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Foreign Direct Investment and Human Development in the Waemu Zone: what Role do Institutions Play?

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ABSTRACT:

This paper analyzes the relationship between foreign direct investment (FDI) and human development in the WAEMU zone over the period 1998–2023, with a focus on the moderating role of institutional quality. Using the Panel Smooth Transition Regression (PSTR) model proposed by Gonzalez et al. (2005), we test whether the effect of FDI on human development depends on the institutional environment. The linearity hypothesis is rejected, and an endogenous institutional threshold of -0.588 is identified. Below this threshold, the estimated coefficient of FDI is negative; above it, the coefficient becomes positive but remains small in magnitude. The results therefore suggest that the association between FDI and human development is conditional on institutional quality and evolves progressively as the institutional environment improves. The estimated transition parameter ($\gamma = 0.911$) points to a gradual shift between regimes rather than an abrupt break. Overall, the results suggest that the contribution of FDI to human development is conditional on institutional quality and strengthens progressively as institutions improve. To enhance the developmental impact of FDI in the WAEMU, policymakers should strengthen institutions, improve infrastructure, raise the efficiency of public spending, and deepen the integration of foreign investment into the domestic economy.

Keywords: Foreign direct investment, PSTR model, human development.

JEL: F02, F15, F49, A12.

1. INTRODUCTION

Awareness of the role of foreign direct investment (FDI) in economic development has gradually grown since the 1980s. This period was marked by the publication of several reports by the World Bank (1985) and UNCTAD (1992), which highlighted the channels through which FDI can contribute to development: technology and skills transfers, creation of skilled jobs, infrastructure development, and international integration. This led to the adoption of FDI attraction policies, notably the "Washington Consensus" of the 1990s, which have continued in various forms since then.

Theoretically, the relationship between FDI flows and human development is highlighted in the evolution of economic thought on the role of institutions (quality of governance, policy effectiveness, corruption, legal certainty, etc.). Adam Smith (1776) emphasized the importance of the institutional framework for economic development. This idea was further developed by Douglass North (1990), who demonstrated how institutions shape economic incentives and influence the effectiveness of development policies. Following them, Dani Rodrik (1999) highlighted the crucial role of quality institutions in the success of economic policies. Meanwhile, Acemoglu and Robinson (2012) argued that only inclusive institutions can guarantee sustainable economic development and

effective poverty reduction. Bowles (2004) developed the concept of the "institutional poverty trap," demonstrating how poverty can limit individuals' ability to organize collectively to create more egalitarian institutions. Sindzingre's work (2006) highlights how certain institutions can contribute to maintaining groups in poverty, while poverty itself can generate institutions that perpetuate this condition. These analyses help to understand the persistence of human development problem in certain regions despite the influx of FDI.

The experience of the West African Economic and Monetary Union (WAEMU) over the past few decades offers a field of analysis within this theoretical framework. Recent data from the Central Bank of West African States (BCEAO) reveals a significant increase in FDI flows, rising from 1,897 billion CFA francs in 2020 to 2,543 billion CFA francs in 2022. However, their distribution remains highly uneven within the zone, with Côte d'Ivoire receiving 45.3% of the flows and Senegal 19.2%, while countries like Guinea-Bissau receive only 1.3%. The growth in FDI has not translated into a proportional human development. The Harmonized Survey on Household Living Conditions (EHCVM 2018-2019) shows that monetary poverty rates remain high, ranging from 37.8% in Senegal to 47.3% in Guinea-Bissau. This situation is also reflected in human development indicators, with HDI scores (UNDP, 2022) ranging from 0.40 for Niger to 0.55 for Côte d'Ivoire, placing all countries in the region in the category of countries with low human development. At the same time, the analysis of global governance indicators (WGI, 2022) for the WAEMU region reveals concerning institutional weaknesses, with negative average scores: government effectiveness (-0.89), rule of law (-0.76), control of corruption (-0.72), political stability (-0.85), regulatory quality (-0.67), and voice and accountability (-0.58). These institutional weaknesses contrast sharply with the situation in other regions that are effectively transforming FDI into social progress. The experience of countries like Estonia in Eastern Europe and Singapore in Southeast Asia demonstrates how strong institutions can maximize the developmental impact of FDI.

Within the specific context of the WAEMU (West African Economic and Monetary Union), the question arises as to whether FDI actually contributes human development in member countries and to what extent the quality of institutions influences this contribution. Recent studies confirm this interaction between institutions and the effectiveness of FDI. Salouka, Kane, and Tiehi (2018) demonstrate that the impact of FDI on human development is significantly amplified in countries with strong institutions. Ouedraogo (2020) also emphasizes that improving institutional quality is an essential prerequisite for maximizing the benefits of FDI in terms of human development.

In light of these observations, the objective of this paper is to determine the impact of FDI on human development in the WAEMU, with a particular focus on the moderating role of institutions. Specifically, it aims to analyze the driving forces behind human development and the critical threshold of institutional quality necessary for FDI to contribute significantly to human development. To answer the research question, we posit that the effect of FDI human development is positively influenced by the quality of institutions beyond a certain threshold.

The distinctive feature of this paper lies in several aspects. First, we use the PSTR method of Gonzalez et al. (2005), a recent approach in the analysis of the conditions for FDI effectiveness, to endogenously identify a threshold of institutional quality. Second, our paper aims to enrich the theoretical understanding of the role of institutions in the effectiveness of FDI in human development, as the literature more often focuses on the overall effects of FDI or solely on the quality of institutions. Finally, the WAEMU zone encompasses a diversity of institutional situations, while sharing a common macroeconomic framework (monetary policy, regional and sectoral policies), which constitutes a good field for comparative analysis. Consequently, the paper is structured as follows: literature review, stylized facts, econometric methodology, results, and their discussion.

2. LITERATURE REVIEW

The analysis of the HDI proves to be relevant because it is a synthetic indicator highlighting certain essential dimensions of well-being and human development (education, health, per capita income). These dimensions constitute important determinants of the living conditions of the populations and make it possible, indirectly, to appreciate certain manifestations of the problems linked to poverty. These problems of poverty in a context of institutional quality, sometimes low, constitute a major concern for the economic literature.

2.1. Determinants of human development and poverty

The theoretical literature generally considers FDI as a means of supplementing economic savings, increasing investment, promoting technological transfers and creating jobs. These different mechanisms can contribute to the improvement of incomes, education and health and, consequently, to human development.

In this perspective, Borensztein, De Gregorio and Lee (1998) show that FDI can constitute an important vector of technological transfer and contribute to accelerating the growth of developing economies. However, the technological benefits associated with FDI depend on the capacities of the host country, in particular on its level of human capital. Economies with a sufficiently qualified workforce are more able to absorb new technologies and benefit from the positive externalities associated with foreign companies. This contribution suggests that FDI can indirectly contribute to human development through the accumulation of human capital and the improvement of productivity. In the same sense, Alfaro, Chanda, Kalemli-Ozcan and Sayek (2004) show that the effects of FDI on economic performance depend on the development of local financial markets. FDI generates more benefits when the host country's financial system is sufficiently developed to efficiently direct resources to productive activities. This conclusion is important for the WAEMU countries, where the inadequacies of the financial systems can limit the diffusion of the benefits of foreign capital throughout the economy.

Githaiga and Kilong'i (2023) directly examine the link between foreign capital flows, institutional quality and human capital development in sub-Saharan Africa. Using a system-based GMM estimator, the authors find a positive relationship between FDI and human development. They also show that

the effect of FDI on human development depends on institutional quality. This relationship is also highlighted by Ha, Doan, Holmes and Tran (2024). Other works highlight particular mechanisms by which FDI can improve living conditions. Afolabi and Raifu (2024) show, based on data on 29 sub-Saharan African countries between 2000 and 2021, that FDI has a significantly favorable effect on employment and that this effect is reinforced by institutional quality. Similarly, Abor, Dwumfour, Agbloyor and Pan (2024) show, on a sample of 90 countries covering the period 2004-2017, that FDI promotes financial inclusion and that institutional quality as well as the development of financial markets strengthen this contribution.

These results therefore suggest that FDI can contribute to human development through several channels: job creation, technology transfer, human capital accumulation, financial development and income improvement. However, the diversity of the results shows that the effect of FDI is not necessarily uniform. It is therefore necessary to examine whether this effect depends on the level of institutional quality.

In linear models, inflation is generally considered a factor that exacerbates poverty, as it can reduce the purchasing power of poor households. Easterly and Fischer (2001) demonstrate that inflation is associated with increased poverty and inequality because the poor have few tools to protect themselves against the decline in the purchasing power of money. Canagarajah and Thomas (2001) show that in African countries, a rise in inflation is linked to an immediate increase in poverty, particularly in urban areas. Ferreira et al. (2007), for Latin America, observe a high sensitivity of poor populations to price increases, especially food prices. Overall, the literature shows a positive linear relationship between inflation and poverty.

Infrastructure is also considered a fundamental driver of economic and social development. It can facilitate access to markets, basic services, education, and healthcare. Linear models posit a direct and negative relationship between infrastructure improvements and poverty rates. Calderón and Servén (2004) demonstrate in developing countries that infrastructure expansion (roads, electricity, telecommunications) leads to poverty reduction. Fan and Chan-Kang (2005) find that investments in rural infrastructure have a direct impact on poverty reduction in China and India by improving agricultural productivity and employment opportunities. Agenor and Moreno-Dodson (2006) emphasize that health and education infrastructure strengthens human capital and enables a sustainable improvement in the living conditions of the poorest. These findings support the idea that infrastructure has a linear, positive, and direct effect in the fight against poverty.However, some studies tend to question the linear effects of economic growth on poverty and other macroeconomic variables. Ravallion (2001) shows that the effect of growth on poverty is stronger in countries with low initial inequality. Conversely, in highly unequal countries, growth primarily benefits the wealthy, thus slowing poverty reduction. Bourguignon (2003) argues that growth reduces poverty in a decreasing manner as the initial level of inequality increases. He proposes a combination of growth and income redistribution. Lopez (2004) and Kraay (2006) observe that in low-income countries, the elasticity of poverty to growth is high at the beginning of the period and then decreases with development. Fosu (2008) confirms that the elasticity of poverty to growth varies according to region and initial income level. Grimm et al. (2007) show that in some African countries, recent growth has been "anti-poor" in that the rich have seen their incomes grow faster than the poor, thus exacerbating inequality. Previously, Ravallion and Chen (2003) introduced the concept of pro-poor growth, which depends on the growth rate and how it is distributed. Loayza and Raddatz (2010) highlight that agricultural growth has a greater impact on poverty than industrial growth. Ravallion (2009) adds that the most inclusive forms of growth are those that generate informal or agricultural employment, as they directly benefit the poor.

Furthermore, high inflation tends to have negative effects on poverty. Bruno and Easterly (1998) conclude that inflation only has a significant effect on growth and poverty when it exceeds a certain threshold (often estimated at 15–20% per year). Below this threshold, the effects are weak or neutral. The work of Ghosh and Phillips (1998) suggests that the effect on poverty can be non-linear: low or moderate inflation is tolerable, even beneficial, but becomes harmful beyond a certain threshold. Khan and Senhadji (2001) consider the impact of inflation on growth and poverty to be non-linear, with negative effects appearing only above certain thresholds: for example, 1% for advanced economies and 11% for developing countries.

As for infrastructure, while essential for inclusive growth, it does not reduce poverty uniformly. Fan, Hazell, and Thorat (2000), using India as a case study, observe that investments in rural roads have a significant impact on poverty in underserved areas, but a very small one in areas already well-served by such infrastructure. Estache and Fay (2007) note that in areas already well-served by infrastructure, the marginal effect of infrastructure on poverty becomes small. Calderón and Servén (2010) find that infrastructure initially has high returns on poverty at low levels, but these returns decrease as coverage improves.

Public spending also has non-linear effects on poverty. For example, Sahn and Younger (2000) show, in the case of certain African countries, that social spending on health and education has a significant effect on poverty when it is well targeted. Furthermore, beyond a certain level of spending, its effectiveness on poverty decreases. Davoodi, Tiongson, and Asawanuchit (2003) emphasize that when public spending is poorly managed, an increase in its volume does not lead to a reduction in poverty. Efficiency, transparency, and targeting are essential to maintaining positive effects. Clements et al. (2004) add that the financing of public spending—through taxes, debt, and inflation—influences its effect on poverty. Baldacci et al. (2008) find that the effects of public spending on poverty reduction are initially positive, then become negligible or negative above 23–25% of GDP. In summary, public spending often has diminishing returns, and its effectiveness depends on institutional factors.

2.2. Relationship Between Institutions, FDI and Human Development

The idea that the effects of FDI vary according to the characteristics of the host country is already present in the work of Borensztein et al. (1998) and Alfaro et al. (2004). The former show that the technological benefits of FDI are conditioned by human capital, while the latter underline the importance of financial development. This work leads to considering FDI not as an automatic source of development, but as an investment whose effectiveness depends on certain prerequisites.Tanzi and Davoodi (1997) show that corruption can reduce the effectiveness of public investments by promoting projects determined more by particular interests than by their economic and social profitability. It can also increase the costs of projects and reduce their quality. Their contribution thus underlines that institutional quality conditions the ability of an economy to transform financial resources into economic and social results. This logic can be applied to IDEs. Githaiga and Kilong'i (2023) show that the effect of FDI on human development is moderated by institutional quality. Abor et al. (2024) show that institutional quality and financial development can be channels and factors for strengthening the effect of FDI on financial inclusion. The authors note in particular that the positive effect of FDI is greater in countries characterized by better institutional quality. Afolabi and Raifu (2024), shows that institutional quality amplifies the effect of FDI on employment in sub-Saharan African countries. These results are consistent with Borensztein et al. (1998) and Alfaro et al. (2004), which respectively emphasize the importance of the institutional quality of human capital and financial development in the transformation of FDI into economic benefits. Similarly, Ha et al. (2024) show that the institutional environment plays a decisive role in the relationship between FDI and human development. Matima and Gossel (2023) also shed important light on the African context and conclude that reducing political risk and improving institutional quality promote the attractiveness of FDI.

The work of Acemoglu and Johnson (2005) and Ali et al. (2010), using more sophisticated econometric techniques, including two-stage least squares (2SLS), demonstrates that in some contexts, institutions are not the primary determinant of FDI. Their research highlights the importance of considering other factors, such as natural resource endowments and the existence of trade agreements. The study by Saidi et al. (2013), using the GMM method in the MENA region, confirms the importance of corruption control and government effectiveness in attracting FDI and reducing poverty. Their results emphasize that improving institutional quality is a prerequisite for FDI effectiveness in poverty reduction. Anyanwu and Yameogo (2015), using a dynamic panel model, confirm the importance of governance and economic stability in attracting FDI in Africa. Rodríguez-Pose et al. (2017) argue that institutional quality is a determining factor in attracting FDI to Africa, while highlighting regional specificities. Asiedu (2003), using fixed-effects panel models, demonstrates the significant impact of institutional quality on FDI attractiveness in Africa. His results particularly emphasize the importance of political stability and good governance.

However, empirical methods exist to capture non-linearity, notably threshold models (Threshold regression, Hansen 1999), Panel Smooth Transition Regression (PSTR) models, and quantile regressions. For example, Azman-Saini et al. (2010) apply threshold models to estimate the minimum level of institutional quality necessary for FDI to reduce poverty. Gohou and Soumaré (2012), in a study on sub-Saharan Africa, find that FDI has a significant effect on poverty reduction only in countries with relatively developed infrastructure. Other work has shown that the impact of FDI on poverty depends on a certain level of institutional strength (see Azman-Saini, Baharumshah, and Law, 2010; Farla, de Crombrugghe, and Verspagen, 2016). Alfaro et al. Nunnenkamp and Spatz (2004) note that the effect of FDI depends on the development of the financial sector in the region. Consequently, countries with weak banking systems fail to channel the benefits of FDI to the poorest segments of the population. Nunnenkamp and Spatz (2004) indicate that FDI has little impact on poverty in very poor countries due to its weak interaction with their economies. Rather, the effects are strongest in middle-income countries. Herzer, Hühne, and Nunnenkamp (2014), in a study of 21 developing countries, find that FDI reduces poverty up to a certain point, beyond which its effect becomes insignificant. This result can be explained by sectoral concentration effects and negative externalities on local workers.

Alfaro's (2003) work distinguishes the effects of FDI according to sector. For example, FDI in the manufacturing sector has a more redistributive effect than that in natural resources. Carbonell and Werner (2018) show that the effects of FDI on employment and poverty reduction vary according to the degree of integration of activities. Thus, an excessive concentration of FDI in weakly integrated activities can have a neutral or even negative effect. More recent work by Nounamo (2018), using smooth transition models (STR), has highlighted the non-linearity of the relationships between corruption, FDI, and economic growth. Kouamé (2023), using a threshold regression model (TRR), reveals the existence of a critical threshold of institutional quality beyond which the impact of FDI on poverty reduction becomes significant in the WAEMU.However, the empirical work devoted to the nonlinear relationship between FDI and human development remains relatively limited in the specific context of WAEMU. Previous studies generally focus either on the direct effects of FDI and institutions, or on threshold relationships without explicitly considering a gradual transition between regimes. Literature also remains limited on the endogenous identification of a level of institutional quality around which the effect of FDI on human development evolves in the WAEMU area. The study of stylized facts could justify the choice of a PSTR model developed by González et al. (2005). This model will then allow to see if the relationship between FDI and human development is gradually changing with institutional quality and to estimate the institutional level characterizing this transition.

3. STYLIZED FACTS

3.1. Evolution of human development and institutional quality in WAEMU countries

The graph shows an overall reduction in poverty, as measured by the Human Development Index (HDI), for WAEMU

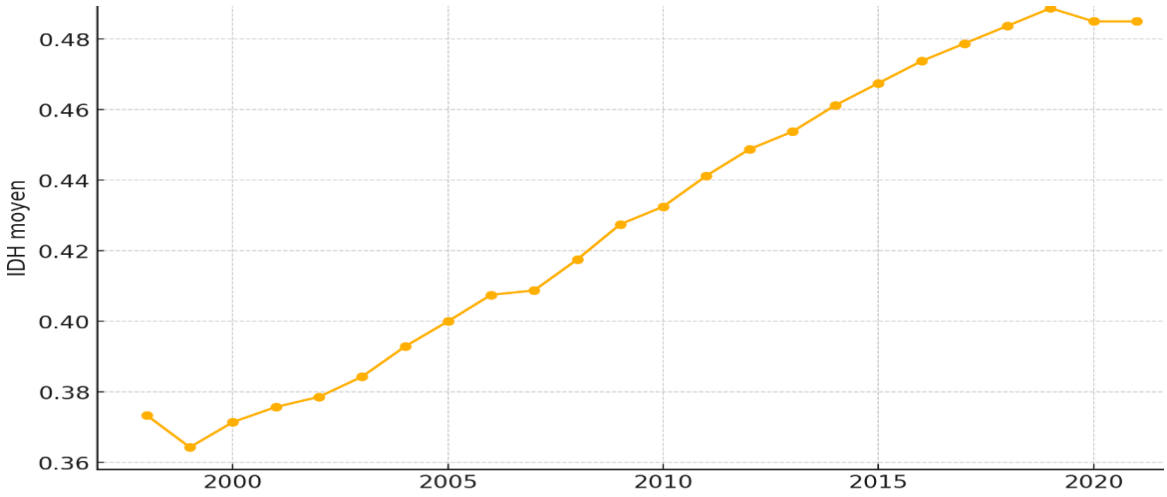

Fig. (1). Evolution of human development in the WAEMU countries. Source: Authors based on data from the BCEAO and the World Bank.

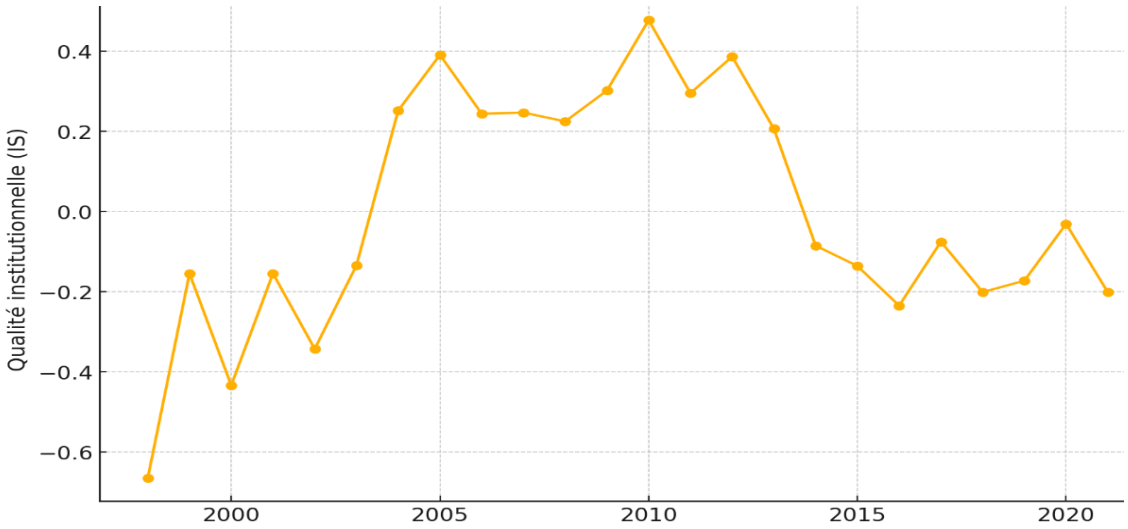

Fig. (2). Evolution of institutional quality in WAEMU countries. Source: Authors based on data from the World Bank.

countries from 1998 to 2023. First, there is a general downward trend inhuman development: the average HDI has increased steadily, reflecting improvements in health, education and living standards in WAEMU countries.

Furthermore, economic and social progress has been achieved through efforts to improve access to education, healthcare, and infrastructure. However, certain periods have shown stagnation or slowdowns in human development, likely due to regional or global economic crises, internal conflicts, or epidemics, such as the Ebola outbreak of 2014–2016.

Finally, a slight stagnation or increase inhuman development is observed around 2020-2023, reflecting the negative effect of the COVID-19 pandemic on the economies and health systems of WAEMU countries.

The graph shows the evolution of institutional quality in WAEMU countries from 1998 to 2023. The data indicate significant fluctuations over the years. In 1998, institutional quality was at a low level of -0.6, marking an initial decline marked by political and economic crises, such as the devaluation of the CFA franc and the conflicts in Côte d'Ivoire. A notable improvement occurred between 2000 and 2007, peaking at 0.4 in 2007, due to favorable political and economic reforms. From 2009 to 2014, the institutional variable remained relatively stable, fluctuating between 0.2 and 0.4. These fluctuations were due to ongoing reforms and security challenges, particularly terrorism in the Sahel. However, from 2015 to 2020, this variable showed a downward trend, reaching approximately -0.2 in 2020, due to political and economic instability, and the COVID-19 pandemic caused major economic and institutional disruptions. Security instability remained a challenge, particularly in Mali and Burkina Faso. Internal factors, such as political reforms and the fight against corruption, and external factors, such as commodity price fluctuations and global economic crises, all influenced this trend. Regional integration through the WAEMU and international support also played crucial roles in improving governance and institutional resilience.

2.2. Analysis of the relationship between institutional quality and FDI flows

Fig. (**3**) shows a general relationship between institutional quality (IS) and FDI flows. The trend line indicates a slight positive correlation: as institutional quality increases, FDI

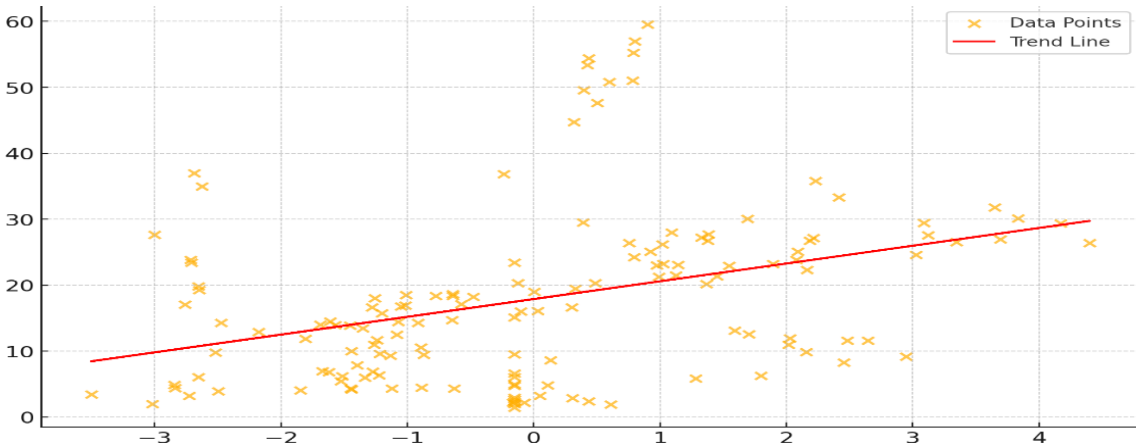

Fig. (3). Relationship between the quality of institutions and FDI flows. Source: Authors based on data from the BCEAO and the World Bank.

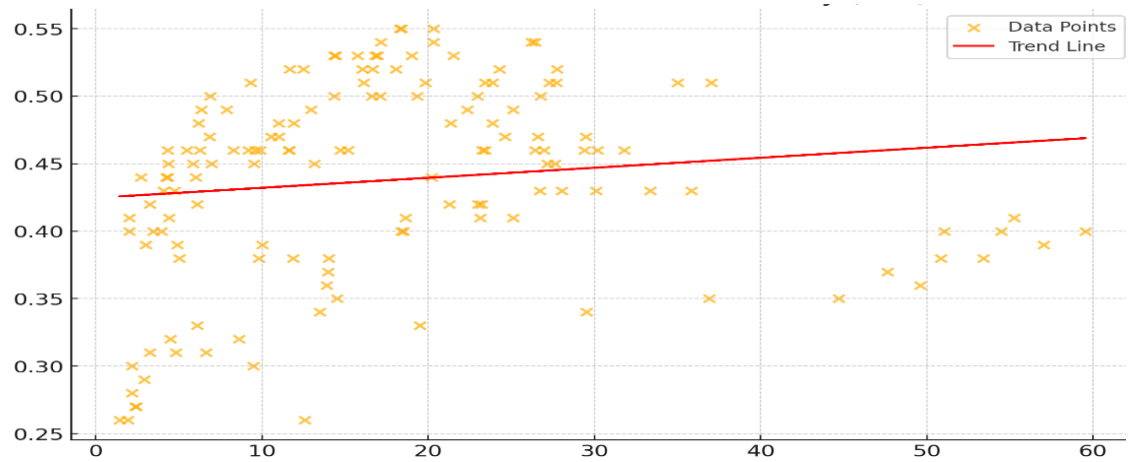

Fig. (4). Relationship between FDI and human development. Source: Authors based on data from the BCEAO and the World Bank

flows also tend to increase. However, the significant variability of the data points around the trend line suggests that other factors also influence FDI flows. Countries with higher-quality institutions appear to attract more FDI, but this relationship is not strictly linear.

Fig. (**4**) suggests a non-linear relationship between FDI and human development(HDI) in WAEMU countries. The dispersion of the data and the variations around the trend show that FDI does not have a linear effect on the HDI.

The use of panel threshold regression models (PSTR) makes it possible to capture these dynamics and better adjust policies to maximize the benefits of FDI in order to reduce poverty.

3. ECONOMETRIC METHODOLOGY

3.1. Presentation of the Model and Estimation Procedure

Studying the influence of institutional quality on the relationship between foreign direct investment (FDI) and human development requires an appropriate econometric model. According to Asongu et al. (2019), these divergent effects suggest critical thresholds where the influence of FDI changes. To analyze this relationship in WAEMU countries, we use panel data smooth transition regression (PSTR) models from Gonzalez *et al.* (2005), which capture threshold effects and gradual transitions between economic regimes. This approach allows us to understand how institutional quality affects the FDI-human development relationship by identifying turning points.

Presentation of the PSTR Model

Threshold effect models are a tool for analyzing nonlinear economic phenomena. They allow economic series to exhibit different dynamics depending on the regimes in which they evolve. The transition mechanism for moving from one regime to another uses an observable transition variable, a threshold, and a transition function.

According to the literature on threshold models, two main models are used for panel data: the model proposed by Hansen (1999) and that of Gonzalez et al. (2005), the latter being an extension of the former (Landry &Cédric, 2018). Hansen's (1999) PTR model assumes an abrupt transition between regimes. In other words, one enters one regime or the other without any intermediate steps. However, this transition may be more gradual than abrupt. The PSTR model proposed by Gonzalez et al. (2005) allows for modeling situations where the transition from one regime to another is gradual. Thus, the transition function is a continuous function rather than an indicator function. In the context of this study, gradual transition models (PSTR) are more appropriate for describing changes

in economic behavior induced by quantitative regime variables for two reasons. The PSTR model allows us to account for the heterogeneity of the relationship between Foreign Direct Investment (FDI) and human development, which is conditioned by institutional quality. The simplest case of the PSTR model, with two extreme regimes and a single transition function, is defined as follows:

$$y_{it} = \mu_i + \beta_0 X_{it} + \beta_1 X_{it} g(q_{it}, \gamma, c) + \delta_0 z_{it} + \varepsilon_{it} (1)$$

Where $i = 1 \ldots N$ denote the cross-sectional dimension and $t = 1 \ldots T$ the temporal dimension of the panel.y_{it}(The Human Development Index (HDI) is the dependent variable, $X_{it}$the Synthetic Index (SI) variable $i$at $\mu_i$time $t$represents the country's fixed effects,$z_{it}$is a vector to$k$dimensionsof exogenous variables that vary over time,$\beta_0 et \beta_1$denote respectively the parameter vectors of the linear and nonlinear models and $\varepsilon_{it}$is the residual term.

$g(q_{it}, \gamma, c)$ is the transition function, whereq_{it}represents the threshold variable; the parameter γthat determines the smoothness of the transition from one regime to another; and$c$is the threshold parameter (institutional quality threshold). In order to define the functional form of the transition function, González et al. (2005), following Granger and Teräsvirta (1993), suggest using a logistic transition function of order n $m$with the following form:

$$g(q_{it}, \gamma, c) = \left(1 + \exp(-\gamma \prod_{j=1}^{m} (q_{it} - c_j))\right)^{-1} (2)$$

With $\gamma > 0$ $et c_1 \leq c_2 \leq \cdots \leq c_m$where $c_j = (c_1, \ldots, c_m)$ is a vector grouping the threshold parameters and γrepresents the smoothing parameter assumed to be positive. The order of the transition function has a direct impact on the transient dynamics between the extreme regimes. From an empirical point of view, González et al. (2005) indicate that it is usually sufficient to consider $m = 1$(the model exhibits two regimes) or $m = 2$ (the model exhibits three regimes).

If $\gamma \to \infty$ the logistic transition function tends towards an indicator function and the PSTR corresponds to a Hansen (1999) PTR model with two regimes .

$$\lim_{\gamma \to \infty} g(q_{it}, \gamma, c) = \mathrm{I}_{(q_{it} \geq c)} = \begin{cases} 1 \; si q_{it} \geq c \\ 0 \; si q_{it} < c \end{cases} (3)$$

$$y_{it} = \mu_i + \beta_0 IS_{it} + \beta_1 IS_{it} \mathrm{I}_{(q_{it} \geq c)} + \delta_0 z_{it} + \varepsilon_{it} (4)$$

If $\gamma \to 0$ the logistic transition function tends towards an indicator function and the PSTR reduces to that of a panel with individual fixed effects, then in general, the impact of institutional quality on FDI and human development can be defined as a weighted average of the parameters $\beta_0 et \beta_1$. Consequently, it is generally difficult to directly interpret the values of these coefficients. We can, however, interpret the signs of these parameters, as they indicate the direction of the impact of institutional quality on FDI and poverty. For example, if the transition variable q _it is different from institutional quality (IS_{it}), then the sensitivity of poverty to foreign direct investment for the ith country at time t is defined as follows:

$$e_{it} = \frac{\partial y_{it}}{\partial IS_{it}} = \beta_0 + \beta_1 g(q_{it}, \gamma, c) (5)$$

When the transition variable q_{it}differs from the explanatory variables, the sensitivity of FDI, and consequently poverty, to institutional quality is defined by:

$$\frac{\partial y_{it}}{\partial IS_{it}} = \beta_0 + \beta_1 g(q_{it}, \gamma, c) (6)$$

This means that the marginal effect of FDI on human development depends on the value of the transition function $g(IS_{it}, \gamma, \mathrm{c})$, which is determined by the synthetic index of institutional quality (IS).

3.2. PSTR Model Estimation Procedure

To estimate the PSTR model in this paperwork, we follow a three-step procedure recommended by Colletaz and Hurlin (2006) and Fouquau et al. (2008). In the first step, we perform a linearity or homogeneity test. This test aims to determine whether the threshold effect is statistically significant and to show that the relationship between the explanatory and explained variables can be represented using a regime-switching model. If linearity is rejected, the second step consists of determining the number of regimes or transition functions needed to capture the threshold effects. In the third step, we estimate the PSTR model using nonlinear least squares, which allows us to endogenously determine the optimal level of institutional quality.

The linearity test in the PSTR model of equation (6) consists of testing for $H_0 : \gamma = 0$ either or $H_0 = \beta_1 = 0$. However, under the null hypothesis, the test will not be the same in both cases, and the PSTR model contains unidentified nuisance parameters. One possible solution is to replace the transition function$g(q_{it}, \gamma, c)$by the Taylor approximation to order 1 around $\gamma = 0$ and testing an equivalent hypothesis in an auxiliary regression. We then obtain the following:

$$y_{it} = \mu_i + \beta_0^* IS_{it} + \beta_1^* IS_{it} q_{it} + \cdots + \beta_m^* IS_{it} q_{it} + \delta_0^* z_{it} + \varepsilon_{it}^* (8)$$

Or $\beta_1^*, \ldots, \beta_m^*$ represent the parameter vectors that are multiples of$\gamma \varepsilon_{it} = \varepsilon_{it} + R_m \beta_1^* x_{it}$, is $R_m$the residual of the Taylor approximation. The linearity test therefore amounts to testing an equivalent hypothesis. ($H_0^* : \gamma = 0$or $H_0^* : \beta_1^* = \cdots = \beta_m^*$) using test statistics based on Wald's Lagrange Multiplier and its Fisher version and on the Likelihood Ratio.

$$LM_W = \frac{NT(SCR_0 - SCR_1)}{SCR_0} \sim \chi^2(k) (9)$$

$$LM_f = \frac{(SCR_0 - SCR_1)/mk}{SCR_0/(NT - N - mk)} \sim F_{NT-N-mk}^{mk} (10)$$

$$LR = -2[\log(SCR_1) - \log(SCR_0)] \sim \chi^2(k) (11)$$

Where $SCR0$ denotes the sum of squared residuals of the constrained model (under the null hypothesis, i.e. linear panel model with individual effects) and $SCR1$ the sum of squared residuals of the unconstrained model (PSTR), N the individual dimension, T the time dimension, m the order of the logistic transition function and k the number of explanatory variables.

To determine the number of transition functions, or equivalently the number of regimes in the model, a residual nonlinearity test is performed. In this test, the null hypothesis of a PSTR model with a single transition function $(H_0 : r = 1)$is

compared to the alternative hypothesis of a PSTR model with at least two transition functions. $(H_0 : r = 1)$. Consider the $r = 2$following model:

$$y_{it} = \mu_i + \beta_0 IDE_{it} + \beta_1 IDE_{it} g(q_{it}^1, \gamma_1, c_1) + \beta_2 IDE_{it} g(q_{it}^2, \gamma_2, c_2) + \delta_0 z_{it} + \varepsilon_{it} (12)$$

The null hypothesis of no residual heterogeneity can be formulated as follows $H_0 : \gamma_2 = 0$. As previously mentioned, the PSTR model contains unidentified nuisance parameters. $g(q_{it}^2, \gamma_2, c_2)$Therefore, the transition function will be replaced by its Taylor expression around $\gamma_2 = 0$. This results in the following auxiliary regression:

$$y_{it}^* = \mu_i + \beta_0^* IS_{it} g(q_{it}^1, szrd\gamma_1, c_1) + \beta_1^* IS_{it} g(q_{it}^1, \gamma_1, c_1) + \beta_2^* IS_{it} g(q_{it}^2, \gamma_2, c_2) + \delta_0^* z_{it} + \varepsilon_{it}^* (13)$$

The hypothesis of no residual heterogeneity therefore amounts to testing the following null hypothesis:$H_0^*: \beta_1^* = \beta_2^* = 0$. Denoting $SCR0$ as the sum of squared residuals under H_0, i.e., in a PSTR model with a transition function, and $SCR1$ as the sum of squared residuals of the transformed model (13), the Wald, Fisher, and likelihood ratio tests can be calculated as before. Given a PSTR model with r^*transition functions, the procedure will consist of testing: $H_0: r = r^*$, against $H_1: r = r^* + 1$. If the null hypothesis is rejected, the model used is ill-specified. It must contain at least one additional transition function to capture the remaining heterogeneity. The procedure must then continue. Thus, the null hypothesis $H_0': r = r^* + 1$is tested against $H_1': r = r^* + 2$. This sequence of tests continues until the first acceptance of the null hypothesis of no residual heterogeneity H_0. After presenting the PSTR model and the estimation procedure we proceed to specify the model.

3.3. Model specification

The specification of the model used to estimate the parameters is presented in a functional form. In functional form, the equation to be studied can be written as follows:

$$\boldsymbol{y = f(IDE, IS, Infl, ouv, infra, IDE * IS, Dep)}$$

With:

$\boldsymbol{y}$: human development index, a synthetic indicator of the level of human development and well-being ;

$\boldsymbol{IS}$: :Is a synthetic index measuring the quality of institutions. This indicator is generated from the six variables of institutional quality, namely: control of corruption (CC), rule of law (ED), political stability and absence of violence (SP), voice and accountability (VR), quality of regulation (QR) and government effectiveness (EG) constructed by Kaufmann et *al*. (2013).

We combine these variables into an overall indicator of institutional quality using a principal component analysis (PCA) taking into account the respective weight of each variable (Bobo, 2018; Langevin, Knock, 2010; OuédraogoIdrissa, 2019).

$\boldsymbol{FDE}$: foreign direct investment, as a percentage of GDP;

$\boldsymbol{Infl}$: The inflation rate, represents the change in the prices of goods and services in the economy;

$\boldsymbol{ouv}$: The degree of openness, measured by the sum of exports and imports relative to GDP;

Infra: measures the number of mobile phone subscriptions per hundred inhabitants, reflecting the development of communication infrastructures, essential to attract FDI;

$\boldsymbol{IDE * IS}$: Interaction term between FDI and the quality of institutions;

$\boldsymbol{dep}$: Public spending expressed as a percentage of GDP and includes government expenditures, excluding expenditures by public enterprises or state-owned companies;

In economic form, the regression model is as follows:

$$y_{it} = \beta_0 IS_{it} + \beta_1 IDE_{it} \beta_2 Infl_{it} + \beta_3 infra_{it} + \beta_4 open_{it} + \beta_5 Dep + \beta_6 IDE * IS_{it} + \sum_{j=1}^{r} \beta_1 IS_{it} g_j \left(IS_{it}^{(j)}, \gamma_j, c_j\right) (\theta_1 IDE_{it} + \theta_2 Infl_{it} + \theta_3 infra_{it} + \theta_4 open_{it} + \theta_5 Dep + \theta_6 IDE * IS_{it}) + \varepsilon_{it} (14)$$

In this specification, the institutional quality index (IS) constitutes the transition variable. The coefficients of the explanatory variables are allowed to differ between the institutional regimes, which makes it possible to see the heterogeneous effects according to the level of quality of the institutions.

Our analysis covers the period from 1998 to 2023 for 6 WAEMU member countries, with the exception of Guinea-Bissau and Burkina Faso due to data issues at the level of the human developmentindicator (HDI). We have a balanced panel.The annual data are collected from different sources namely: UNDP, BCEAO and World Bank.

4. MODEL ESTIMATION AND PRESENTATION OF RESULTS

4.1. Descriptive statistics and multicollinearity test of variables

The descriptive analysis of the variables in our sample highlights key points for the HDI, institutional quality, and FDI. The HDI, used as a human developmentindicator, the poverty proxy, has a mean of 0.43 with a standard deviation of 0.07. The maximum value is 0.55 (Benin, 2019) and the minimum is 0.26 (Niger, 1998). The institutional quality indicator has a mean of 0 points with a standard deviation of 1.74, ranging from -3.501 points (Togo, 2005) to 4.398 points (Senegal, 2002). The FDI stock represents on average 17.90% of GDP with a standard deviation of 13.13.

Table 1. Descriptive statistics of variables.

Variable	Observation	Average	Standard deviation	Minimum	Maximum
HDI	156	0.437	0.0722	0.26	0.55
IDE	156	17,901	13.136	1.4279	77,346
SyntheticIndicator (SI)	156	5.40e-17	1.7472	-3.501	4.398

Degree of openness	156	35,874	15,711	9.712	78.132
Infrastructure	156	47,790	43.881	0.012	162.170
Inflation	156	2013	2.434	-3.099	11.305
Public spending	156	12,068	3.065	7.416	17,793
IDE*IS	156	8.170	37,450	-99.570	122,507

Source: Authors based on data from the BCEAO and the World Bank and Stata15 software

Regarding the multicollinearity test (Table **2**), the VIF of the different variables is less than 10. Therefore, there is no multicollinearity problem and the coefficients are stable.

Table 2. Results of the multicollinearity test.

Variables	LIVELY	1/VIF
IDE*IS	5.64	0.1773
IS	5.58	0.1793
INFRA	1.62	0.6164
OPEN	1.52	0.6581
IDE	1.49	0.6693
DEP	1.28	0.7827
INFLA	1.08	0.9264
Mean VIF	2.60	

Source: Authors based on data from the BCEAO and the World Bank.

The descriptive analysis reveals significant variations in the variables of interest. In order to analyze the results obtained with the PSTR model, we must verify the model's suitability for two regimes by performing linearity tests and determining the number of thresholds.

4.2. Linearity Test Results

The first step is to verify the linearity of the model with respect to the PSTR using institutional quality as a transition variable. The hypotheses tested are as follows:

H_0: Linear Model;

H_1: PSTR model with at least one threshold variable;

The results of the linearity tests are recorded in the following table:

Table 3. Linearitytest.

Dependent variable	HDI	
Threshold variable	Synthetic Index of Institutional Quality	
Wald test (LM)	W=40.368	P value = 0.000
Fisher's test (LMF)	F = 6.330	P value = 0.000
LRT Test (LRT)	L = 47.372	P value = 0.000

Source: Authors based on data from the World Bank's WDI.

The LM, LMF and LRT tests allow rejection at a significance level of 5% (*P value < 0.05*).the null hypothesis of the linear model. Using the synthetic index of institutional quality as the threshold variable, we can therefore state with 5% ofrisk of being mistaken that there is a non-linear relationship between FDI and human development conditional on the variable of the quality of institutions considered within the WAEMU. This proves to be in accordance with the structures of the WAEMU economies. In a linear specification, the coefficient associated with FDI is assumed to remain constant regardless of the level of institutional quality. Such an assumption implies that an additional unit of FDI would have the same marginal effect on human development in countries characterized by very different institutional environments. This assumption can be restrictive, especially in developing economies where the institutional quality greatly varies between countries and over time.

4.3. Results of the Regime Number Tests and Model Estimation results

Given that the linearity assumption is rejected, the second step is to determine the optimal number of transition functions needed to capture the non-linearity of the relationship between FDI and human development, the proxy variable of poverty in the WAEMU space.

The assumptions are as follows:
$$\begin{cases} H_0 : \text{ PSTR model with r} = 1 \text{ et m} = 1 \\ \qquad\qquad vs \\ H_1 : \text{ PSTR model with r} = 2 \text{ et m} = 2 \end{cases}$$

If the null hypothesis is not rejected, the process is resumed, but this time by testing the following hypotheses:

$$\begin{cases} H_0(\text{r} = 1 \text{ et m} = 2) \\ \qquad vs \\ H_1\ (\text{r} = 3 \text{ et m} = 3) \end{cases}$$

The process stops only if the null hypothesis is accepted.

Table 4. Test for determining the number of regimes.

Dependent Variable	HDI	
Threshold variable	Synthetic Index of Institutional Quality	
Wald test (LM)	W=14.066	P value = 0.080
Fisher's test (LMF)	F = 1.543	P value = 0.150
LRT Test (LRT)	L = 14.801	P value=0.063

Source: Authors based on data from the BCEAO and the IMF.

These results show that the hypothesis with at least two thresholds is significantly rejected (*p-value > 0.05*) . Thus, a single threshold is sufficient to account for the non-linearity of the relationship between foreign direct investment and poverty in the WAEMU zone.

Table 5. Results of the PSTR model estimations.

Dependent Variable: Human Development Index						
Threshold variable	SyntheticIndicator					
Threshold (C)	-0.588					
Smoothingparameter γ	0.911					
	Regime 1 Regime 2					
IS		0.0329	(-3.654)		0.0019***	(0.7106)
IDE		-0.0016***	(-2.977)		0.0002***	(3.4188)
OPEN		0.0009***	(11,215)		0.0007***	(14,0881)
INFRA		0.0025**	(2.012)		0.0020**	(2.117)
IDE*IS		-0.0006	(-1.4845)		0.0167**	(1.8191)
DEP		-0.0067	(-0.7812)		0.0030**	(2.4002)
INFL		0.0711	(1.2034)		0.0050**	(2.3170)

Source: Authors based on data from the World Bank. **Note:** The values in parentheses ( ) are Student's t-values. *, ** and *** denote significance at 10%, 5% and 1% respectively.

4.4. Threshold Identification and Model Validity

The PSTR model estimation reveals an optimal institutional quality threshold of -0.588. This value, which minimizes the sum of squared residuals and the Akaike and Bayes information criteria, is consistent with previous studies on the WAEMU zone. Below this threshold, the estimated coefficient of FDI is negative, whereas above it, the coefficient becomes positive but remains small in magnitude. The results therefore suggest that the association between FDI and human development is conditional on institutional quality and evolves progressively as the institutional environment improves. The relevance of this threshold is explained by the general weakness of governance in WAEMU countries, as measured by the Worldwide Governance Indicators (WGI) on a scale of -2.5 to +2.5, and by the current context of the WAEMU zone, characterized by persistent governance challenges. The estimated transition parameter ($\gamma = 0.911$) further supports the existence of a gradual transition between regimes rather than a sharp discontinuity. Confirming the suitability of the PSTR model for this analysis.

4.5. Analysis of the Impact of FDI on Human Development According to Institutional Quality

In the first regime ($IS < -0.588$), FDI has a negative effect on human development, suggesting that low institutional quality prevents FDI from contributing to improvements in the HDI. Conversely, in the second regime ($IS \geq -0.588$), FDI has a positive, significant but very small, or even neutral, impact on human development. The marginal effect of foreign direct investments on human development is conditional on the quality of the institutions. The direct coefficient of FDI increases from -0.0016 in the first regime to 0.0002 in the second regime, indicating an attenuation of the negative effect of FDI when the institutional quality improves.This suggests that in a favorable institutional environment, FDI could contribute positively to improving the HDI.

Moreover, the interaction between FDI and the quality of institutions (FDI*IS) becomes positive and significant. The coefficient associated with the FDI×IS interaction term changes from -0.0006 in the first regime to 0.0167 in the second, which suggests that institutional quality gradually strengthens the contribution of FDI to human development. This confirms that improving the quality of institutions strengthens the beneficial effect of FDI on human development.

This non-linearity in the relationship between FDI and human development underlines the importance of institutional quality as a prerequisite for the effectiveness of FDI in improving the well-being of populations in the WAEMU zone.

5. DISCUSSION OF RESULTS AND VERIFICATION OF HYPOTHESES

The estimation methodology of Gonzalez et al. (2005) identified a significant endogenous threshold for institutional quality of -0.588 for the period 1998-2023. Above this threshold, FDI has a significant positive effect on the Human Development Index (HDI), indicating an amplified impact of FDI due to improved institutional quality. These results confirm the work of Kouamé (2023). Asongu *et al.* (2019) who show that FDI is more effective in strong institutional environments.

Analysis of control variables highlights the existence of a relationship between FDI and human development within the WAEMU, with institutional quality acting as a lever. Infrastructure has a positive effect on human development in both regimes, influenced by institutional factors. According to Calderón and Servén (2004), quality infrastructure stimulates economic productivity and improves access to basic services, directly contributing to human development. Inflation, on the other hand, has a positive and significant effect in the second regime. This difference suggests that better institutional quality allows for a more efficient transmission of inflationary

growth, the diffusion of which could contribute to human development within the WAEMU. Based on Fischer (1993) and Khan and Senhadji (2001), moderate inflation can stimulate economic growth in Africa. Regarding public spending, it has a significant positive effect only in the second regime, corroborating the findings of Tanzi and Davoodi (1997) on the importance of institutional quality and the effectiveness of such spending. The interaction between FDI and institutional quality becomes significantly positive in the second regime, highlighting the catalytic role of quality institutions in maximizing the benefits of FDI (Devarajan *et al*. 1996).

CONCLUSION

This paper examines the impact of foreign direct investment (FDI) on human development in the West African Economic and Monetary Union (WAEMU) over the period 1998-2023, with a focus on the role of institutions. Using a Panel smooth Transition Regression (PSTR) model and control variables drawn from the literature, we find non-linear effects of public spending, inflation, and FDI, with the effect of FDI depending on institutional quality. Thus, Institutional quality acts as a key moderating factor in the relationship between FDI and human development. To maximize the contribution of FDI, WAEMU countries should strengthen institutions, improve infrastructure, raise the efficiency of public spending, and deepen the integration of foreign investment into the domestic economy.

AUTHOR CONTRIBUTIONS

N'goran led the study conception, data curation, formal analysis, software development, visualization, and original drafting. Grekou contributed to methodology development, formal analysis, and result validation All authors provided resources, and validated findings and critically revised and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

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HIGHLIGHTS

Institutional quality plays an important moderating role in the relationship between FDI and human development.

Higher-quality institutions increase the effectiveness of these investments in human development determinant in poverty reduction.

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