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Foreign direct investment, bad governance and forest resources degradation: evidence in Sub-Saharan Africa

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Abstract This paper examines foreign direct investment's (FDI) effects on forest area change conditional on governance in Sub-Saharan Africa (SSA). This research is motivated by an apparent lack of attention on the unrestrained extraction of non-renewable natural resources in developing countries by multinational corporations in the empirical literature of pollution haven hypothesis. Using a panel data set of 38 SSA countries, over the period 1996–2011, this study reveals that FDI has a negative and significant net effect on forest area. The magnitude of this effect depends on the level of governance in these countries, despite the positive impact of governance indicators on forest preservation. This means that multinational corporations activities are associated with a lost of forest cover due to the low level of governance in SSA. Moreover, among the selected governance indicators, the findings suggest that in a regime where the rule of law and corruption control are not enforced, FDI leads to more forest degradation. More precisely, a marginal increase in the FDI stock (resp. flow) conditional on the average levels of rule of law and corruption control lead to a reduction of 6.63% (resp. 9.77%) and 5.74% (resp. 8.86%) respectively of forest cover per capita.

Keywords Sub-Saharan Africa · FDI · Forest degradation · Governance

JEL Classification F18 · F21 · O55 · Q23 · Q28

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1 Introduction

Since the last decade, foreign direct investment (FDI) flows to Africa and to the Sub-Sahara African (SSA) region in particular have increased. According to the 2009 World Investment Report (UNCTAD 2009), FDI inflows to the region rose from US$ 9 billion in 2000 to US$ 68.2 billion in 2007 and has reached US$ 88 billion its highest level in 2008. The SSA region is now the preferred destination with a share of 73% in 2008 against 64% in 2007. Although FDI represents a major funding source for Africa's development in bringing capital and new technologies, it can however be also a source of environmental degradation.

Nonetheless, the potential effects of FDI on the local environment of host developing country remain controversial (Meyer 2004). Some studies show that pollution-intensive industries from developed countries (with strict environmental regulations) tend to be relocated in the developing countries with low environmental regulation in order to reduce their abatement cost. This hypothesis known as the pollution haven, therefore argues that FDI aggravates pollution or environmental degradation in the host country (Mani and Wheeler 1998; Bommer 1999; Keller and Levinson 2002; Xing and Kolstad 2002; Cole 2004; List et al. 2003; Copeland and Taylor 1994; Dong et al. 2012; Tang 2015). In contrast, other studies find that FDI firms from developed countries bring modern technologies and good management practices which contribute to environmental improvements. These good management practices and advanced environmental technologies allow creating "pollution halos" in developing countries by reducing pollution (Christmann and Taylor 2001; Eskeland and Harrison 2003; Baek and Koo 2008).

These contradictory findings may be explained by the fact that these studies assume that local environmental regulation is exogenous with respect to multinational enterprises' relocations decisions. However, foreign firms may exert pressure and corrupt governments of the host countries in order to influence the environmental regulations in their favor (Cole and Fredriksson 2009). Indeed, Desbordes and Vauday (2007) have shown that multinational corporations derive substantial tax and regulatory advantages of their political influence and their ability to negotiate the best conditions for entry into the markets from 48 developing countries. Nevertheless, the political influence exerted by foreign firms decreases with the number of units of legislation guaranteeing a greater share of honest legislators (Cole and Fredriksson 2009).

Consequently, the effects of FDI on environmental degradation of host country depend on the level of institutional development (Wang and Chen 2014). Specifically, FDI will generate positive environmental externalities when the host country's institutions are developed. In other words, FDI halo effects will occur provided that the government gives more weight to welfare compared to bribe paid by the lobby group (Cole et al. 2006), which implies a good governance implementation.

The concept of governance or good governance refers to the process of decision-making and the one through which these decisions are performed. According to the World Bank, governance can be defined as "the manner in which power is exercised

in the management of a country's economic and social resources for development". This definition will be expanded to take into account all the aspects of governance. Kaufman et al. (2010) thus define governance as "the traditions and institutions by which authority in a country is exercised. This includes (a) the process by which governments are selected, monitored and replaced; (b) the capacity of the government to effectively formulate and implement sound policies; and (c) the respect of citizens and the state for the institutions that govern economic and social interactions among them".

In Africa, more precisely in SSA, good governance is a major challenge (Akokpari 2004). This challenge seems more important in the natural resources management, insofar as most African economies are characterized by weak law enforcement, government bureaucracy, and inefficient regulatory structures (Ezeoha and Cattaneo 2012). Oyefara (2013) shows that good governance has a significant impact on the environmental sustainability of the Lagos State in various environmental projects. He argues that good governance can allow this State to reverse the loss of natural resources and support the development of the environment.

His finding is particularly interesting in the implementation of forest management policy because forest resources are experiencing strong exploitation in SSA region, i.e. an annual loss of 3.4 million hectares between 2000 and 2010 (FAO 2010). The unrestrained exploitation of forest resources may be due to the increase of FDI inflows in all the Africa's sub-regions, which represents 29% of gross fixed capital formation in 2008 against 27% in 2007 (UNCTAD 2009). Indeed, according to the 2005 World Investment Report (UNCTAD 2005), in SSA, the percentage of FDI flows in the primary sector has increased significantly, ranging from 55 to 80% between 1996 and 2002. And the largest recipients of FDI are resource-rich countries (Angola, Nigeria and South Africa) which swallowed up about 65% of FDI flows to the region (UNCTAD 2009; Asiedu 2006).

Besides, several studies show that natural resources are the most significant determinants of FDI inflow in Africa. Examining the determinant of FDI into Africa, Onyeiwu and Shrestha (2004) find that the availability of natural resources promotes FDI inflows. Asiedu (2006) shows also that countries that are endowed with natural resources will attract more FDI into SSA. Hailu (2010) analyses the demand side determinants of the inflow of FDI to African nations. His results show that natural resources are also found to be a significant factor influencing FDI flows into Africa. Considering 53 African countries, Anyanwu (2012) concludes that natural resources endowments (especially oil) attract substantial FDI into Africa. Finally, Kariuki (2015) finds a positive and significant relationship between commodity price index (as proxy of natural resources endowment) and FDI flows into ASS.[1]

Therefore, FDI in SSA region is largely driven by natural resources which cause their unrestrained extraction in accordance with the third dimension of the pollution haven hypothesis (Aliyu 2005). Indeed, Aliyu (2005) proposed three dimensions of

[1] Commodity prices index refer to the price changes of commodities exported from developing countries in the food, agricultural, minerals, ores, metals, and energy sectors.

this hypothesis, the last focusing on the large-scale depletion of nonrenewable resources such as petroleum, timber, and other forest resources by multinational corporations in developing countries. For example, in the Congo Basin, deforestation and forest degradation are caused by timber industries, mining and biofuels industries (Megevand 2013).[2] Furthermore, this report also shown that institutional weaknesses have also contributed to forest degradation in the Congo Basin. The objective of this paper is therefore to examine FDI's effects on forest area change conditional on governance in SSA countries.

This paper is motivated by the fact that the previous studies have not taken into account the environmental degradation linked to the exploitation of natural resources in the pollution haven hypothesis (PHH). Thus, this research seeks to fill this gap by extending the PHH to forest cover degradation. Moreover, the analysis is also different from previous studies in dealing with the endogeneity bias of the interaction term FDI-Institution (governance) ignored in the literature. In fact, according to the PHH literature, FDI is an endogenous variable, therefore it is likely that the interaction term FDI-Institution be also endogenous (Wooldridge 2010, p. 133).

The main result is that FDI has a negative and significant net effect on forest area. The magnitude of this effect depends on the level of governance in SSA, despite the positive impact of governance indicators on forest preservation. This means that the activities of multinational corporations are associated with a lost of forest cover due to the low level of governance in SSA. Moreover, among the selected governance indicators, the findings suggest that a regime where the rule of law and corruption control are not enforced, FDI leads to more forest degradation. More clearly, a marginal increase in the FDI stock (resp. flow) conditional on the average levels of rule of law and control of corruption leads to a reduction of 6.63% (resp. 9.77%) and 5.74% (resp. 8.86%) respectively of forest area per capita.

The rest of the paper is organized as follows: Sect. 2 presents the conceptual framework and hypotheses of the research. Sect. 3 discusses the methodological problems. Section 4 analyses data. Results are presented in Sects. 5 and 6 concludes.

2 Conceptual framework and hypotheses

2.1 FDI and environmental degradation

FDI and environmental degradation relationship between developing and developed countries has been the subject of many theoretical and empirical studies with mixed results. Some studies have pointed a positive FDI's effect on the environmental degradation through a pollution haven effect because of the gap in national environmental standards, which creates "pollution havens" in developing countries

[2] The Congo Basin forests cover six countries: Cameroon, Central African Republic, Democratic Republic of Congo, Republic of Congo, Equatorial Guinea, Gabon. It includes about 70% of the forest of Africa area, either 300 million hectares. More than 99% of the forest area are made up of primary forests and 46% are dense forests of low altitude (Megevand 2013).

for dirty industries (Mani and Wheeler 1998; Bommer 1999; Keller and Levinson 2002; Xing and Kolstad 2002; Cole 2004; List et al. 2003; Copeland and Taylor 1994; Dong et al. 2012; Tang 2015). In contrast, other studies have found a negative effect of FDIs on the environmental degradation inasmuch as the global market forces constraint foreign companies to diffuse best management practices and advanced environmental technologies, creating "pollution halos" in developing countries (Christmann and Taylor 2001; Eskeland and Harrison 2003; Baek and Koo 2008).

The theoretical mechanisms underlying the two effects are based on economic growth processes in which FDI inflows play an important role in developing countries. Three different channels are discussed in the literature, including growth (scale effect), industrial composition (structural effect), and environmental technology spillovers effects (technique effect) (Grossman and Krueger 1995). The scale effect means that the increase in production is accompanied by pollution or another environmental degradation like forest degradation. Indeed, increasing production requires more input thus more natural resources are used in the production process, which contributes to environmental degradation (Dinda 2004). The structural effect refers to the changes in the patterns of economic activity that may occur when the country is open to the flow of external capital. This effect is the mechanism through which the PHH would affect pollution in the host country (Cole 2004). However, the way though which the structural effect affects the environmental degradation depends not only on a country's sources of comparative advantages but also of the stringency of its environmental regulation. Developing countries where environmental standards are more lax, attract the inflow of dirty foreign capital, leading to a greater proportion of polluting sectors in industrial composition (Wang and Chen 2014). In contrast, when developing countries are rich in cheap labor endowment, it may allow less polluting, labor-intensive industries to expand due to FDI inflows (He 2006). Finally, the technique effect describes technological changes in the production process. This change may be both direct by the transfer of advanced environmental technology (Christmann and Taylor 2001; Eskeland and Harrison 2003) and indirect through the enhancing of economic growth and hence an income increase induced by FDI inflows, which leads to environmental quality demand (Roca 2003).

Given the economic structure of SSA countries dominated by the natural resources endowments and more lax in environmental standards, I predict a greater pollution haven effect. In the 2000s, all African regions had enjoyed impressive economic growth, with average annual growth in 2006–2008 amounting to about 6% and gross domestic product (GDP) per capita growth of almost 4%. This strong economic performance has been due to a combination of favourable factors including high commodity prices and FDI inflows (African Economic Outlook 2010). As intended by scale effect, this strong growth has been accompanied by a serious environmental degradation. Indeed during the same period, Africa have experienced a strong forest area loss of 3.4 million hectares annually.

Concerning the structure effect, the composition of FDI inflows in ASS countries reveals that resource FDIs are more important than non-resource FDIs because most FDIs go to extractive industries (African Economic Outlook 2010). For example, in

2006, the bulk of Chinese FDI flows was directed in the mining, agriculture, forestry and fisheries sector (41.74%) while the sector of manufactured goods received only a marginal part (4.33%) (Kiggundu 2008). Between 2003 and 2007, over half of Chinese FDI flows in direction to Africa were absorbed by three resource-rich countries including Nigeria (20.2%), South Africa (19.8%) and Sudan (12.3%) (Renard 2011). The fact that natural resources are more extracted by foreign multinationals, leads to environmental degradation. In addition, as in ASS, environmental regulations are more lax, FDI therefore contribute to more environmental externalities, including forest degradation.

Finally, as resource FDIs are very capital intensive, one expects that they will lead to fewer spill-over effects into the non-resource sectors in the host SSA countries, which would reduce their direct effect of transfer of advanced environmental technology (Poelhekke and Van der Ploeg 2010). The combination of all these factors makes the negative side of the impact of FDI on SSA countries' local environments, particulary on forest area, more likely to appear. Thus, the first hypothesis is:

> Hypothesis 1: FDI has negative effect on the forest area for host SSA countries.

2.2 An institution-based perspective

The traditional argument of the PHH according to which the stringency of environmental regulation determines the patterns of FDI has limits insofar as multinational corporations can influence the environmental regulation of the host country (Desbordes and Vauday 2007). Thus, the net effects of FDI on local environments depend on the level of institutional development of the host country (Cole et al. 2006; Cole and Fredriksson 2009; Wang and Chen 2014). Indeed, the institutional development and governance of the host country including formal organizations (social, economic and political) and the standards and rules (North 1990; Scott 1995) influence the policies and behavior of multinational corporations (Wang and Chen 2014). They also determine the patterns of interaction between foreign and local firms; transfers of technology, resources and capacities of the local community; and economic, social and ecological systems of the country (Hoskisson et al. 2000; Cantwell et al. 2010; Zhu et al. 2013).

The institution-oriented approach is therefore relevant to understand the impact of FDI on environmental degradation in African countries where political and economic governance is a major challenge. On the political governance side, the rule of law and the protection of citizens from any kind of abuse, including abuse of political power are not guarantee because credible and independent courts are still rare in Africa. Furthermore, corruption remains a serious problem. And this affect negatively the local institutional effectiveness and accountability that are necessary to foster transparency and good governance in managing natural resources. According to a study conducted by the Commission of the African Union (AU) in 2009, corruption costs amount to up to 10% of Africa's resources-generated wealth (African Economic Outlook 2010). Concerning economic governance, the major

issues are the securing of land and property rights. Indeed, in SSA, only about 10% of rural lands are registered; the rest is undocumented, informally administered, and thus people are vulnerable to land grabbing and expropriation without adequate compensation (Byamugisha 2013). This low rate of registered land is due not only to bad governance but also to a long and difficult bureaucratic procedures which create enormous time and costs for property transfers (Toulmin 2009). For example, it takes about 334 days to register land rights in Angola (World Bank 2007). Securing land rights is essential for managing agricultural land and natural resources in oder to generate shared and sustained growth and eradicate poverty (Byamugisha 2013).

Institutional failure both at political and economic levels might be likely to exacerbate the negative environmental impact of FDIs. Moreover, the weakness of environmental regulation in SSA might be a motive for multinational corporations to not take into account environmental costs in their optimisation behavior, and this leads me to formulate the second hypothesis hereafter:

Hypothesis 2: The negative effect of FDI on forest area are amplified by governance failure in SSA countries.

3 Empirical analysis

3.1 Model specification

To test my hypotheses on the role of institution into FDI and forest degradation relationship, I use the reduced-form stemming from the theoretical framework developed in the study of Cole et al. (2006). These authors have indeed developed a lobby group model *à la* Grossman and Helpman (1996) in which the effects of FDI on environmental degradation is conditioned by the level of corruptibility in the host country. As part of this work, I extend this model by conditioning the effects of FDI on environmental degradation by the level of good governance as measured by several dimensions of institutional quality in the host country.

The reduced-form model thus is as follow:

$$\begin{aligned} Fa_{it} &= \beta_0 + \beta_1 FDI_{it} + \beta_2 GOV_{it} + \beta_3 FDI_{it} \times GOV_{it} + X'_{it}\theta + \varepsilon_{it} \\ \varepsilon_{it} &= \alpha_i + \lambda_t + \mu_{it}, \end{aligned} \tag{1}$$

where Fa_{it} is the rate of forest area change in the country i in year t, $i = 1,\ I$ and $t = 1,\ T$; $I = 42$, $T = 16$. FDI_{it} are the stocks and flows of inward foreign direct investment in the country i in year t. GOV_{it} is the level of governance indicator (Political Stability and Absence of Violence/Terrorism, Regulatory Quality, Rule of Law and Control of Corruption) in the country i in year t. X_{it} is a vector of control variables including GDP per capita, population growth rate, agriculture production index (API), official development assistance (ODA) per capita, forest rent, degree of openness. ε_{it} is the composed error term where α_i and λ_t denote any *unobservable*

country and time specific effects respectively and μ_{it} denote the remainder disturbance and varies over countries and time; $\mu_{it} \rightarrow iid(0,\ \sigma_{\mu}^{2})$.

3.2 Identification strategy

3.2.1 Endogeneity issues and choice of instruments

Some potential issues of endogeneity bias in the relationship to be tested have been raised in the literature of the PHH. The most prominent is the simultaneity issue in the environmental degradation and FDI relationship. Indeed, a host country may use environmental policy as a comparative advantage to attract FDI. To address this bias, I use two instruments for FDI: number of telephone mainlines (per 100 inhabitants) as a proxy of the level of infrastructure (Cole et al. 2011) and the financial system deposits which capture the level of financial development and the macroeconomic stability.

Infrastructure is a significant determinant of FDI because not only it affects investment almost at every stage of the investment process including input accusation, operation and market accession, but it reduces also the transaction costs faced by foreign investors. Some papers found a significant and positive effect of infrastructure on FDI inflows into SSA (Bartels et al. 2009; Hailu 2010; Kariuki 2015). I used telecommunication infrastructure (number of telephone mainlines per 100 inhabitants) to avoid any potential correlation with forest degradation.

Financial development can affect FDI through several channels including the allocative channel, the transaction cost reduction channel, the liquidity channel, and the financial enforcement contract channel. For example, through the allocative channel, financial intermediaries increase the productivity of capital by directing financial resources to projects with the highest rates of return, and by providing the mechanisms for risk reduction and diversification (Ncube 2007; Claessens and Laeven 2003). Within a financial system, deposit takers are central since they provide a convenient location for the placement and borrowing of funds and, as such, are a source of liquid assets and funds to the rest of the economy (IMF 2006). So, financial system deposits are a good proxy to capture financial development.

These instruments are economic determinants of FDI in developing countries and have no direct effect on the forest degradation process. I test the validity of these instruments using the Sargan–Hansen's over-identification test. This test assumes that instruments are exogenous under the null hypothesis.

3.2.2 Instrumental variables method

Since FDI is potentially endogenous then it might be that the interaction term $FDI_{it} \times GOV_{it}$ be also endogenous (Wooldridge 2010, p. 133). Unfortunately endogeneity on the interaction term was ignored in the literature on the PHH. Let Z denote the FDI's instruments vector, so that of the interaction term can be defined by $W = Z' \times GOV$.

Given that two explanatory variables are now endogenous in Eq. (1), the estimation of the model by the method of instrumental variables will require to

estimate two equations in the first stage of the IV method. Following Nunn and Qian (2014), the first equation to be estimated in the first stage of the IV method for FDI is:

$$FDI_{it} = Z'_{it}\Pi_1 + W'_{it}\Pi_2 + \tilde{X}'_{it}\theta + \eta_{it}, \quad (2)$$

where $\tilde{X}_{it}$ includes the governance and others control variables and $\eta_{it} \rightarrow iid(0,\ \sigma_\eta^2)$ a error term.

The other equation is for the interaction term $FDI_{it} \times GOV_{it}$. The only difference between the previous equation and this one is that the dependent variable is $FDI_{it} \times GOV_{it}$.

Finally, the model is estimated using a Fixed effects Three-Stage Least Squares estimator (FE3SLS). I use the fixed-effects estimation because it is preferred when the instruments variables that are uncorrelated with the error term, can be correlated with historical and environmental factors contained in the unobservable effects of each country (Wooldridge 2010, p. 353). This case is more likely to intervene in this analyse insofar as the economic determinants of FDI flows may be related to unobservable characteristics of each country including the historical links between foreign firms and recipient countries. For example, French multinational corporations would tend to invest more in Francophone African countries because of the historical ties between these countries. I use thereafter Newey and West (1987) method for a robust variance–covariance matrix in the presence of Heteroskedasticity and autocorrelation standard errors.

4 Data

I use panel data for 38 SSA countries over the period from 1996 to 2010 to test my hypotheses. Table 4 in the Appendix 1 provides all data sources and the Appendix 2 lists countries included in the sample.

4.1 Variables and measures

The dependent variable, rate of forest area change is the percentage of change in forest area per capita. It allows capturing forest degradation which is one of the major environmental degradation in the SSA countries (Bhattarai and Hammig 2001; Culas 2007). This variable has been divided by the population's size to minimize the bias that may occur when population is large relative to the available forest resources. Indeed, countries with a large population size and less size of forest will have a strong forest degradation due to increasing population and thus a low part of this degradation will be due to FDI. I use two measures of inward FDIs: flows and stocks as a percentage of GDP (UNCTAD 2010). The FDI flow variable allows capturing the effect of the new investments made on the changes in forest area while the FDI stock variable may better capture the overall effect of foreign investments. The stock variable is interesting in the sense that it allows taking into

account a possible delay between the investments made and its environmental effects (Cole and Fredriksson 2009).

Concerning the institution perspective, I use governance indicators because they are well suited to capture how decisions are made and how they are implemented by the selected governments. This is very important in the implementation of environmental policy. Theses indicators focus on three categories of measures of governance developed by Kaufmann et al. (2010). The first category is linked to the process by which governments are selected, monitored and replaced (Voice and Accountability Political Stability and Absence of Violence and/Terrorism). The second category reflects the government's ability to effectively formulate and implement sound policies (Government Effectiveness and Regulatory Quality). The last category covers the respect of citizens and state of the institutions that govern economic and social interactions (Rule of Law and Control of Corruption). In this study, I use the following indicators reflecting various aspects of governance: Political Stability and Absence of Violence/Terrorism, regulatory quality, rule of law and control of corruption. In fact, these indicators are relevant for the protection of forest resources in the context of SSA and they range from − 2.5 (low) to 2.5 (high performance). I consider a country as being in the category of less-performing countries in terms of governance if the value of the indicator is negative and good-performing countries in terms of governance when its value is positive.

In addition, I include several control variables, used in previous studies, which have a direct effect on forest degradation. For example, GDP per capita impacts forest degradation though the scale of economic activity. Agricultural production index (API) measures the agricultural production which is one of the main causes of deforestation and forest degradation in developing countries (Culas 2007). Population growth is also a determinant in explaining the loss of forest cover. I capture that effect though the rate of population growth (Bhattarai and Hammig 2001). Moreover, to capture the foreign aid effects on forest protection, I use the ODA per capita variable due to the lack of data on aid directly destinated to forest protection. These data come from WDI (2013) of the World Bank.

4.2 Descriptive statistics and correlation pairs

Tables 1 and 2 present the descriptive statistics and correlation pairs respectively.

Table 1 shows that the rate of forest area change (*Fa*) is negative (− 0.031) on average in SSA, which is an indication of forest degradation. However, the maximum value of this variable is positive (0.013). It indicates that some countries make an effort of afforestation and reforestation. According to the FAO (2010), the level of afforestation and reforestation in Africa amounted to 160,113 and 237,123 hectares per year respectively since 2005. FDI flows represent an average of 5% of GDP while stocks are at 42.14% of GDP, which supposes that stocks are expected to have more impact on forest degradation. As for governance indicators, Table 1 indicates that all the governance indicators are negative on average, lower than the world mean whose the value is zero. This means that the level of governance in SSA is low on average. ODA represents an average of US$ 53.71 per capita. The

Table 1 Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Fa	608	− 0.031	0.016	− 0.088	0.013
FDI_flow	608	0.050	0.119	− 0.829	1.618
FDI_stock	608	0.421	1.075	0.0005	12.699
GOV1	608	− 0.640	0.589	− 2.057	1.249
GOV2	608	− 0.646	0.611	− 2.413	0.893
GOV3	608	− 0.594	0.935	− 2.986	1.115
GOV4	608	− 0.729	0.673	− 2.229	1.057
ODA_PC	608	53.709	64.290	1.267	672.455

Variables GOV1, GOV2, GOV3 and GOV4 represent control corruption, regulatory quality, political stability and absence of violence and the rule of law respectively

ODA_PC is ODA per capita

Table 2 Correlation matrix

	Fa	FDI_Flow	FDI_Stock	GOV1	GOV2	GOV3	GOV4	ODA_PC
Fa	1.000							
FDI_Flow	− 0.051	1.000						
FDI_Stock	− 0.146*	0.327*	1.000					
GOV1	0.352*	− 0.088*	− 0.184*	1.000				
GOV2	0.190*	− 0.179*	− 0.304*	0.801*	1.000			
GOV3	0.243*	− 0.002	− 0.180*	0.666*	0.672*	1.000		
GOV4	0.277*	− 0.083*	− 0.247*	0.861*	0.862*	0.797*	1.000	
ODA_PC	0.241*	0.119*	0.129*	0.284*	0.116*	0.299*	0.265*	1.000

Variables GOV1, GOV2, GOV3 and GOV4 are control corruption, regulatory quality, political stability and absence of violence and the rule of law respectively. ODA_PC is ODA per capita. * $P < 0.05$

minimum and maximum values are US$ 1.26 and US$ 672.45 respectively characterizing a wide dispersion of aid.

Table 2 shows that FDI is negatively related to the rate of forest area change per capita, which is compatible with the PHH in the case of forest degradation. However, all the governance indicators are moving in the same sense that forest area protection. This is a proof of the importance of the quality of institutions in protecting environmental resources. Nevertheless, given the low level (negative values) of these indicators on average (Table 1), one may expect that foreign firms negatively influence the forest cover. This could be justified by the negative correlation between FDI and the good governance indicators consistent with the institutionalized pollution haven hypothesis. Moreover, ODA per capita is positively related to the increase in forest cover, which suggests that ODA is more directed towards green policies in SSA.

5 Results

Table 3 reports results of Fixed effects (FE) 3SLS estimates of model using both stock and flow measures of FDI.

Table 3 Estimation results

Dependent variable: forest area change (*Fa*)								
	(1) Stock	(2) Flow	(3) Stock	(4) Flow	(5) Stock	(6) Flow	(7) Stock	(8) Flow
FDI	− 0.0765***	− 0.159**	− 0.0492**	− 0.174*	− 0.0458***	− 0.0780*	− 0.0870***	− 0.169**
	(0.0260)	(0.0763)	(0.0202)	(0.0953)	(0.0176)	(0.0414)	(0.0322)	(0.0780)
FDI × GOV1	− 0.0299***	− 0.110**						
	(0.0115)	(0.0526)						
GOV1	0.00657	0.00513*						
	(0.00567)	(0.00301)						
FDI_GOV2			− 0.0208**	− 0.101*				
			(0.00841)	(0.0549)				
GOV2			0.00878***	0.00776**				
			(0.00306)	(0.00377)				
FDI_GOV3					− 0.0141***	− 0.0379*		
					(0.00533)	(0.0194)		
GOV3					0.00386**	0.00258**		
					(0.00153)	(0.00102)		
FDI_GOV4							− 0.0284***	− 0.0977**
							(0.00985)	(0.0454)
GOV4							0.00636	0.00825***
							(0.00387)	(0.00299)
GDP	− 0.00572**	− 0.00240	− 0.00315*	− 0.00168	− 0.00801***	− 0.00831**	− 0.00734**	− 0.00510*
	(0.00231)	(0.00156)	(0.00173)	(0.00163)	(0.00263)	(0.00419)	(0.00329)	(0.00271)
API	0.0102***	0.00737**	0.00653**	0.00734**	0.00922***	0.00940**	0.0105**	0.00825**
	(0.00366)	(0.00302)	(0.00280)	(0.00334)	(0.00340)	(0.00414)	(0.00525)	(0.00355)
POP_GROW	− 1.199***	− 0.931***	− 1.010***	− 0.875***	− 0.858***	− 0.809***	− 1.130***	− 0.869***
	(0.208)	(0.0645)	(0.0961)	(0.0721)	(0.0838)	(0.0896)	(0.161)	(0.0720)
ODA_PC	0.00112	0.000235	0.000653	− 0.00017	0.00144*	0.000724	0.00144	0.000161
	(0.000939)	(0.000646)	(0.000657)	(0.000745)6	(0.000808)	(0.000593)	(0.00110)	(0.000712)

Table 3 continued

Dependent variable: forest area change (*Fa*)								
	(1) Stock	(2) Flow	(3) Stock	(4) Flow	(5) Stock	(6) Flow	(7) Stock	(8) Flow
FRST_RENT	0.113* (0.0623)	0.0493* (0.0284)	0.0497* (0.0288)	0.0399 (0.0243)	− 0.00365 (0.0240)	0.0325 (0.0218)	0.114 (0.0744)	0.0649* (0.0347)
OPEN_DEGREE	0.0329* (0.0178)	0.0151 (0.00979)	0.0171* (0.00908)	0.0118 (0.00993)	0.0240* (0.0127)	0.00838 (0.00795)	0.0399** (0.0176)	0.0147 (0.0109)
Observations	608	608	608	608	608	608	608	608
Centered R^2	− 0.562	0.129	0.218	0.094	0.037	0.193	− 1.009	− 0.032
Number of ident	38	38	38	38	38	38	38	38
F-test on IVs	3.84 [0.0043]	4.17 [0.0024]	4.57 [0.0012]	3.13 [0.0252]	3.21 [0.0127]	2.73 [0.0432]	2.40 [0.0489]	2.83 [0.0243]
DWH endogeneity test: χ^2 (dl)	6.275 [0.0434]	5.990 [0.0144]	4.436 [0.0352]	5.782 [0.0162]	8.508 [0.0035]	5.776 [0.0162]	9.074 [0.0107]	8.252 [0.0041]
Sargan–Hansen test: χ^2 (dl)	1.604 [0.4485]	4.110 [0.2498]	5.768 [0.1234]	3.830 [0.1473]	6.062 [0.1086]	4.503 [0.1052]	0.216 [0.8977]	3.370 [0.3381]

3SLS are reported. Columns present the results for each governance indicator. Variables gov1, gov2, gov3 and gov4 are control corruption, regulatory quality, political stability and absence of violence and the rule of law respectively. Oda_pc is ODA per capita. *** $P < 0.01$, ** $P < 0.05$, * $P < 0.1$ are the significance levels. Variables GDP, API and ODA_PC have been log-transformed. The numbers in brackets are robust standard errors in the presence of heteroscedasticity and autocorrelation (HAC). Those hooks are the P-values associated with each statistic. Endogeneity tests (DWH endogeneity) reveal that FDI and their interaction with the governance indicators are significant for all equations. This means that FDI and their interaction term are endogenous variables and implies that the OLS method is not consistent to deal with endogeneity issues. So the 3SLS estimates are preferred. The results of Sargan and Hansen over-identification tests show that we can not reject the null hypothesis of validity of instruments chosen, namely, instruments are uncorrelated with the error term. An F-test on the instruments variables (IVs) also indicates that instruments are jointly significant in the first stage estimations

Overall, estimations indicate that the coefficients associated with the FDI variable are negative and significant. The interaction of FDI with all the governance indicators is also negative and significant. This means that FDI has a negative direct effect on forest area and this effect is amplified by the low level of governance. This result supports the two hypotheses 1 and 2 formulated previously. It is consistent with the institutionalized pollution haven theory which states that when the quality of a host country institutions is low, FDI inflow tends to contribute to environmental degradation (Cole et al. 2006; Cole and Fredriksson 2009). This, despite the fact that all the governance indicators have a positive and significant effect on the forest cover (columns 2–8, Table 3).

Specifically, columns 1 and 2 of table show that FDIs affect negatively and significantly the forest cover conditional on a low average level ($-0.640 < 0$) of control of corruption. For example, a marginal increase in FDI stock (resp. in the FDI flow) (at the mean of control corruption) causes a decrease in *Fa* of -0.0574 ($= -0.0765$ to $0.0299 \times (-0.640)$) (resp. of -0.0886), namely, a decrease by 5.74% (resp. 8.86%) of forest cover per capita.

Concerning the quality of regulation indicator, columns 3 and 4 of table show that FDI stocks also influence negatively and significantly the forest area conditional on a low average level ($-0.646 < 0$) of this governance indicator. More precisely, a marginal increase in FDI stock conditioning to the average level of the quality of regulation leads a decrease in *Fa* of -0.0358 i.e. a decrease by 3.58% of the forest cover per capita.

Columns 5 and 6 of the table exhibit also that the negative effect of the FDI stocks on the forest cover is exacerbate for the low level of the political stability indicator ($-0.594 < 0$). Indeed, a marginal increase in the level of FDI stock conditioned by political stability leads to a decline in *Fa* of -0.0374, i.e. a reduction of 3.74% of the forest cover per capita.

Like the previous indicators of governance analysed, columns 7 and 8 show that FDI stocks have also a significant and negative effect on the forest area conditional on a low average level ($-0.729 < 0$) of rule of law. This means that a marginal increase in FDI stock conditioning to the average level of the rule of law leads to a decline in -0.0663, either a decrease in *Fa* of 6.63%. Similarly, a marginal increase in FDI flows conditioning to the average level of rule of law leads to a decrease in *Fa* of -0.0977, either a decrease of 9.77% of forest area per capita.

Finally, the findings on all the governance indicators reveal that in a regime where the rule of law and the corruption control are not enforced, FDI leads to more forest degradation.

Furthermore, columns 1, 3, 5, 6, 7 and 8 show that GDP per capita negatively influences the forest area change. This result is consistent with the scale effect of production in the EKC theory. Similarly, the rate of population growth reduces very significantly (at the 1% for all equations) the forest cover. Indeed, more the population increases, more the forest area per capita decreases. In contrast, API has a positive effect on forest area change (all columns). This result is contrary to my expectations since the agricultural sector would be one of the main causes of forest degradation in SSA. However, this can be justified in part by the fact that countries with a strong agricultural production finance more reforestation policies to maintain

their production level. Similarly, the degree of openness of the economy has a positive effect on the forest cover (columns 1, 3, 5 and 7). This may be explained by the fact that the opening of the economy led to the creation of other types of jobs that are not agricultural activities, which further reduces the pressures on the forest. Again ODA has a positive effect on forest area change (column 5). This result suggests that the foreign aid have positive externalities on forest protection. Finally, as expected, forest rent improves the forest area change (columns 1–3 and 8).

6 Conclusion

The empirical literature on the PHH has been generally based on the environmental issues such as air pollution. Another dimension of this hypothesis which is increasingly analysed concerns the environmental degradation problems caused by excessive exploitation of non-renewable natural resources in developing countries (Aliyu 2005). The unrestrained extraction of these resources may occurs because the bad political and economic governance might be attractive for the activities of extractive multinational companies located in these countries.

In this paper, I address these concerns by examining the FDI's effects on the forest area conditional on the level of governance in the SSA countries. The main results show that FDI has a negative and significant effect on forest area in SSA countries. This effect is amplified by the low level of governance in SSA, despite the positive impact of governance indicators on the forest cover. This result is consistent with the institutionalized pollution haven hypothesis which predicts that when the level of intitution quality is lower, multinational corporations tend to reduce the environmental policy stringency and therefore to degrade the local environment (Cole et al. 2006; Cole and Fredriksson 2009). Furthermore, among the selected governance indicators, the findings reveal that the weak control of corruption and the failure to enforce the rule of law lead FDI to have greater effect on forest degradation.

This paper shows to what extent the sustainable management of natural resources in the SSA countries is more sensitive to their level of governance. Hence, a country where the principles of good governance are well enforced, would be a bulwark against the unrestrained extraction of non-renewable natural resources by multinational corporations. I believe this paper makes novel contributions to the empirical literature insofar as it extends the PHH to the large-scale depletion of forest resources. These findings may lead to other future tests of PHH focusing on the extraction of other non-renewable resources.

Appendix 1

See Table 4.

Table 4 Variables, sources and descriptions

Variables and sources	Description
Fa	% Change forest area per capita
FAO	
FDI	Inward stocks and flows in % of GDP
UNCTAD	
GDP	Per capita in ppp (US$, 2005)
PWT	
POP_GROW	Rate of population growth
PWT	
API	Agriculture production index
FAO	
ODA_PC	Per capita in US$
WDI	
FRST_RENT	Forest rent in % of GDP
WDI	
OPEN_DEGREE	Trade openness (import + export)/2PIB
UNCTAD	
GOV (Kaufmann et al. 2010)	Governance indicators:
	Political stability
	Regulatory quality
	Control corruption
	Rule of law

FAO Food and Agriculture Organisation of United Nation, *PWT* Penn World Table, version 8.0 (Feenstra et al. 2013); *WDI* World Development Indicator, 2013, *UNCTAD* United Nation Conference on Trade and Development

Appendix 2: List of countries

Angola	Cape verde	Madagascar	Swaziland
Burundi	Ethiopia	Mali	Chad
Benin	Gabon	Mozambique	Togo
Burkina	Ghana	Malawi	Tanzania
Botswana	Gambia	Mauritius	Uganda
Central Africa Rep.	E. Guinea	Niger	South Africa
Cote d'Ivoire	Kenya	Nigeria	Zambia
Cameroun	Liberia	Rwanda	Zimbabwe
Congo. Demo. Rep.	Lesotho	Sudan	
Congo	Guinea-Bissau	Senegal	

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