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Effect of foreign direct investment on population health in Africa: Is there any threshold role of governance?

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Abstract

The aim of this paper is to evaluate the conditional effect of governance into Foreign Direct Investment (FDI) impact on population health captured by life expectancy at birth. The study covers a sample of 41 SSA countries and is conducted across three years of average data over the period 1996-2016. By using the "PTR model" as the main econometric model of analysis and the System GMMs estimator as an alternative technique, our findings show that governance does not have a threshold effect. Nevertheless, this study confirms the "halo hypothesis" of pollution in SSA. Moreover, governance measured by Kaufmann, Kraay and Mastruzzy indicators, plays a favorable mediating role in the nexus between FDI and population health.

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1. Introduction

Nowadays, several studies have investigated the effect of Foreign Direct Investment (FDI) on economic development. Many studies have focused on the effect of FDI on economic growth (Nguegang, Nembot Ndeffo and Ndjieunde 2019, Gui-Diby 2014, Shuaibu and Fowowe 2014, Othman Jafari and Sarmidi 2014, Brahim and Rachdi 2014, Jude and Levieuge 2013, Trojette 2016, Agbloyor and al. 2016, Zghidi and al. 2016, Malikane and Chitambara 2017, Ozekhome 2017, etc.) while its health effects are still little known or no sufficiently explored (Immurana 2020).

For the World Health Organization (2001), "Healthier workers are physically and mentally more energetic and robust, more productive, and earn higher wages. Their productivity makes companies more profitable, and a healthy workforce is important when attracting foreign direct investment". In that regards, the studies of Alsan, Bloom, and Canning (2006), Jorgenson (2009), Azémar and Desbordes (2009), Oster (2009) and Ghosh and Renna (2015) are some illustrations of the empirical studies addressing the effect of population health on FDI. Talukdar and Parvez (2017) show that improving life expectancy by one year increases gross FDI inflows by about 7% in 46 developing countries studied over the period 1996 to 2011.

Even though health is an integral part of development as underlined by United Nations (1980), to our knowledge, just a few and relatively recent studies have focused on the effect of FDI on health outcomes (Jorgenson 2009, Hitam and Borhan 2012, Nunnenkamp 2012, Herzer and Nunnenkamp 2012, Herzer, Nagel and Nunnenkamp 2015, Nagel 2015, Asiedu, Yi Jin, and Kanyama 2015, Alam and al. 2015, Golkhandan 2017, etc.). Most recently, Immurana (2020) has assessed the influence of FDI on health outcomes in Africa. Many authors (Immurana 2020, Burns and al. 2017, Herzer and Nunnenkamp 2012, etc.) have identified some channels by which FDI may affect population health positively. These channels are: income, knowledge, technology, corporate responsibility and so on (Burns et al. 2017, Herzer and Nunnenkamp 2012, Gentry 1998). However, the effects of FDI are like "Janus faces" insofar FDI can have either positive or negative effects. For Kawachi and Kennedy (1999), the positive effects expected from FDI increases through "the pollution halo hypothesis" the health outcomes, but FDI could give rise to greater inequality in the host countries which in turn leads to poor health through "stressful social comparisons"[1]. On the other point of view and most remarkably, inward FDI could be accompanied by a massive implantation of Multinational Enterprises (MNEs) and at the same time by an increase in environmental pollution which could deteriorates population health in host countries (Kheder 2010, Zhang and Fu 2008, Jaffe and al. 1995, Mabey and NcNally 1999, etc.). Briggs (2003) stated that about 8 to 9% of all diseases in the world can be attributed to pollution and the effects of this environmental pollution are more pronounced in developing countries than in developed countries This raises the issue of promoting FDI through incentives, which increasingly tends to involve setbacks or trade-offs that policymakers use to largely overlook (Nagel, Herzer and Nunnenkamp 2015). In fact, through moral judgment, Sen (1985) studied the relation between well-being, and agency with "persons characterized as rational agents of construction" and "having the moral power to have conception of the good". He saw that well-being and agency leads to a particular concept of freedom. Therefore, he pointed out some outcomes in terms of positive and negative freedoms that can arise because agency failure. Thus, Sen (1985) outlined a number of issues related to control and power that underlie the role of governance. According to Kaufmann,

[1] According to the "relative income hypothesis" people appreciate their well-being relatively to their peers. Therefore, health quality is not good in societies where income inequalities are bigger (Wilkinson and Pickett 2006).

Kraay and Mastruzzi (2008), “Governance consists of the traditions and institutions by which authority in a country is exercised” and “this includes the process by which governments are selected, monitored and replaced; this capacity of government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them”. But many of studies carried out in that effect concerned only developing countries. To our knowledge, apart from the studies of Bokpin (2017) or Herzer, Nagel and Nunnenkamp (2015) showing that governance captured by lax or strict environmental regulation - reflecting regulatory quality - increases the health outcomes of FDIs, very few studies have so far examined the mediating role of governance in this relationship with sufficient attention.

In the line of United Nations for Conference on Trade and Development (Unctad), an analysis along these lines leads to test empirically the halo or pollution havens hypotheses in sub-Saharan Africa (SSA) according to the great attractiveness of this region for MNEs (Unctad, 1999). Overall, related empirical studies of FDI and health and how they have neglected or not sufficiently considered governance given its role in influencing the effects of FDI on health. As the literature shows, apart from a few rare studies such as those by Eskeland and Harrison (2003), Bokpin (2017) or Lovely and Wang (2005) which emphasize the mediating role of the quality of regulation in the FDI host country, the role of governance remains very little explored mainly in its different dimensions. Moreover, conducting this study in SSA is all the more relevant as the level of inward FDI in this region has been steadily increasing since 2009 while the overall level of governance performance is slightly improving (Nguegang and al., 2019)

In order to address this issue, this article is structured around the following points: First, a review of the literature on the nexus between FDI and population health (section 2); secondly, the methodology and data of the study are presented (section 3); thirdly, the empirical results (section 4) and finally the conclusion (Section 5).

2. Literature Review

2.1 The negative effect of FDI on population health: *the pollution havens hypothesis*

The relocation of MNEs can be accompanied by highly polluting activities that alter the quality of the environment. By deteriorating the environment, MNE activities can be a major threat to population health quality (Kheder 2010). However, the flexibility or stringency of environmental regulations in FDI host countries may respectively encourage or discourage the establishment of MNEs.

The pollution "havens" hypothesis means in practice that FDI is directed towards regions where environmental policies are relatively weak or less stringent (Zhang and Fu 2008; Jaffe and al. 1995, Mabey and NcNally 1999). In the United States, for example, the cost of pollution has a moderate deterrent effect on FDI inflows (Keller and Levinson 2002).

The pollution "havens" hypothesis also assumes that environmental standards are strengthened with the income level of FDI host countries. This hypothesis reflects the shift of highly polluting industries from rich countries to developing countries (DCs) characterized by low environmental standards (Kukla-Gryz 2009). This is possible through trade or the free movement of capital (He and Yao 2016). In support of this argument, Kearsley and Riddel (2010) argue that the emission reductions observed in developed countries are partly the result of the relocation of "dirty" production to developing countries characterized by less stringent environmental standards and which cannot relocate their “dirty” production to other countries. This hypothesis is confirmed by Aliyu (2005), who explains that environmental policies are an important determinant of MNE location. For Condliffe and Morgan (2009), there is a correlation between low environmental standards and the location of new MME. In addition,

low or lax environmental standards attract FDI from highly polluting industries (Xing and Kolstad 2002). Smarzynska and Wei (2004), by improving data quality and taking into account the role of corruption, found a small but statistically significant effect of environmental regulations on investment decisions.

2.2 The positive effect of FDI on population health: *the pollution halo hypothesis*

The pollution haven hypothesis is not always empirically proven. Indeed, trade liberalization and FDI can lead to technology transfers that are favorable to improving the quality of the environment. Through a "pollution halo" effect, FDI can improve the quality of the environment (Zugravu 2012). Indeed, the phenomenon of globalization, materialized by a redeployment of FDI, promotes knowledge and technology transfers that can contribute to the improvement of the environment.

MNEs can be a vehicle for clean technology and thus contribute to environmental improvement in FDI host countries. According to Wallace (1996), Gentry (1998), Lagos and Velasco (1999), Zarsky (1999), such technologies can be transferred to domestic firms through externalities. Gentry (1998) argues that FDI in the agricultural sector in Costa Rica and Brazil, and in manufacturing in Costa Rica and Mexico has beneficial effects on environmental quality. Lagos and Velasco (1999) showed, in a study in Chile in 1970 and 1980, that two foreign firms outperformed domestic firms in terms of their effect on environmental quality. This is largely due to the use of "cleaner" technologies. This finding is reinforced by the study carried out in India by Ruud (2002), in which he shows that foreign firms are less polluting than domestic firms. Blackman and Wu (1999) show that FDI increases energy efficiency and contributes to pollution reduction in China.

Eskeland and Harrison (2003) argue that sometimes the MNE opts for more stringent environmental standards than those imposed by host country regulations. They explain that this happens when the MNE is concerned about its reputation or when it is costly for it to change the environmental standards applied in its home country.

Dean, Lovely and Wang (2005), in a study of China, find a completely different relationship to that predicted by the pollution haven hypothesis. The authors show that a less stringent policy is a significant determinant of the attractiveness of a Chinese location for joint ventures from similar countries, while industrialized countries, on the contrary, are attracted by higher and more stringent standards.

2.3 The net effect of FDI on population health: *Havens, halos and spaghetti*

Grossman and Krueger's (1993) seminal study identified a U-inverted relationship between certain health indicators, such as water and air quality. This means that pollution may initially increase with per capita income and then decrease with higher incomes. Indeed, when primary needs are met, a threshold level is reached where concern for the environment increases and the trend is reversed. From this point on, countries have the means and the will to reduce the level of environmental degradation and the use of resources to create wealth tends to decrease (Kheder and Zugravu 2012). Thus, Grossman and Krueger (1993) verify Kuznets' environmental curve. Kheder and Zugravu (2012) argue that there is no consensus in the literature on the evidence of "pollution havens". This leads to the "pollution halo" hypothesis. The establishment of MNEs results in an increase in production and consequently in increase of pollution. FDI can be accompanied by the transfer of new, relatively "clean" technologies when the host country has a good capacity to absorb the know-how. Thus, economic growth generated by technology transfer and environmental quality can simultaneously follow a predictable trajectory under the Kuznets environmental curve. Thus, for a relatively low level of per capita income, economic growth alters the quality of the environment. This deterioration

continues until it stabilizes at a middle-income level. From this level, more growth leads to an improvement in the quality of the environment. In sum, the transfer of technology conveyed by FDI has two effects: an upward effect and a downward effect on pollution. In other words, the "pollution havens" hypothesis and the "pollution halo" hypothesis can occur simultaneously.

Because of complementarities between improvement and environmental deterioration, environmental regularization can lead to an increase or decrease in investment in both the host country and the country of origin of the investment. This means that environmental regulation in the host country may lead an MNE to increase or reduce its investments both in the host country and in the country where environmental standards are less stringent (Eskeland and Harrison 2003).

3. Methodology and data

3.1 Estimation strategy

The model used in this paper is inspired by the seminal study of Kosack and Tobin (2006) which shows that FDI can have an indirect effect and that this effect can be conditioned by the level of governance; this leads us to introduce in the analysis model, cross variables of FDI with each of the six governance indicators of Kaufmann, Kraay and Mastruzzi. The dependent variable of the model is life expectancy at birth($Ev_{i,t}$). Indeed, this variable is one of the most widely used for studies in developing countries (Herzer and Nunnenkamp 2012, Burns and al. 2017).

$$Ev_{i,t} = \mu + \theta X_{i,t} + Fdi_{i,t}(Gov_{i,t} \leq \gamma)\beta_1 + Fdi_{i,t}(Gov_{i,t} > \gamma)\beta_2 + \mu_i + e_{it} \quad (1)$$

Equation (1) shows that with Hansen's (1999) Panel Threshold Regression (PTR), the level of population health is generated by two processes, depending on a certain threshold level of governance noted γ. X_t represents the set of control variables. The measurement of these explanatory variables comes from the literature (Alsan, Bloom and Canning 2006, Azémar and Desbordes 2009, Asiedu, Yi Jin, and Kanyama 2015, Ghosh and Renna 2015; Nagel Herzer and Nunnenkamp 2015) (See Table 1 for more information on variables). $e_{i,t}$ is the error term that measures the effect of variables not accounted in the analysis model. μ is fixed effect and μ_i is individual effect.

This equation can be rewrite as follow: $Ev_{i,t} = \mu + \theta X_{i,t}\, Fdi_{i,t}(Gov_{i,t}, \gamma)\beta + \mu_i + e_{it}$ (2)

Where $Fdi_{i,t}(Gov_{i,t}, \gamma) = \begin{cases} Fdi_{i,t} I(Gov_{i,t}, \leq \gamma) \\ Fdi_{i,t} I(Gov_{i,t}, > \gamma) \end{cases}$

Marginal effect or slope parameters satisfy: $\frac{\partial Ev_{it}}{\partial Fdi_{it}} = \begin{cases} \beta_1 & if\ Gov_{i,t}, \leq \gamma \\ \beta_2 & if\ Gov_{i,t}, > \gamma \end{cases}$

If γ is given, ordinary least-squares estimator of β is given by:

$\hat{\beta} = \{Fdi^*(\gamma)' Fdi^*(\gamma)\}^{-1}\{Fdi^*(\gamma)' Ev^*\}$ Fdi^* and Ev^* are whithin-group deviations. The residual sum of squares noted RSS is equal to $\hat{e}^{*\prime}\hat{e}^*$. γ, the value that minimizes the RSS, is estimated over a subset of the threshold variable $Gov_{i,t}$. It is equal to:

$\hat{\gamma} = arg_{\gamma} min S_1(\gamma)$

However, γ is unknown because of nuisance parameter problems which make nonstandard the distribution of γestimator's. Hansen (1999) has shown that $\hat{\gamma}$ is a consistent estimator of γ. He also proved that the best way to test γ=γ_0 is to use a confidence interval of "no-rejection region" with likelihood-ratio (LR) statistic with bootstrap.

$LR_1 = \frac{\{LR_1(\gamma) - LR_1(\hat{\gamma})\}}{\hat{\sigma}^2} \overset{Pr}{\rightarrow} \omega$ with $Pr(x < \omega) = \left(1 - e^{-\frac{x}{2}}\right)^2$

Given to significance level of α, the lower limit corresponds to the maximum value in LR series with is upper than α and the upper limit corresponds to minimum of LR series, with is less than α. The last one can be computed from the following function:

$$c(\alpha) = -2\log(1-\sqrt{1-\alpha})$$

If a single threshold hypothesis is validated, the same procedure is applied on the general model in order to identify the number threshold necessary to take in account all the non-linearity. The new H_0 hypothesis consists to test specification with r regime against specification with $r+1$ regime. This procedure is stopped when H_0 hypothesis is rejected.

Then, in order to ensure the robustness of the results obtained with Panel Threshold Regression (PTR model), we use system Generalized Moments Method (Syst-GMM) of Arellano and Bover (1991) as alternative estimator for two reasons: (i) Syst-GMM is able to control the presence of unobserved country-specific effects through first-difference transformation and (ii) it is able the simultaneity bias caused by potential endogeneity of the explanatory variables by using higher-order lag of regressors as instrument. The equation is as follows:

$$Ev_{i,t} = \mu_{i,t} + \beta Ev_{i,t-1} + \alpha_j Gov_{i,j,t} + \delta Fdi_{i,t} * Gov_{i,t} + \theta Gdp_{it} + \pi Pop_{it} + \sigma Hiv_{it} + \varepsilon_{it} \qquad (3)$$

In this equation, i represents the country i; j, one of six governance index and t the time index. $Evi,-1$ represents life expectancy at birth delayed by one period and $\boldsymbol{Fdi_{i,t}}*\boldsymbol{Gov_{i,t}}$ is the interactive variable that helps to measure the intermediate effect of governance into nexus between FDI and population health. To appreciate the relevance of instruments we use second order autocorrelation test of Arellano and Bond (1991) and Sargan test. For Roodman (2009), too many instruments can seriously weaken and bias restriction test on identification and, therefore, the rule of thumb is that the number of instruments should be less than the number of countries. $AR(2)$ allows us to test the validity of the hypothesis that the error term does not have a serial correlation. This is the case when $A(2)$ is less than 1.96. The over identification test of Sargan test helps to check validity of instruments.

3.2 Data and variables of the study

Data on most of the explanatory variables (dp, Fdi, Pop and Hiv) and dependent variable (Ev) are from the World Bank's World Development Indicators (WDI) database. The indicators measuring the level of governance come from another World Bank database obtained using the methodology of Kaufmann, Kraay and Mastruzzy (2008). This database is known as the Worldwide Governance Indicators (WGI). It contains the six governance indicators measured on a scale of -2.5 to +2.5. In this study, these indicators are expressed as percentages and therefore ranked on a scale of 0 to 100%3 . Table 1 below provides much more details on all the variables in the study.

The reasons behind the expected signs of the explanatory variables in Table 1 are provided by FDI literature (see, for example, Ghosh and Renna 2015, Alsan, Bloom and Canning 2006, Nagel Herzer and Nunnenkamp 2015, Azémar and Desbordes 2009, Asiedu, Yi Jin, and Kanyama 2015). The uncertainty concerning the sign of FDI is due to two situations. On one hand, FDI inflows may produce much economic growth and income which in turn would increase people's capabilities to afford more health-related goods and services (Immurana 2020, Golkhandan 2017, Herzer, Nagel and Nunnenkamp 2015, Asiedu, Yi Jin, and Kanyama 2015, Alam and al. 2015, Jorgenson 2009, Hitam and Borhan 2012, Nunnenkamp 2012, Herzer and Nunnenkamp 2012, etc.) or MNEs can vehicle clean technology and thus contribute to environmental improvement and therefore health outcomes improvement in FDI host countries (Wallace 1996, Gentry 1998, Lagos and Velasco 1999, Zarsky 1999, Blackman and Wu 1999, Ruud 2002, etc.). On the other hand, delocalization of MNEs can be accompanied by a high pollution activity that may affect environment negatively

and population health (Kheder, 2008, Zhang and Fu 2008; Jaffe and al. 1995, Mabey and NcNally 1999, etc.).

According to Asiedu, Yin Jin and Kanyama (2015), the larger the population, the more vulnerable it is to a health crisis. This finding explain the expected positive sign of growth rate of labour force. Regarding the signs of governance index, Lewis (2006) shows that health investments are insecure due to poor institutions, government failure, and a lack of transparency. This means that poor-quality of governance harm population health

. For the HIV variable, the expected sign is negative insofar as an increase in the number of adults over 15 years of newly infected with HIV/AIDS also reduces labor force and life expectancy at birth [Alsan, Bloom, and Canning (2006), Azémar and Desbordes (2009), Asiedu, Yi Jin, and Kanyama (2015)].

Table 1. Measurement of variables and expected signs

Variable	Definition/measurement	Expected sign	Sources
Ev	Average life expectancy of a newborn baby if mortality trends prevailing at the time of birth remained unchanged throughout his or her life.	Not applicable	WDI
GDP per capita, PPP (Gdp)	GDP per capita based on purchasing power parity (PPP). GDP is the sum of the gross value added of all resident producers in an economy plus all taxes on products, minus subsidies not included in the value of products. It is measured in current US dollars. PPP GDP is GDP converted to international dollars using purchasing power parity rates. GDP per capita is GDP divided by population at mid-2011.	+	WDI
Hiv	Number of adults over 15 years of age newly infected with HIV/AIDS	-	WDI
Foreign Direct Investment (Fdi)	FDI inflows in US dollars (voting stock of 10% or above)	+/-	WDI
Labour force Growth rate (Pop)	Measures the change in the population over a given period of time.	-	
Fighting against Corruption Control (Corrupt)	monitoring corruption measures perceptions of the use of public force for private gain, including both petty and grand corruption and the capture of the state by elites and private interests	+	WGI
Government Effectiveness (Bur)	Measures perceptions of the quality of public services, the quality of bureaucracy and its degree of dependence on political pressure, the quality of policy formulation and implementation, and the credibility of government commitments to such policies.	+	WGI
Political Stability ($PolS$)	Political stability measures perceptions of the occurrence of political instability and/or politically motivated violence, including terrorism.	+	WGI
Regulations quality ($RegQ$)	Regulatory quality is an indicator that measures perception of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development	+	WGI
Rule of Law (*Law*)	Measures perceptions of the quality of contract enforcement, police, and courts, as well as the occurrence of crime and violence.	+	WGI
Voice and Accountability ($Voice\&Ac$)	Measures perceptions of the ability of a country's citizens to participate in choosing their government, as well as freedom of expression, freedom of association and freedom of the media.	+	WGI

Notes: "-" means falling life expectancy at birth, while "+" means improvement in life expectancy. "+/-" means that both positive and negative effect can be observe. Thus in the regression, negative coefficients imply a deterioration in population health in terms of life expectancy as regards death rate and positive coefficients improvement of population health.

This study is conducted across 41 countries4 in sub-Saharan Africa, over the period 1996-2016. In order to minimize the effect of business cycles and to test the hypothesis of a dynamic effect of foreign direct investment (FDI) on population health, we use 3-year average data between 1996 and 2016 (Nagem Herzer and Nunnenkamp 2015; Nguegang, Nembot Ndeffo and Ndjieunde 2019). The mean centered period are as follows: 1996-1998, 1999-2001, 2002-2004, 2005-2007, 2008-2010, 2011-2013 and 2014-2016.

Table 2 (column 2, rows 11 to 16) shows that the correlation between FDI and the interaction variables of FDI with governance indicators is important. In other words, the simultaneous introduction of these variables is a source of multicollinearity. The same is true for the governance variables. Introduction simultaneously of Gov_j into the model causes multicolinearity (Table 2, column 5 to 10, row 5 to 10). On the other hand, the multicollinearity problem also arises when the cross interaction variables $Fdi * Gov_j$ are introduced simultaneously into the analysis model. For these reasons, the governance indicators as well as the cross-variables will be inserted one by one rather than simultaneously. In addition, the introduction of the variable Fdi and each of the governance level indicators Gov_j in the same model does not create any multicolinearity problems (Table 2, column 2, row 5 to 10).

Table 2: Test of significance of correlations

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1.	Ev	1.00															
2.	Fdi	0.03	1.00														
3.	Hiv	-0.12	0.51*	1.00													
4.	Pop	-0.22*	-0.02	-0.11	1.00												
5.	$Corrupt$	0.50*	0.02	0.11	-0.45*	1.00											
6.	Bur	0.51*	0.09	0.26*	-0.42*	0.87*	1.00										
7.	$PolS$	0.57*	-0.06	-0.10	-0.39*	0.71*	0.68*	1.00									
8.	$RegQ$	0.44*	0.13	0.20*	-0.30*	0.78*	0.87*	0.59*	1.00								
9.	Law	0.59*	0.04	0.08	-0.40*	0.88*	0.90*	0.80*	0.86*	1.00							
10.	$Voice\&ac$	0.55*	0.13	0.20*	-0.32*	0.77*	0.80*	0.71*	0.75*	0.83*	1.00						
11.	$Fdi * Corrupt$	0.10	0.75*	0.48*	-0.12	0.26*	0.32*	0.12	0.36*	0.26*	0.32*	1.00					
12.	$Fdi * Bur$	0.07	0.86*	0.50*	-0.10	0.18*	0.27*	0.06	0.33*	0.21*	0.28*	0.97*	1.00				
13.	$Fdi * PolS$	0.12	0.77*	0.47*	-0.11	0.23*	0.32*	0.12	0.36*	0.27*	0.32*	0.98*	0.98*	1.00			
14.	$Fdi * RegQ$	0.08	0.87*	0.50*	-0.09	0.18*	0.26*	0.06	0.30*	0.20*	0.29*	0.97*	0.99*	0.97*	1.00		
15.	$Fdi * Law$	0.14	0.79*	0.34*	-0.10	0.20*	0.25*	0.19*	0.28*	0.23*	0.27*	0.88*	0.88*	0.90*	0.88*	1.00	
16.	$Fdi * Voice\&Ac$	0.08	0.78*	0.51*	-0.13	0.22*	0.32*	0.09	0.34*	0.25*	0.30*	0.98*	0.98*	0.99*	0.97*	0.89*	1.00

Notes: * represent variables that are significant at least at 5%.

The correlation between life expectancy at birth (Ev), and the annual growth rate (Pop) is negative and significant at the 5% threshold (Table 2, column 1). This suggests an inverse relationship consistent with the idea of the demographic dividend. Ev is also positively correlated with $\mathrm{Gov_j}$. These correlations have a significance of 5%. Furthermore, the correlations between Ev and the cross variables $Fdi * Gov_j$ and the correlation between Ev and Fdi are positive but not significant (Table 2, column 1). Finally, the correlation between Ev and HIV/AIDS prevalence rate (Hiv) is negative but not significant (Table 2, column 1).

4. Empirical results

4.1 Threshold Validation Test Result

The homogeneity test of the analysis model shows that in sub-Saharan Africa, the relationship between FDI and population health is non-linear (Table 3). In other words, no governance variable exerts a threshold effect in the analysis of the health effect of the FDI. In fact the *p-value* associates to each *LR* statistic shows non significativity for "Fighting against corruption", "Government effectiveness", "Political stability", "Regulation quality", "Rule of law" and "voice and accountability". So the "PTR model" must be considered as simple panel model.

Table 3: Test for non-linearity of governance indicators

	Single threshold test, SSA					
	(Cprrupt)	(Bur)	(PolS)	(RegQ)	(Law)	(Voice&Ac)
LR	11.92	11.61	15.21	12.35	13.48	10.64
p-value	(0.40)	(0.4000)	(0.2700)	(0.39)	(0.46)	(0.49)
Critical values						
10%	18.77	19.19	19.94	19.99	21.98,	18.29
5%,	21.55	23.75,	24.99	23.34	26.49	21.69,
1%	29.71	29.25	31.00	28.52)	31.54	28.31

Notes: LR represent statistic corresponding to Lagrange test and p-value probability associates to this statistic. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4.1 Analysis of results

As the results of the homogeneity test rejected the non-linearity hypothesis of governance in the effect of FDI on health, this relationship must be analyzed as linear. The results in Table 4 show that in this part of Africa, "Fighting against corruption" component contributes positively and significantly to the strengthening of the effect of the FDI on the population health. This result is robust for System GMM (Table 4, column 2). An analysis of the role of the "Government effectiveness" component shows that it has a positive and significant contribution to strengthening the effect of the FDI on health in sub-Saharan Africa. Although small in magnitude, an analysis of the role of "Political stability" in the health effect of the FDI shows that this role is positive and significant (Table 4, column 5). This result is robust for system GMM (Table 4, column 6). The same is true for "Quality of regulation" which shows a positive and significant sign (Table 4, column 7), robust for system GMM (Table 4, column 8). The "Rule of law", like the other components of the governance index, plays a positive and significant role in the effect of the FDI on health when its level is at least at 15.07% (Table 4, column 9). Finally, the "voice and accountability" also plays a positive and significant role in strengthening the effect of the FDI on population health when its level is at least at 28.36% (Table 4, column 11). This results is not really surprisingly as race to the bottom in terms of deteriorating social standards seems to be a less a pressing problem for countries with low income where FDI is more likely to improve local health conditions, if only because these conditions have traditionally or usually been much worse in lower income countries than in higher income countries (Herzer, Nagel and Nunnenkamp 2015).

The results also show that despite its relatively low level, governance positively and significantly affects the health of the SSA population (Table 4, Column 1, Column 3, Column 5, Column 7, Column 9 and Column 11). These results are robust for system GMM (Table 4, column 2, column 4, column 6, column 8, column 10, column 12), and support the results of the study by Klomp and Haan (2008). Above all, these results confirm the findings of Lazarova et Mosca (2007) who found that governance as measured by Kaufmann's indicators positively affects the life expectancy of population.

Table 4: *Estimation results for sub-Saharan Africa, 1996-2016*

VARIABLES	Dependent variable : Life expectancy at birth(Ev)											
	(Corrupt)		(Bur)		(PolS)		(RegQ)		(Law)		(Voice&Ac)	
	PTR	Syt-GMM	PTR	Syst-GMM	PTR	Syst-GMM	PTR	Syst-GMM	PTR	Syst-GMM	PTR	Syst-GMM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(mean) EV (t-1)		0.890***		0.889***		0.891***		0.876***		0.872***		0.819***
		(0.0376)		(0.0389)		(0.0349)		(0.0428)		(0.0416)		(0.0495)
(mean) Fdi∗Gov		7.55e-12***		7.32e-12***		7.59e-12***		6.68e-12***		8.15e-12***		6.15e-12***
		(2.38e-12)		(2.29e-12)		(2.42e-12)		(2.21e-12)		(2.50e-12)		(2.11e-12)
(mean) Fdi		6.41e-8***		6.22e-8***		6.5e-8***		6.5e-8***		6.45e-8***		5.1e-8***
		(2.43e-10)		(2.12e-10)		(2.6e-10)		(2.36e-10)		(2.5e-10)		(2.2e-10)
(mean) Fdi(Gov < γ)	9.30e-10***		4.19e-10		9.75e-10***		2.50e-08***		2.48e-10		4.73e-10	
	(2.88e-10)		(3.55e-10)		(2.85e-10)		(7.40e-09)		(3.34e-10)		(3.25e-10)	
(mean) FDI(Gov > γ)	8.87e-09***		2.21e-09***		6.18e-09***		9.85e-10***		2.06e-09***		1.92e-09***	
	(2.48e-09)		(4.64e-10)		(1.44e-09)		(2.87e-10)		(4.33e-10)		(4.31e-10)	
(mean) Gdp	0.000313***	3.05e-05	0.000332***	2.54e-05	0.000192*	-2.60e-06	0.000313***	3.02e-05	0.000321***	2.49e-05	0.000322***	5.54e-05**
	(0.000113)	(1.97e-05)	(0.000113)	(1.93e-05)	(0.000115)	(1.80e-05)	(0.000112)	(1.98e-05)	(0.000106)	(1.90e-05)	(0.000110)	(2.27e-05)
(mean) Hiv	-1.52e-05	-7.07e-06***	1.10e-05	-8.18e-06***	6.93e-06	-5.14e-06***	7.39e-06	-7.86e-06***	1.23e-05	-7.32e-06***	1.10e-05	-9.36e-06***
	(1.01e-05)	(1.51e-06)	(9.02e-06)	(1.68e-06)	(8.41e-06)	(1.34e-06)	(8.49e-06)	(1.68e-06)	(8.33e-06)	(1.52e-06)	(8.70e-06)	(1.77e-06)
(mean) Pop	0.526	0.897***	0.341	0.884***	0.302	0.834***	0.393	0.807***	0.722	0.895***	0.148	0.839***
	(0.472)	(0.142)	(0.470)	(0.140)	(0.458)	(0.128)	(0.477)	(0.134)	(0.443)	(0.136)	(0.459)	(0.133)
(mean) Gov	0.0801**	0.0187**	0.0779**	0.0221**	0.0679**	0.0232***	0.132***	0.0204*	0.203***	0.0279***	0.139***	0.0387***
	(0.0310)	(0.00765)	(0.0383)	(0.00917)	(0.0273)	(0.00682)	(0.0415)	(0.0106)	(0.0364)	(0.00950)	(0.0375)	(0.0108)
Constant	49.34***	4.353**	48.75***	4.484**	49.50***	4.364**	47.05***	5.302***	43.82***	5.093***	47.01***	7.601***
	(1.794)	(1.811)	(1.795)	(1.865)	(1.639)	(1.765)	(2.036)	(2.016)	(1.795)	(1.957)	(1.718)	(2.329)
Threshold (γ)	**75.12**		**17.86**		**51.67**		**3.12**		**15.07**		**28.36**	
Sargan test		6.29		6.77		5.90		6.53		7.36		4.95
Sargan P-value		(0.000)		(0.001)		(0.000)		(0.004)		(0.000)		(0.000)
AR(2) test		-0.96		-0.99		-0.97		-0.93		-1.00		-0.66
AR(2) p value		(0.337)		(0.322)		(0.331)		(0.352)		(0.317)		(0.508)
Number of instrument		10		10		10		10		10		10
Number of observation	259	222	259	222	259	222	259	222	259	222	259	222
R Square	0.170		0.155		0.191		0.174		0.262		0.197	
Number of country	41	41	41	41	41	41	41	41	41	41	41	41

Notes: * $p < 0.1$, ** $p < 0.05$, ***$p < 0.01$. Values in parentheses represent standard deviations. For all the estimations, the number of instruments is less than the number of countries, so all instruments are validated (Roodman 2009). Moreover, there is no serial correlation of error terms as shown by $A(2)$ test. The Sargan test shows the validity of instruments.

5. Conclusion

This paper aims to investigate the mediating role of governance into the effect of FDI on population health in Africa. To achieve this goal, we used a threshold model named "PTR model" to evaluate this conditional role of governance in the FDI effects on health outcomes, especially on life expectancy at birth. Threshold validation tests on analysis models were not conclusive. Nevertheless, the results show that governance plays a mediating role without threshold effect in this nexus. Although of low amplitude due to scale of variables, this mediating role is positive in Africa countries as shown by results. In fact, the net effect of FDI on population health measured by life expectancy at birth has been shown to be positive. Although the literature presents a mixed effect of the FDI on the health of the population, the dominant effect of the FDI in Africa remains favorable to the well-being of populations. This result confirms the findings of some previous studies which plead for a favorable effect of FDI on the environment (Gentry 1998, Blackman et Wu 1999, Eskeland et Harrison 2003, Dean Lovely et Wang 2005). This reflects a dominance of positive effects of FDI than bad ones on population health. Thus, this finding makes it possible to validate the pollution "halo hypothesis" in Sub-Saharan Africa. Based on these results, we are tempted to say that the positive mediating effect of governance makes it possible to argue that environmental policies are less lax than one might think. But these results are not in line with the findings of Herzer, Nagel and Nunnenkamp (2015).

The results of this paper argue for the need to continue to promote FDI incentives, with the understanding that low-income countries are more likely to experience improved health standards as a result of a large influx of FDI. In order to avoid a long-term negative effect of FDI on health, policymakers when connecting incentives need to broaden the objectives of investment-promotion agencies to include, for example, health-related standards, rather than limiting to the solely objective to job creation. Thus, there is still considerable room of improvement when designing incentives suitable with sustainable development goals as stated Herzer, Nagel and Nunnenkamp (2015) and Unctad (2014).

As a result of this analysis, we believe it has some limitations that can be refined in future research. Indeed, the use of a population health indicator other than life expectancy at birth, such as the mortality ratio, may make it possible to improve the quality of these results for future studies. This approach allows us to check sensitivity of these results to changes in the dependent variable. At last, an extension of this analysis by carrying out a comparison between low-income and middle-income countries may make it possible to have another broader analysis grid.

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