AN EMPIRICAL ANALYSIS OF THE RELATIONSHIP BETWEEN MULTINATIONAL ENTERPRISES AND SUSTAINABLE DEVELOPMENT OF ENERGY SECTOR IN AFRICA

Emanuela Colombo, Politecnico di Milano, +39-02-2399-3820, emanuela.colombo@polimi.it

Matilde D'Amelio, Politecnico di Milano, +39-02-2399-4834, matilde.damelio@polimi.it

Paola Garrone, Politecnico di Milano, +39-02-2399-2742, paola.garrone@polimi.it

Lucia Piscitello, Politecnico di Milano, +39-02-2399-2740, lucia.piscitello@polimi.it

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Abstract

This article aims at assessing whether multinational enterprises play a role in the reduction of energy poverty, while not causing environment degradation or inefficient usage of energy resources. Sub-Saharan Africa has been identified as an ideal test-field for this study. Using a panel of more than 1500 home-host country pairs observed from 2005 and 2011, we study the effect of foreign direct investment on the access to electricity, energy intensity and carbon factor, based on the level of economic and institutional development of home and host countries. Results reveal that institutions and income play a different role. In countries with weak institutions, foreign direct investment increases access to electricity, especially if from other institutionally backward contexts, and transfers cleaner technologies. On the contrary, in poor countries, investment from multinational enterprise increases environmental degradation without bringing any benefit to the local energy sector.

I. INTRODUCTION

This article empirically analyses the relationship between the presence of multinational enterprises (MNEs) and sustainable development of energy sector in Sub-Saharan Africa (SSA). The research is aimed at assessing the role of MNEs in driving the diffusion of modern energy services and reducing energy poverty, without causing environment degradation or inefficient uses of energy resources. SSA has been identified as an ideal test-field for this study. In the recent years several countries of this region have experienced an unprecedented growth of inward foreign direct investments (FDI), but most of them are still suffering from the lack of modern energy services, a necessary condition to eradicate extreme poverty and pursuing the path to development (IEA, 2013). A lasting, inclusive and efficient use of energy sources is a fundamental driver of sustainable development (IAEA, 2005). In this scenario, MNEs have been explicitly called to support energy sustainable development by promoting access to modern energy services in SSA (IEA, 2013).

International agencies and transnational, national and local policymakers are striving to understand to what degree and under what conditions MNEs engagement can really ensure developing countries a sustainable access to modern energy services. In general, terms, the impact of MNEs on host country development, particularly for poorer countries, is controversial. This is even truer for the diffusion of access to electricity and more generally for the sustainable development of energy sector. This paper aims at supporting policymaking decisions through an empirical analysis of the moderating role played by two major contingencies, namely, the quality of formal institutions and the level of economic development.

Our research emphasizes that policymakers should be aware that the effectiveness of MNEs' involvement depends on the quality of local institutions, and the institutional context of home countries. Electricity is a utility service that requires the deployment of grids or mini-grids, and may suffer from several inefficiencies owing to providers' market power. A certain degree of institutional sophistication is generally deemed to be necessary for private players to be involved in an efficient form (Spiller 2010). At the same time, however, electric infrastructure are typical examples of collective goods, and MNEs are expected to replace governments with weak and unsteady formal institutions exactly in the provision of such goods (Boddewyn & Doh, 2011; Khanna & Palepu, 1997), for self-supplying an essential input or gaining legitimacy credentials with stakeholders. In a previous research we showed that MNEs were found to promote access to electricity, i.e. to modern energy services, in SSA countries whose quality of institutions is less than fair, even more when they come from countries with similar weakness in formal institutions (D'Amelio et al., 2015). This evidence lends support to the "institutional void" view of international business.

However, in order to be of help to policymakers, any analysis of the role of MNEs should take into account the multifaceted nature of sustainable development. The social, economic and environmental dimensions of energy sector mutually interact, and a focus on the dynamic of households' access to electricity that overlooks possible noxious side effects of energy production, distribution and use, such as a boost of air pollution, acid precipitation, greenhouse gas (GHG) emissions, forest destruction would be misleading (Omer, 2008; Soytas et al., 2007). More in detail, MNEs are supposed to impact on three core dimensions of the domestic development of energy uses, namely, the diffusion of modern energy services, the production of polluting and climate changing emissions, the efficiency of energy uses.

Environmental externalities and excessive energy intensity have to be modeled simultaneously with access to electricity, as Kivyiro and Arminen (2014) did in a recent paper. Nevertheless, they analyzed the relationships between FDI, carbon emissions, energy consumption, and economic development separately for 6 SSA countries. By contrast, we seek general patterns of energy production and uses in less developed countries. Therefore, we analyze 15 SSA countries jointly by modeling differences in institutional quality across these countries and likewise differences in MNEs' source countries. The relationship between MNEs' presence and environment protection in host countries through resource efficiency and a decrease in noxious, polluting or climate-changing emissions was studied through the lens of different effects of inflow FDI, namely scale of the economy, its industry composition, and technological change (Hübler & Keller, 2010). More particularly, paths from cleaner agricultural stages of economic development to heavy industry, and to lighter, cleaner specialization, can be predicted according to the "pollution haven hypothesis" (Cole & Elliott, 2005), or the Environmental Kuznets Curve studies (Dinda, 2004; Roberts & Grimes, 1997). These streams of research also highlight MNEs' influence in terms of host countries' technological change, with contrasting views on the final diffusion of cleaner technologies (Albornoz et al., 2009; Dinda, 2004). Host and home country's institutions drive the influence of MNEs on environment and resource efficiency (Oetzel & Doh 2009; Zeng & Eastin 2012).

Finally, in order to support policymakers in the identification of effective strategies to fight energy poverty according to real country characteristic, we test whether institutional quality and economic development act in a different way in driving MNEs to promote access to electricity.

Our sample concerns 15 sub-Saharan countries, and FDI from 83 worldwide home countries are observed throughout the period 2005 - 2011. The final number of observations is 1547. Variables are classified in seven groups that represent: (i) MNEs' presence; (ii) access to modern energy services; (iii) efficiency of the energy use; (iv) environmental implications of the energy use (v) institutional quality of home and host country; (vi) income level of home and host country and; (vii) controls. Given the nature of data, our econometric analysis relies on dynamic panel data techniques. Results reveal that in countries with weak institutions, FDI increase access to electricity, especially if from other institutionally backward contexts, and transfers cleaner technologies. On the contrary, in poor countries, investment from multinational enterprise increases environmental degradation without bringing any benefit to the local energy sector.

The paper is organized as follows: Section II describes the background and conceptual framework and develops our research questions, Section III presents data and methodology, while Sections IV illustrates our results. Finally, Section VI reports our discussion and conclusion.

II. BACKGROUND AND CONCEPTUAL FRAMEWORK

a. Energy and sustainable development

The diffusion of modern energy services is key to the economic and social development and transition from subsistence agricultural economies to modern industrial and service-oriented societies (Smith et al., 1993; Winkler et al., 2011). On one hand, energy is a key asset for economic development, as it is a necessary input, together with machinery, land, natural resources, and human capital in the productive base of the economy (Winkler et al., 2011). On the other hand, access to clean and reliable energy is critical to human welfare and income generation possibilities for the households (IAEA, 2005; Toman & Jenelkova, 2002). By gaining access to modern energy services communities substantially improve their quality of lives, particularly as they have a greater amount of usable time, their health is improved and opportunities for income generating activities increases. For this reason, as an integral part of settlement policies and strategies, a conscious mobilization and allocation of resources for providing adequate energy supply, and the development of energy policies are necessary. In developing countries, especially in sub-Saharan Africa (SSA), the most relevant energy problem is what the international organization call "energy poverty", defined as the "inability to cook with modern cooking fuels and the lack of a bare minimum of electric lighting to read or for other household and productive activities at sunset" (IEA, 2013). The International Energy Agency (IEA) estimated that, only in sub-Saharan Africa in 2013, 600 million of people did not have access to electricity and 695 million still relied on traditional biomass for cooking activities.

However, when choosing energy fuels and technological solutions to overcome this shortage, policy makers have also take into account environmental and economic consequences of these choices. Thus, it is not only important that energy is available in a clean, safe and reliable way but is also essential that this energy is produced and its distribution is efficient and environmentally sustainable. In other words, energy is essential for development but it is only a means to an end. "The end is good health, high living standards, a sustainable economy and a clean environment" (IAEA, 2005). For this reason, the development of modern energy services should be sustainable, and that all that all consequences on the society, economy and environmental have to be taken into account.

b. Multinational enterprises and the sustainability of energy sector

Between the different solutions that could be adopted to solve the shortage of access to modern energy services in SSA, the development of the private sector has increasingly been seen as an efficient and conducive tool. SSA has historically been characterized by a mass of private business activities, but the majority of it comprises micro and small enterprises engaged in the provision of trade and services (Schulpen & Gibbon, 2002). Nevertheless, these enterprises have little division of labor, low level of technical capability and productivity and few or no linkages with larger, more dynamic enterprises (Schulpen & Gibbon, 2002). For this reason, MNEs may be a viable option to eradicate energy poverty. Absolute level of inflow FDI have increased from USD 8.3 billion/year in 1996-99 to around USD 52.5 billion/year in 2011/13 (Schulpen & Gibbon, 2002; UNCTAD, 2014). This raise has been driven by international and regional market-seeking and infrastructure investments. Historically, a large part of FDIs were directed to the extractive sector, but expectations for sustained growth of an emerging middle class attracted FDI also in consumer-oriented industries, including food, IT, tourism, finance and retail (UNCTAD, 2014).

The debate over the impact of MNEs on host country development, particularly in developing countries, has generated substantial controversy among different actors, i.e. academia, national and international organizations and civil society. On one hand, researches argue that MNEs are important actors for social-economic development and environmental protection. Thus, MNEs complement domestic savings, transfer technology and management skills, increase competition and stimulate entrepreneurship (Caves, 1974; Rugman, 1981; Teece, 1997). Some scholars also suggest that these firms ameliorate environmental, labor and safety standards in developing countries (Oetzel & Doh, 2009; Talukdar & Meisner, 2001). On the other hand, other researchers oppose this view suggesting that MNEs are more likely to uproot domestic firms, use technology inappropriate for the context, constrain potential technology spillover and reduce the local capital stock due to transfer pricing manipulation and excessive profit repatriation (De Backer & Sleuwaegen, 2003; Haddad & Harrison, 1993). MNEs are also accused to force developing countries to participate in the global “race to the bottom”, as they adopt inadequate safety standards, employ child labor and pollute the environment (Clapp & Dauvergne, 2005; Oetzel & Doh, 2009).

c. Research questions

In a previous paper, we showed that MNEs can promote access to electricity, i.e. to modern energy services, and institutions of host and home countries play a crucial role (D’Amelio et al., 2015). Governments have always been involved in the supply or regulation of collective goods, such as electricity utilities (Levy & Spiller, 1994). Nevertheless, many governments of developing countries are likely to lack the necessary strong and stable formal institutions that are necessary to the provision of collective goods to the population (Khanna & Palepu, 1997; Bergara et al., 1998; Robbins & Perkins, 2012). Nevertheless, MNEs, through FDI, could replace governmental actions in host countries that experience institutional voids (Boddewyn & Doh, 2011; Khanna & Palepu, 1997). This is more likely to be true if MNEs come from institutional weak countries. Reasons are various. First MNEs need electricity for their business activities. Second, the raising of access to electricity is achieved mainly through the development of electricity infrastructures. This type of investment can be employed as a strategy to gain the legitimation with the developing country stakeholders (Oetzel & Doh, 2009). In particular, MNEs from weak institutional environments are more incentivized to adopt this strategy as they suffer from a liability of origin, i. e. higher lack of legitimacy than firms from highly institutional developed countries (Cuervo-Cazurra & Ramamurti, 2014; Kostova & Zaheer, 1999).

However, international and domestic policy makers also need to understand the economic and environmental sustainability of the involvement of MNEs in the provision of modern energy services. Accordingly, this paper also analyzes the implications of MNEs presence for efficiency and environmental quality of energy uses. The energy intensity, i.e. energy use divided by gross domestic product (GDP), represents the inverse measure of the country efficiency in energy uses. On the contrary, the carbon factor, defined ad CO_2 emissions per unit of energy use, is used as an intensive measure of the impact of energy uses on the environment (Kivyiro & Arminen, 2014). A number of studies link environmental degradation and energy efficiency to FDI inflows across a number of developing and developed countries (e.g., Eskeland & Harrison, 1997; Smarzynska & Wei, 2001). Several theories have been proposed in the literature to define the relationship between these variables via multiple channels, namely, scale, composition and technique effects (Hübler & Keller, 2010).

As inward FDI are likely to stimulate economic growth, since expanded economic activity is related to a higher energy use and overall pollution level, the “scale effect” from FDI implies a greater energy consumption but if scale economies are at work it may reduce energy intensity (Hübler & Keller, 2010; Zarsky, 1999).

The “composition effect” of FDI inflows represents a structural shift in the economic activity and can impact either negatively or positively on energy intensity and carbon factor. The sign depends on the sector specialization of the economy. According to the “pollution haven hypothesis”, in low-income countries, the environmental regulation is weak and this may attract FDI by more polluting and energy inefficient industries raising environmental degradation and relative energy use (Cole & Elliott, 2005). By contrast, coherently with the Environmental Kuznets Curve studies (Dinda, 2004; Roberts & Grimes, 1997), energy intensity and carbon factor can be expected to follow an inverted-U relationship with economic development and its determinants, including FDI inflows. As the presence of MNEs increases, countries progress from cleaner stages of earlier economic development, i.e. agricultural specialization, to more polluting activities related to heavy industries to a cleaner economy, i.e. light industry and service specialization. Since heavier industries are more pollutant and more energy intensive, this implies a positive "composition effect" for countries moving from very low income to low and medium income, i.e. greater energy intensity and carbon factor (Hübler & Keller, 2010). Later in the development process, activities move from the industry to the service sector or from the heavy to the lighter industry. As the latter is less energy intensity and pollutant, this means a negative "composition effect" in this stage (Hübler & Keller, 2010).

Finally, the "technique effect" covers the impact of openness on the implementation of better and less emission-intensive technologies or the adoption of more resource-efficient management practices and has a negative effect on energy intensity and carbon factor. This "technique effect" is distinguished in direct and indirect channels (Hübler & Keller, 2010). The indirect effect works via a wealth increase: if FDI causes economic growth and greater per capita income, the demand of a cleaner environment increase, resulting in the adoption of stricter environmental regulations. Environmental Kuznets Curve literature also emphasizes the role played by environmental awareness. As income grows beyond a threshold level, possibly owing to FDI, people attach a greater value to environment protection, and citizens and consumers of rich countries demand environmental quality and greener products (Dinda, 2004). The direct effect implies the transfer of more energy efficient and cleaner technologies by FDI, i.e. "technological spillover" (Oetzel & Doh, 2009). The dissemination of cleaner technologies in host countries by MNEs is also termed "halo effect" (Albornoz et al., 2009).

So far, we have highlighted the controversial and multifaceted nature of the relationship linking MNEs and sustainability of energy uses in host countries. However, countries highly differ in terms of formal institutions, an event that adds a considerable degree of complexity to the framework. Indeed, literature in the "pollution haven" tradition hypothesizes a relocation of more resource-intensive, polluting and noxious activities in less developed countries, exactly because the latter are likely to be laxer in their regulations (Cole & Elliott, 2005). At the same time, however, our past research emphasized that MNEs are likely to provide infrastructure investments under institutional voids to improve their reputation with local and international stakeholders. By the same token, it can be argued that MNEs adopt more energy efficient technologies and mitigate carbon emissions in host countries that suffer from weaker institutions, including less stringent environmental and energy regulations, because they need to gain legitimation with local customers, government and communities, and international stakeholders (Oetzel

& Doh, 2009). The role of home countries is relatively underinvestigated. A notable exception is the analysis by Zeng and Eastin (2012). They found that country-level intensity of environmental certification increases with the share of FDI inflows from less developed countries, especially if source countries have higher certification rates.

This wide set of theories led as to define two groups of research questions, which state as follow.

Research Question 1a. *What are the implications of MNEs presence on the carbon factor of SSA countries?* ***1b.*** *Does MNEs potential depend on the quality of formal institutions in host countries?* ***1c.*** *Do home country institutions play a role in moderating the relationship between MNEs and carbon factor?*

Research Question 2a. *What are the implications of MNEs presence on the energy intensity of SSA countries?* ***2b.*** *Does MNEs potential depend on the quality of formal institutions in host countries?* ***2c.*** *Do home country institutions play a role in moderating the relationship between MNEs and energy intensity?*

Finally, an objective of this paper is to add a piece of history to our previous work (D'Amelio et al., 2015), in three ways. First, we recognize that social, economic and environmental dimensions of energy sector sustainability mutually interact over time, i.e. we simultaneously model access to electricity, carbon factor and energy intensity, similarly to Kivyiro and Arminen (2014). Second, while Kivyiro and Arminen (2014) analyzed the relationships between FDI, carbon emissions, energy consumption, and economic development separately for 6 SSA countries, we seek more general patterns of energy sector development. Therefore, we depart from their analysis by employing a dynamic panel data approach for 15 SSA countries and making the role of country-level moderators explicit. Finally, we attempt to disentangle the moderating role of institutions from the role played by economic development. In fact, most of the received literature frames the relationship between FDI and environmental degradation or FDI and energy intensity, in the phase of economic development of the host and home country, even though several arguments refer to the maturity of regulatory institutions of host and home countries. More generally, we want to rule out the risk that our previous findings about the relevance of the quality of institutions hide the role of economic development. For this reason, the last part of this paper test whether institutional quality and economic development act in a different way. For this reason, our third and last group of research questions states as follow.

Research Question 3a. *Does MNEs' contribution toward a wider access to electricity in SSA countries depend on the economic development in home and host countries? Does the moderating effect of countries' income differ from the effect of countries' institutional quality?* ***3b.*** *Does MNEs' contribution toward carbon intensity of SSA countries depend on the economic development in home and host countries?* ***3c.*** *Does MNEs' contribution toward energy intensity of SSA countries depend on the economic development in home and host countries?*

III. METHODOLOGY

a. Sample

The econometric analysis is performed using a panel dataset. The sample is composed of pairs of 83 home countries and 15 host countries from sub-Saharan Africa, which are observed from 2005 to 2011. Missing data prove to be an issue, but the problem is solved by adopting statistical techniques (see the description of single variable parts for more details) and this lead to a final sample size of 1,547 observations. Appendix 1 shows the list of host and home countries considered for this study.

b. Dependent variables

In order to estimate the impact of FDI on the development of modern energy services and verify if this process is efficient and environmental sustainable, following the guidelines of the International Atomic Energy Agency (IAEA), we adopted the three following dependent variables: access to electricity, carbon factor and energy intensity (IAEA, 2005). They describethe development of modern energy services, environmental degradation and the inverse measure of energy efficiency, respectively.

Access to electricity. This variable is the percentage of households with access to a minimum level of electricity consumption per year (Source: IEA). According to the definition provided by IEA, access to electricity involves more than the simple household connection to the grid; it also comprises consumption of a specified minimum level of electricity[1]. This variable is affected by a problem of missing data, i.e. 30 percent, which we overcome by adopting an approach that has shown good statistical properties, i.e., multiple imputation (Allison, 2001)[2].

[1] The consumption threshold was computed by IEA by assuming five people per household and was set equal to 250 kilowatt-hours (kWh) per year for rural households and to 500 kWh per year for urban households (IEA, 2013).

[2] With multiple imputation, missing values are drawn from a distribution of observed variables, including the variables at stake. It should be pointed out that multiple imputation does not entail interpolation from contiguous values. Instead, it is generated by chained equations, i.e. an option that is suitable for dealing with a high proportion of missing data (Allison, 2001). In order to guarantee the consistency of imputed data, all the paired countries with less than 3 observations per variable, over the 7 years, are removed. The results of the multiple imputation are available upon request from the authors.

Carbon factor. This variable represents national carbon emissions per unit of energy use. The national carbon emissions are measured in CO_2 equivalent tons and they refer to carbon emissions from the combustion of fossil fuels for energy use (Source: World Bank). The unit of energy use is measured by the total primary energy consumption in Mega-Watt hours (MWh), and it includes the country-level consumption of fossil fuels (petroleum, natural gas, coal), hydroelectric, nuclear, and geothermal, solar, wind, and wood and waste electricity, and net electricity imports (Source: International Energy Statistics). Carbon emissions are at the origin of global warming and, at the same time, are correlated with other pollutants that are locally noxious, such as nitrogen oxide and sulphur dioxide (Kivyiro & Arminen, 2014).

Energy Intensity. This variable represents the energy use per unit of GDP which, given the economy structure, is inversely related to energy efficiency (Garrone & Grilli, 2010). Specifically, it is the ratio between the total primary energy consumption and the GDP, measured by 2005 Purchasing Power Parity US dollar (Source: World Bank).

The two latter variables are not affected by a problem of missing data, so no multiple imputation is required.

c. Explanatory variables

FDI per capita. The presence of MNEs in sub-Saharan countries is proxied by inward FDI stocks disaggregated according to home and host country, i.e., country-pair FDI (Source: UNCTAD). Since inward FDI stocks constitute an extensive variable, which varies on the basis of the country's size, and our dependent variable is expressed as a percentage of population, country-pair FDI per capita are employed. Since this variable is also affected by missing data, i.e. 26 percent, the treatment is replicated by means of multiple imputation.

Institutional quality of host and home countries. The institutional quality of a country has been described through the six World Bank's Worldwide Governance Indicators (WGIs): regulatory quality, control of corruption, voice and accountability, rule of law, governance effectiveness and, political stability and the absence of violence and terrorism. Due to the high correlation between these variables and in line with previous literature (e.g., Farla et al., 2014), a factorial analysis is performed in order to obtain a unique indicator. A factor is built for the host countries and another for the home ones.

Income level. Two dummies, i.e. low-income (LIC) and lower middle-income (LMIC) countries, are used to model the income group to which the host country belongs, as defined by the World Bank.

Furthermore, the income level of the home country is defined throughout three dummies: LIC-home, LMIC-home and upper middle-income (UMIC) home.

d. Control variables

In order to reduce the risk of spurious correlations, we control for the following host-country specific characteristics.

Population. This variable allows controlling for the host country size (Source: World Bank).

Rural population. Only 37 per cent of the sub-Saharan population lives in urban areas (UNDP, 2013). This raises barriers to the access to electricity and the adoption of efficient and cleaner solutions, as the deployment of electricity infrastructures and more sophisticated technology for the production, distribution and use of energy is more difficult and costly outside cities and their outskirts (IEA, 2014). For this reason, we control for the share of rural population in the host country, expressed as a percentage of the total population (Source: World Bank).

Population density. Like the rural population, the low population density, i.e. people per square kilometer per land area (Source: World Bank), is also a barrier to the diffusion of electricity access, especially through national or regional grids. In addition, a high population density could lead to the adoption of more efficient and environmental friendly technological solutions.

Industry and service value added. These two variables aim to control the host country's economic structure (Source: World Bank). Industry value added, expressed as a percentage of the GDP, covers mining, manufacturing, construction, electricity, water and gas. Services value added, also expressed as a percentage of GDP, comprises wholesale and retail trade (including hotels and restaurants), transport, government, financial, professional and personal services, such as education, health care, and real estate services. The two variables obviously take on a low value if the country is specialized in agriculture, husbandry, forestry and fishing.

Time and country-pair dummies. These dummies are included in the model in order to capture time varying macroeconomic shocks and unobservable country-pair specific factors.

e. Model

We describe access to electricity through a growth model (e.g., Henisz & Zelner, 2001). Specifically, we run three separate models for each dependent variable. Since the three variables are likely to be linked by simultaneity, each variable is also explained by the remaining two dimensions on the right hand side of the model. Thus, our models have the following form:

$$
\begin{aligned}
(1)\quad & \Delta Access\ to\ Electricity_{\ i,t} = \alpha_0 + \alpha_1\ Access\ to\ Electricity_{\ i,t-1} + \\
& + \beta_1\ FDI\ per\ capita_{\ i,j,t-1} + \beta_2\ Institutional\ quality\ host_{\ i,t-1} + \\
& + \beta_3\ Institutional\ quality\ home_{\ j,t-1} + \beta_4\ L\ (host)_{\ j,t} + \beta_5\ LMIC\ (host)_{\ j,t} \\
& + \beta_5\ LIC\ (home)_{\ j,t} + \beta_6\ LMIC\ (home)_{\ j,t} + \beta_7\ UMIC\ (home)_{\ j,t} \\
& + \beta_8\ Carbon\ Factor_{\ j,t-1} + \beta_9\ Energy\ Intensity_{\ j,t-1} + \\
& + \gamma\ Z'_{\ i,t-1} + \varphi_t + \chi_{ji} + \varepsilon_{ij,t}
\end{aligned}
$$

$$
\begin{aligned}
(2)\quad & \Delta Carbon\ Factor_{\ i,t} = \alpha_0 + \alpha_1\ Carbon\ Factor_{\ i,t-1} + \\
& + \beta_1\ FDI\ per\ capita_{\ i,j,t-1} + \beta_2\ Institutional\ quality\ host_{\ i,t-1} + \\
& + \beta_3\ Institutional\ quality\ home_{\ j,t-1} + \beta_4\ L\ (host)_{\ j,t} + \beta_5\ LMIC\ (host)_{\ j,t} \\
& + \beta_5\ LIC\ (home)_{\ j,t} + \beta_6\ LMIC\ (home)_{\ j,t} + \beta_7\ UMIC\ (home)_{\ j,t} \\
& + \beta_8\ Access\ to\ electricity_{\ j,t-1} + \beta_9\ Energy\ Intensity_{\ j,t-1} + \\
& + \gamma\ Z'_{\ i,t-1} + \varphi_t + \chi_{ji} + \varepsilon_{ij,t}
\end{aligned}
$$

$$
\begin{aligned}
(3)\quad & \Delta Energy\ Intensity_{\ i,t} = \alpha_0 + \alpha_1 Energy\ Intensity_{\ i,t-1} + \\
& + \beta_1\ FDI\ per\ capita_{\ i,j,t-1} + \beta_2\ Institutional\ quality\ host_{\ i,t-1} + \\
& + \beta_3\ Institutional\ quality\ home_{\ j,t-1} + \beta_4\ L\ (host)_{\ j,t} + \beta_5\ LMIC\ (host)_{\ j,t} \\
& + \beta_5\ LIC\ (home)_{\ j,t} + \beta_6\ LMIC\ (home)_{\ j,t} + \beta_7\ UMIC\ (home)_{\ j,t} \\
& + \beta_8\ Carbon\ Factor_{\ j,t-1} + \beta_9\ Access\ to\ Electricity_{\ j,t-1} + \\
& + \gamma\ Z'_{\ i,t-1} + \varphi_t + \chi_{ji} + \varepsilon_{ij,t}
\end{aligned}
$$

Where i is the host country, j is the home country, t is the year, φ_t and χ_{ji} are the unobservable year and country-pairs fixed effects, respectively; $\varepsilon_{ij,t}$ is the i.i.d. disturbance term. For the sake of simplicity, the three error components are represented in the same way across equations.

$\Delta Y_{i,t}$ is the yearly increase of the dependent variable between time t-1 and t. $Y_{i,t-1}$ is the lagged-dependent variable in level, which allows to control for the dynamics of the process. $Z'_{i,t-1}$ is vector of controls, i.e. population, rural population, population density, and industry and services value added. Finally, in order to alleviate reverse causality problems, we lag the explanatory variables and controls by one period (except for the income level dummies).

The model of growth is extended by introducing two typologies of interaction terms: one between FDI and the two institutional variables and; the other between FDI and the income level variables for the home and home country. The introduction of interaction terms requires the evaluation of marginal effects. In the case of institutional quality, marginal effects are estimated first assuming that host institutions are weak and home institutions have a mean quality. Then we simulate how, setting the quality of host institutions at the minimum value, the effect of FDI varies when the quality of the home institutions decreases from a maximum to a minimum level. In the case of income level, marginal effects are estimated first assuming that host country is a LIC and then setting one by one a different income level for the home country.

According to the literature on dynamic panel data, in order to deal with the endogeneity problems due to the lagged-dependent variable, and the potential correlation of the explanatory variables with the error term, the Arellano-Bover/Blundell-Bond Generalized Method of Moments estimator; i.e., the system-GMM, is utilized (Arellano & Bover, 1995; Blundell & Bond, 1998). This estimator instruments the lagged-dependent variable and any other similarly endogenous variables with variables that are uncorrelated to the fixed effects, thus dramatically improving efficiency of the estimates (Roodman, 2009). The two-step method results in more asymptotically efficient estimates than the one-step (Baltagi, 2008), and the bias in the standard errors is fixed by means of Windmeijer's (2005) correction procedure. In addition, we control for the endogeneity of lagged-dependent variable, *FDI per capita, institutional quality host, industry* and *service value added, carbon factor, energy intensity and access to electricity, LIC (host)* and *LMIC (host)* variables. The variables *population, rural population* and *population density* are considered pre-determined. I*nstitutional quality home, LIC (home), LMIC (home)* and *UMIC (home)* are dealt as exogenous variables. Finally, some external instruments is added and treated as predetermined variables, namely the degree of a country's globalization, the level of human capital, the internal ethnic and religious tensions, and other aspects of economic development not inserted into the model. In order to prove the robustness of the findings, the bias-corrected Least Square Dummy Variable method (corrected LSDV) is also used to estimate the regression coefficients (Kiviet, 1995; Bruno, 2005). This estimator has the drawback that it relies on the assumption that all other repressors other than the lagged-dependent variable are uncorrelated to any time-varying unobserved heterogeneity. However, its advantage is that it corrects the endogeneity bias of the lagged-dependent variable without the use of any instrumental variables.

f. Descriptive Statistics and Correlations

Tables 1 and 2 show the correlation matrix and the descriptive statistics of the model variables. The overall pattern of our variables does not reveal a tendency toward multi-collinearity.

[Insert Table 1 Here]

[Insert Table 2 Here]

IV. RESULTS

First, we check if there is a reverse causality between access to electricity, carbon factor, energy intensity and FDI. The system-GMM reveals that the carbon factor negatively impacts on the FDI ($p< 0.01$), while the effect of the energy intensity is positive ($p< 0.1$). This means that results obtained with corrected LSDV when the dependent variables are carbon factor or energy intensity could be biased, as with this estimator we cannot control for the endogeneity of FDI. Results of reverse causality analysis are shown in Table 3.

[Insert Table 3 Here]

Table 4, 5 and 6 show estimates obtained respectively with access to electricity, carbon factor and energy intensity as dependent variables, with the system-GMM.

[Insert Table 4 Here]

[Insert Table 5 Here]

[Insert Table 6 Here]

In Table 4, 5 and 6 Model 1 is our baseline, Model 2 is obtained by interacting FDI with quality of home and host institutions and Model 3 comes from the interaction of FDI with the income level of home and host country.

Looking at the controls, the population has a significant and positive effect on the access to electricity ($p< 0.01$), while its impact is negative on the carbon factor ($p< 0.1$) and positive but not significant on the energy efficiency. This means that the "scale effect" is only confirmed for the access to electricity variable. On the contrary, rural population is confirmed to act as a barrier for the diffusion of access to electricity ($p< 0.01$), while no evidence is found for the other two dimensions. Regarding the population density, as expected access to electricity grows faster in countries with a higher urbanization rate ($p< 0.01$). No significant results have been obtained on the role of services value added for all three variables. A reason could be that this sector is still not well developed in SSA. Finally, the industry value added has a negative impact on the access to electricity ($p< 0.05$) and energy intensity ($p< 0.1$ Model 1 of Table

6). While for energy intensity this effect can be explained by the "composition effect", access to electricity requires more investigations.

Regarding our main explanatory variable, FDI, if we consider the variable in level we see that it has a direct impact only on the access to electricity dimension ($p < 0.05$ Model 2 of Table 4). This result is confirmed also when the system GMM is replaced by the corrected LSDV estimator (see Table 7)[3].

[Insert Table 7 Here]

Regarding the institutions, if we consider the variable in level, we find that host institutions have a positive but not significant impact on the access to electricity and carbon factor, while their impact is positive and significant on the energy intensity ($p<0.05$). On the other hand, quality of home institutions positively acts only on the access to electricity dimension ($p < 0.01$ Model 1 of Table 7).

However, in order to understand how the role of FDI is influenced by the institutions we need to refer to the results of the marginal effects (see Table 8).

[Insert Table 8 Here]

Table 8 shows that what we found in our previous paper is confirmed: FDI promote access to electricity in countries affected by institutional voids and this is more likely true if they come from institutionally weak nations. In addition, in countries where institutions are weaker, FDI reduce the carbon factor ($p < 0.1$). This seems to suggest that the "pollution haven hypotheses" is not confirmed if the quality of institutions is considered as a marker of development. We interpret this finding by arguing that, in order to gain legitimacy, FDI bring more efficient and less emissions-intensive technologies to the host countries, i.e. "technique effect" or "technological spillover" or "investing up" effect, and this reduces the environmental pressures in contexts where institutions are weak and not able to implement and adopt a stringent environmental regulation.

Table 9 displays how the role of FDI is affected by the income level of the home country, when the host one is a LIC. We find no impact on the access to electricity and on the energy intensity. On the contrary, in LIC, FDI always lead to an increase of carbon factor independently of the stage of economic development of the home country, confirming the "pollution haven hypotheses" ($p < 0.1$).

This result contradicts the one presented in Table 8 and this confirms our idea that there is not a perfect overlapping between quality of institutions and stage of economic development of a country. These two dimensions can act in a different, and sometime contradictory, way.

[3] We can rely on the estimates obtained with the corrected LSDV with access to electricity as dependent variable as no reverse causality occurs between FDI and access to electricity (see Table 1). Estimates with the corrected LSDV for energy intensity and carbon factor are available upon request from the authors.

[Insert Table 9 Here]

Finally, some words should be spent to describe the relationship between carbon factor, access to electricity and energy intensity. Our estimates show that an increase in the energy intensity speeds up the growth of access to electricity ($p < 0.05$ Model 1 of Table 7) and slows down the growth of carbon factor ($p < 0.1$ Model 1 of Table 5). This means that most probably in our sample, in the investigated period, the structure of the economy changed from agricultural based to an industrial based, and this leads to an increase of the access to electricity. At the same time, this growth has been led by FDI, which bring to the country more-environmental friendly, and probably more efficient, technologies.

V. DISCUSSION AND CONCLUSION

This paper is addressed to international and SSA policy makers interested in the development of energy sector in SSA countries. Managers of MNEs operating in the region, who need to settle efficient strategies to overcome their lack of legitimacy, mighty also find interesting evidence here.

Specifically, the goal of the work is to provide a tool that will support policy makers in the definition of measures aimed at involving foreign enterprises in the fight against energy poverty. However, in order to design policies that really support sustainable development, i.e. a balanced development of energy sector along social, economic and environmental dimensions, they cannot limit themselves to consider the diffusion of modern energy services. Resource efficiency and environmental implications of the process are relevant as well. In addition, in order to implement successful policies, attitude towards MNEs should be tuned with the level of economic and institutional development of the home nation. In addition, this paper can be used as a viable tool also by managers of MNEs that invest in SSA and that need to identify successful strategies to deal with local governments, to fill a lack of legitimacy and to overcome their liability of origin with stakeholders. In other words, the paper shows what are the dimensions of local energy development on which MNEs can have a more significant impact and what are the institutional and economic conditions for this impact to occur, for both host and home countries.

In order to achieve these goals an econometric analysis is performed using a panel of more than 1500 home-host country pairs observed from 2005 to 2011. We study how MNEs affect the development of modern energy systems and if this development is efficient and clean. Furthermore, we try to disentangle the effect of institutional environment from level of economic development of the home and host country, and see if these two aspects act in a different way. Sub-Saharan Africa provides a particularly good testbed for this analysis.

The role of institutions cannot be neglected. In countries with powerless institutions FDI promote the development of modern energy systems and introduce cleaner technologies that reduce the environmental pressures coming from the energy use. The level of development of home country institutions is confirmed to have an impact, that is, MNEs that come from institutionally weaker countries result to speed up the growth of modern energy systems; nevertheless, the environment is only affected by local institutions. This means that, independently on the institutional environment of origin, MNEs introduce cleaner technology to gain legitimacy credentials with local customers, government and communities, and international stakeholders.

On the other hand, we demonstrate that overlapping between institutions and economic development of a country is far from being perfect when the moderating role of country characteristics is considered. We find that in poor host country, i.e. LIC, FDI increase the environmental degradation originated by energy uses, independently on the level of economic development of the country of origin, without bringing any benefit to the efficiency and the implementation of modern energy systems. MNEs can be regarded by poorer countries as allied parties in the fight against energy poverty and environmental degradation only when local institutions are weaker. The joint effect of economic and institutional development is a matter for further research

In conclusion, in this paper, we confirm the robustness of the results of our previous work (D'Amelio et al., 2015) and, at the same time, we move forward by showing that the development of energy sector is a complex and multiphase phenomenon. MNEs can play a role, but several contingencies should be taken into consideration.

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Tables

Table 1. Descriptive statistics.

	Variable	Mean	Std. Dev.	Min	Max	Observations
1	Access to electricity	58.908	28.066	5.800	100	1547
2	Energy intensity	3982.628	8603.393	29.027	248873	1456
3	Carbon factor	1558.483	7754.023	7.626	151268	1547
4	FDI per capita	181.812	1496.379	0.035	39379.230	1547
5	Institutional quality host	0	1	-2.582	1.383	1547
6	Institutional quality home	0	1	-2.495	1.269	1547
7	LIC (host)	0.279	0.448	0	1	1547
8	LMIC (host)	0.130	0.336	0	1	1547
9	LIC (home)	0.093	0.291	0	1	1547
10	LMIC (home)	0.129	0.335	0	1	1547
11	UMIC (home)	0.145	0.353	0	1	1547
12	Population	29.209	24.546	1.200	160	1547
13	Population density	170.757	205.002	2.462	633.523	1547
14	Rural population	279.016	6347.569	13.852	176645	1547
15	Services value added	55.229	14.118	18.909	70.939	1547
16	Industry value added	32.788	13.738	10.390	77.414	1547

Source: Authors' calculation.

Table 2. Correlation matrix.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Access to electricity	1															
2	Energy intensity	0.1507*	1														
3	Carbon factor	0.0334	-0.0076	1													
4	FDI per capita	0.1121*	-0.0177	-0.0012	1												
5	Inst. quality host	-0.0877*	-0.0209	-0.01	0.0455	1											
6	Inst. quality home	0.7831*	0.1056*	0.03	0.1005*	-0.1098*	1										
7	LIC (host)	-0.5908*	-0.0066	-0.0036	-0.0713*	0.0943*	-0.4604*	1									
8	LMIC (host)	-0.2221*	-0.0332	0.0166	-0.0091	0.0704*	-0.4382*	-0.2401*	1								
9	LIC (home)	0.0756*	0.0017	-0.025	-0.0316	-0.5071*	0.1643*	-0.0552	-0.1106*	1							
10	LMIC (home)	0.0356	-0.0259	-0.0112	-0.0258	-0.4957*	0.0114	-0.0665*	0.041	-0.1231*	1						
11	UMIC (home)	-0.0002	-0.0104	0.0394	0.008	-0.2472*	0.0478	-0.0314	-0.0394	-0.1322*	-0.1585*	1					
12	Population	-0.1211*	0.0898*	-0.0727*	-0.1170*	-0.0344	-0.1849*	0.2121*	-0.2192*	0.0344	-0.0367	0.0486	1				
13	Population density	0.6194*	-0.019	0.0342	0.1696*	0.0131	0.5682*	-0.1645*	-0.1884*	0.0009	0.0166	-0.0553	-0.4690*	1			
14	Rural population	-0.0151	-0.0109	-0.0018	-0.0037	0.025	-0.0604	0.0596	-0.0142	-0.0117	-0.0139	-0.0149	0.1918*	-0.0267	1		
15	Services value added	0.6333*	0.1706*	-0.0358	0.0718*	-0.0882*	0.7609*	-0.2935*	-0.5350*	0.1158*	-0.0002	0.0442	0.1234*	0.4022*	-0.006	1	
16	Industry value added	-0.1617*	-0.0396	0.0452	-0.0125	0.0204	-0.3393*	-0.4192*	0.4882*	-0.0643	0.0154	-0.0414	-0.2673*	-0.2827*	-0.0222	-0.5881*	1

Source: Authors' calculation.

* Significant at least at 1% level.

Table 3. Reverse causality.

VARIABLES	(1) System GMM	(2) Corrected LSDV
FDI per capita t-1	-0.8797***	-1.8835***
	(0.265)	(0.008)
Access to electricity t-1	-0.8505	-4.3452
	(1.679)	(5.957)
Carbon factor t-1	-1.6288***	-0.2057
	(0.565)	(0.427)
Energy intensity t-1	0.0027*	0.0039
	(0.001)	(0.015)
Population t-1	-2.4797*	-7.1074
	(1.355)	(12.098)
Rural population t-1	4.0267	0.7501
	(2.796)	(1.974)
Population density t-1	1.4142**	0.1620
	(0.615)	(0.868)
Industry value added t-1	11.4842**	4.3607
	(4.941)	(15.225)
Services value added t-1	4.3544	-1.5318
	(3.875)	(9.265)
Institutional quality host country t-1	31.0234	247.4987
	(43.999)	(591.758)
Institutional quality home country t-1	122.2123	52.7280
	(88.471)	(219.152)
LIC (host country)	12.4289	1,051.4793***
	(101.356)	(398.639)
LMIC (host country)	-105.0705	233.8412
	(114.419)	(143.959)
LIC (home country)	114.2961	-66.2983
	(183.576)	(70.531)
LMIC (home country)	71.1985	49.1051
	(235.769)	(69.699)
UMIC (home country)	221.6055*	126.4086
	(119.918)	(155.576)
Constant	-200.1359	
	(327.573)	
Year dummy	Yes	Yes
Country pair dummy	Yes	Yes
Observations	1,105	1,326
Number of pair countries	221	221
AR(1)	-2.615986	
AR(2)	-0.557482	
Wald test	219.347258	

Notes: Dependent variable ΔFDI per capita.
Model (1) Two-step system-GMM. Robust standard errors in parentheses. All AR(1) test statistics statistically significant at the 1 percent level. All AR(2) test statistics statistically insignificant. All Wald test statistics statistically insignificant.
Model (2) corrected LSDV. Standard errors in parentheses.
Source: Authors' calculation.

*** Significant at 1 percent level.

** Significant at 5 percent level.

* Significant at 10 percent level.

Table 4. ΔAccess to electricity, System GMM.

VARIABLES	(1) Baseline	(2) Institutions	(3) Income level
Access to electricity t-1	-0.7016***	-0.7064***	-0.7137***
	(0.076)	(0.066)	(0.066)
FDI per capita t-1	0.0003	0.0047**	-0.0004
	(0.002)	(0.002)	(0.001)
Carbon factor	0.0024	0.0025	0.0006
	(0.021)	(0.023)	(0.024)
Energy intensity t-1	0.0000	0.0000	0.0000
	(0.000)	(0.000)	(0.000)
Population t-1	0.1308***	0.1356***	0.1318***
	(0.028)	(0.032)	(0.032)
Rural population t-1	-0.4522***	-0.4499***	-0.4597***
	(0.097)	(0.090)	(0.091)
Population density t-1	0.0536***	0.0543***	0.0546***
	(0.010)	(0.008)	(0.008)
Industry value added t-1	-0.2186	-0.2366**	-0.2368**
	(0.134)	(0.103)	(0.111)
Services value added t-1	0.1513	0.1562	0.1468
	(0.133)	(0.106)	(0.108)
Institutional quality host country t-1	1.2004	1.3744	1.0296
	(1.283)	(0.975)	(0.988)
Institutional quality home country t-1	1.4954	1.4716	1.5137
	(1.538)	(1.112)	(1.156)
LIC (host country)	-12.8475***	-12.9424***	-14.2254***
	(4.291)	(3.222)	(3.860)
LMIC (host country)	-0.9702	-1.0180	-1.7576
	(3.039)	(2.449)	(2.795)
LIC (home country)	2.7130	2.6388	3.1364
	(10.743)	(2.843)	(3.208)
LMIC (home country)	3.5204	3.6167	3.3630
	(3.295)	(2.519)	(2.573)
UMIC (home country)	1.2994	1.1872	1.1832
	(2.436)	(1.596)	(1.686)
FDI per capita t-1* Institutional quality host t-1		-0.0047**	
		(0.002)	
FDI per capita t-1* Institutional quality home t-1		-0.0008	
		(0.002)	
FDI per capita t-1* LIC (host)			0.0637
			(0.101)
FDI per capita t-1* LMIC (host)			0.0041
			(0.007)
FDI per capita t-1* LIC (home)			-0.0159
			(0.083)
FDI per capita t-1* LMIC (home)			0.0052**
			(0.002)
FDI per capita t-1* UMIC (home)			0.0002
			(0.003)
Constant	56.5570***	56.5359***	58.6216***
	(11.559)	(10.175)	(10.937)
Year dummy	Yes	Yes	Yes
Country pair dummy	Yes	Yes	Yes
Observations	1,326	1,326	1,326
Number of pair countries	221	221	221
AR(1)	-5.213	-5.347	-5.361
AR(2)	1.045	1.026	1.023
Wald test	220.208	219.876	219.514

Notes: Dependent variable ΔAccess to electricity. Two-step system-GMM. Robust standard errors in parentheses. All AR(1) test statistics statistically significant at the 1 percent level. All AR(2) test statistics statistically insignificant. All Wald test statistics statistically insignificant. *Source:* Authors' calculation. *** Significant at 1 percent level. ** Significant at 5 percent level. * Significant at 10 percent level.

Table 5. ΔCarbon factor, System GMM.

VARIABLES	(1) Baseline	(2) Institutions	(3) Income level
Carbon factor t-1	-0.8824***	-0.8618***	-0.8495***
	(0.044)	(0.052)	(0.065)
FDI per capita t-1	-0.0004	-0.0060	0.0000
	(0.001)	(0.006)	(0.001)
Access to electricity t-1	0.3215	0.3158	0.1833
	(0.206)	(0.211)	(0.128)
Energy intensity t-1	-0.0001*	-0.0001*	-0.0001
	(0.000)	(0.000)	(0.000)
Population t-1	-0.1098*	-0.1135*	-0.0814
	(0.064)	(0.068)	(0.100)
Rural population t-1	0.1777	0.1333	0.1996
	(0.153)	(0.146)	(0.148)
Population density t-1	-0.0272	-0.0268	-0.0256
	(0.018)	(0.018)	(0.016)
Industry value added t-1	0.1804	0.2004	-0.0680
	(0.206)	(0.211)	(0.132)
Services value added t-1	-0.0390	-0.0439	-0.1518
	(0.149)	(0.146)	(0.168)
Institutional quality host country t-1	1.2974	0.5390	0.1282
	(1.513)	(1.703)	(2.562)
Institutional quality home country t-1	-0.5167	-1.4896	1.5348
	(2.967)	(2.374)	(3.504)
LIC (host country)	11.5041	11.8543	-13.8936
	(9.347)	(9.944)	(11.363)
LMIC (host country)	4.5905	5.7170	1.5225
	(4.614)	(4.780)	(5.547)
LIC (home country)	-2.4090	-5.9453	-1.7583
	(6.948)	(6.237)	(7.934)
LMIC (home country)	0.9605	-7.0864	6.0030
	(8.578)	(5.290)	(9.238)
UMIC (home country)	0.4287	-1.4654	2.7482
	(5.003)	(6.503)	(5.597)
FDI per capita t-1* Institutional quality host t-1		0.0132**	
		(0.007)	
FDI per capita t-1* Institutional quality home t-1		-0.0118	
		(0.009)	
FDI per capita t-1* LIC (host)			1.4570*
			(0.864)
FDI per capita t-1* LMIC (host)			-0.0178*
			(0.011)
FDI per capita t-1* LIC (home)			0.1384
			(0.178)
FDI per capita t-1* LMIC (home)			0.0096
			(0.007)
FDI per capita t-1* UMIC (home)			0.0004
			(0.005)
Constant	-22.1147	-18.3671	0.4545
	(25.306)	(23.314)	(11.000)
Year dummy	Yes	Yes	Yes
Country pair dummy	Yes	Yes	Yes
Observations	1,326	1,105	1,326
Number of pair countries	221	221	221
AR(1)	-1.818063	-1.695632	-2.680101
AR(2)	-1.143935	-1.037315	-0.925980
Wald test	219.939543	213.114038	213.611097

Notes: Dependent variable ΔAccess to electricity. Two-step system-GMM. Robust standard errors in parentheses. All AR(1) test statistics statistically significant at the 1 percent level. All AR(2) test statistics statistically insignificant. All Wald test statistics statistically insignificant. *Source:* Authors' calculation. *** Significant at 10 percent level. ** Significant at 5 percent level. * Significant at 10 percent level.

Table 6. ΔEnergy intensity, system GMM.

VARIABLES	(1) Baseline	(2) Institutions	(3) Income level
Energy intensity t-1	-0.7803***	-0.7800***	-0.7818***
	(0.042)	(0.042)	(0.047)
FDI per capita t-1	0.2380	-1.2440	0.6835
	(0.807)	(1.458)	(0.885)
Carbon factor t-1	10.6549	12.6512	13.1829
	(9.529)	(10.086)	(10.992)
Access tot electricity t-1	99.3563	99.9656	108.5390
	(67.679)	(69.530)	(71.662)
Population t-1	-29.2278	-32.9824	-32.1975
	(20.878)	(21.852)	(22.939)
Rural population t-1	46.8624	54.5833	48.0939
	(69.394)	(70.538)	(65.221)
Population density t-1	-9.4979	-10.0595	-10.2512
	(6.594)	(6.580)	(6.628)
Industry value added t-1	-145.7251*	-148.9869*	-151.2446**
	(74.804)	(82.698)	(74.421)
Services value added t-1	11.0812	3.6026	4.4472
	(53.730)	(59.443)	(60.334)
Institutional quality host country t-1	-2,817.8622**	-2,710.0000**	-2,820.8132**
	(1,242.402)	(1,267.806)	(1,209.651)
Institutional quality home country t-1	2,125.5406*	2,022.0997	2,089.2583*
	(1,209.879)	(1,244.103)	(1,202.856)
LIC (host country)	-4,107.9033*	-4,281.9639*	-3,299.4673
	(2,179.665)	(2,373.451)	(2,683.819)
LMIC (host country)	1,106.2304	1,074.2886	720.2007
	(1,944.905)	(2,038.662)	(1,504.111)
LIC (home country)	4,375.1656	4,465.6801	4,045.4689
	(2,700.898)	(2,980.949)	(2,539.149)
LMIC (home country)	3,638.6141	3,744.6935	3,656.0953
	(2,533.043)	(2,487.944)	(2,505.587)
UMIC (home country)	1,889.7802	2,115.6269*	2,198.7639
	(1,335.889)	(1,177.846)	(1,370.069)
FDI per capita t-1* Institutional quality host t-1		0.0484	
		(2.564)	
FDI per capita t-1* Institutional quality home t-1		3.1271	
		(2.541)	
FDI per capita t-1* LIC (host)			-66.6946
			(62.946)
FDI per capita t-1* LMIC (host)			4.5923
			(7.528)
FDI per capita t-1* LIC (home)			9.7076
			(40.447)
FDI per capita t-1* LMIC (home)			-2.4926
			(1.543)
FDI per capita t-1* UMIC (home)			-4.7942
			(4.343)
Constant	-305.1377	28.4818	-189.3028
	(9,712.948)	(10,284.410)	(9,574.625)
Year dummy	Yes	Yes	Yes
Country pair dummy	Yes	Yes	Yes
Observations	1,326	1,326	1,326
Number of pair countries	221	221	221
AR(1)	-1.811148	-1.808188	-1.837778
AR(2)	-0.783773	-0.794177	-0.696289
Wald test	218.470183	217.799280	214.237699

Notes: Dependent variable ΔAccess to electricity. Two-step system-GMM. Robust standard errors in parentheses. All AR(1) test statistics statistically significant at the 1 percent level. All AR(2) test statistics statistically insignificant. All Wald test statistics statistically insignificant. *Source:* Authors' calculation. *** Significant at 10 percent level. ** Significant at 5 percent level. * Significant at 10 percent level

Table 7. ΔAccess to electricity, corrected LSDV.

VARIABLES	(1) Baseline	(2) Institutions	(3) Income level
Access to electricity t-1	-0.9758***	-0.9784***	-0.9790***
	(0.067)	(0.068)	(0.066)
FDI per capita t-1	0.0003	0.0039*	-0.0005
	(0.001)	(0.002)	(0.001)
Carbon factor	-0.0022	-0.0044	-0.0044
	(0.007)	(0.008)	(0.009)
Energy intensity t-1	0.0003**	0.0003**	0.0003**
	(0.000)	(0.000)	(0.000)
Population t-1	-0.2054**	-0.1958**	-0.1956*
	(0.098)	(0.095)	(0.103)
Rural population t-1	0.0293**	0.0287*	0.0275*
	(0.015)	(0.015)	(0.016)
Population density t-1	0.0034	0.0035	0.0040
	(0.006)	(0.006)	(0.006)
Industry value added t-1	-0.2648***	-0.2651***	-0.2707***
	(0.094)	(0.094)	(0.089)
Services value added t-1	0.0232	0.0323	0.0408
	(0.079)	(0.082)	(0.079)
Institutional quality host country t-1	1.3569	1.4105	0.9827
	(3.474)	(3.486)	(3.052)
Institutional quality home country t-1	7.7974***	7.9859***	7.6277***
	(1.504)	(1.544)	(1.377)
LIC (host country)	-9.6753**	-9.3166*	-10.7395*
	(4.720)	(4.798)	(6.171)
LMIC (host country)	-0.5250	-0.0645	-1.5123
	(1.989)	(2.109)	(3.011)
LIC (home country)	-7.0060***	-5.9730***	-7.2672***
	(0.508)	(0.743)	(0.818)
LMIC (home country)	-2.5128***	-2.2332***	-2.1514***
	(0.127)	(0.190)	(0.169)
UMIC (home country)	-0.5151	-0.1224	-0.2990
	(2.212)	(2.312)	(2.359)
FDI per capita t-1* Institutional quality host t-1		-0.0008	
		(0.001)	
FDI per capita t-1* Institutional quality home t-1		-0.0047***	
		(0.001)	
FDI per capita t-1* LIC (host)			0.0066
			(0.036)
FDI per capita t-1* LMIC (host)			0.0070
			(0.005)
FDI per capita t-1* LIC (home)			0.0344***
			(0.001)
FDI per capita t-1* LMIC (home)			0.0045***
			(0.001)
FDI per capita t-1* UMIC (home)			0.0089***
			(0.001)
Year dummy	Yes	Yes	Yes
Country pair dummy	Yes	Yes	Yes
Observations	1,326	1,326	1,326
Number of pair countries	221	221	221

Notes: Dependent variable ΔAccess to electricity. Corrected LSDV, standard errors in parentheses.

Source: Authors' calculation.

*** Significant at 1 percent level.

** Significant at 5 percent level.

* Significant at 10 percent level.

Table 8. Institutional quality marginal effects.

	System GMM		corrected LSDV	
Host country:	Inst. Qual. Low	Inst. Qual. Low	Inst. Qual. Low	Inst. Qual. Low
Home country:	Inst. Qual. Mean	Inst. Qual. from High to Low	Inst. Qual. Mean	Inst. Qual. from High to Low
FDI per capita → ΔAccess to electricity	0.0165**	0.0032	0.0058*	0.01847***
	(0.007)	(0.006)	(0.003)	(0.004)
FDI per capita → ΔEnergy intensity	-1.3647	-12.3988	-	-
	(7.554)	(10.074)		
FDI per capita → ΔCarbon factor	-0.0389*	0.0469	-	-
	(0.020)	(0.035)		

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.10

Table 9. Income level marginal effects.

	System GMM				corrected LSDV			
Host country:	LIC				LIC			
Home country:	LIC	LMIC	UMIC	HIC	LIC	LMIC	UMIC	HIC
FDI per capita → ΔAccess to electricity	0.0474	0.0634	0.0634	0.0633	0.0404	0.0106	0.0149	0.0061
	(0.122)	(0.100)	(0.100)	(0.101)	(0.035)	(0.033)	(0.034)	(0.035)
FDI per capita → ΔEnergy intensity	-56.3034	-68.504	-70.805	-66.011	-	-	-	-
	(56.973)	(63.330)	(62.999)	(62.856)				
FDI per capita → ΔCarbon factor	1.5954*	1.4666*	1.4574*	1.4570*	-	-	-	-
	(0.921)	(0.863)	(0.863)	(0.864)				

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.10

Appendix

Appendix 1. List of home and host countries of our dataset.

HOME COUNTRIES			HOST COUNTRIES
Angola	Israel	Saudi Arabia	South Africa
Argentina	Italy	Seychelles	Ghana
Aruba	Japan	Singapore	Mauritius
Australia	Kenya	Slovenia	Angola
Austria	Korea, Rep.	South Africa	Cameroon
Bahamas, The	Lebanon	Spain	Congo, Rep.
Bahrain	Liberia	Sri Lanka	Congo, Dem. Rep.
Belgium	Libya	Swaziland	Gabon
Bermuda	Liechtenstein	Sweden	Kenya
Botswana	Luxembourg	Switzerland	Uganda
Brazil	Madagascar	Taiwan, China	Eritrea
Bulgaria	Malawi	Tanzania	Ethiopia
Canada	Malaysia	Thailand	Botswana
Cayman Islands	Maldives	Togo	Namibia
China	Malta	Turkey	Nigeria
Cote d'Ivoire	Mauritius	United Kingdom	
Cyprus	Morocco	United States	
Czech Republic	Mozambique	Uganda	
Denmark	Namibia	United Arab Emirates	
Finland	Netherlands	Uruguay	
France	New Zealand	Yemen, Rep.	
Germany	Nigeria	Zambia	
Ghana	Norway	Zimbabwe	
Greece	Pakistan		
Hong Kong SAR, China	Panama		
Hungary	Paraguay		
Iceland	Philippines		
India	Poland		
Indonesia	Portugal		
Ireland	Russian Federation		