−0.7337*	0.0093	0.7788*	0.6081*	1.000

* denotes 5% significance level

Table A-2: Results of the bounds test procedure

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Significance	I (0)	I (1)
			Asymptotic n=1000	
F-statistic	19.39836	10%	1.85	2.85
K	8	5%	2.11	3.15
		2.5%	2.33	3.42
		1%	2.62	3.77