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Foreign land acquisitions and environmental regulations: Does the pollution-haven effect hold?

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Abstract

The recent wave of foreign land acquisitions (FLA) has raised several concerns in terms of their environmental and social sustainability. An unexplored issue is whether pollution-haven mechanisms are driving the pattern of FLA. This paper investigates whether and how differences in environmental stringency between investing and target country affect the pattern of FLA. We estimate a panel gravity equation and use different indexes to measure the environmental stringency. Our results show that, by and large, differences in environmental stringency do affect FLA. The wider the gap in the environmental stringency between the investor and the target country, the higher is the number of firms investing abroad. Our results also show that the impact of environmental stringency differentials on FLA depends on the investor country and on corruption in the target country, and that in a number of estimations the choice over the index of stringency may be a relevant factor.

KEYWORDS

developing countries, environment, foreign land acquisitions, gravity model

JEL CLASSIFICATION

Q17; Q27; F14; F18; F23

1 | INTRODUCTION

Following the 2007–2008 crisis, the growth in the number of foreign land acquisitions (FLA) has been a highly debated issue. In just a few years, millions of hectares in many developing countries have been acquired by private firms, private equity or governments from both developed and developing countries (e.g., Von Braun & Meinzen-Dick, 2009). Serious concerns have been raised mainly by non-governmental organisations (NGOs) and the media about displacement of local communities from the land, and the potentially negative effects of this new wave of land acquisitions on the rural poor and the overall food security of the host economy. On the other hand, international organisations highlight the fact that FLA may provide an opportunity to reverse the long-term trend of under-investment in agriculture in developing countries (FAO, 2013; World Bank, 2011). It is widely held that the implications of FLA largely depend on the nature of and the reasons for such investments (Cotula et al., 2009; Lay & Nolte, 2017; Messerli et al., 2014; Nolte & Voget-Kleschin, 2014; Schoneveld, 2014).

One key issue often mentioned in this debate is the existence of negative environmental externalities. Because FLA lead to the rapid industrialisation of agricultural practices in developing countries, soil depletion, eutrophication and coastal dead zones may well result (Ezarus, 2014). The expansion of large-scale monoculture in developing countries, often involving the felling of forests, has produced a number of negative impacts: more pesticide, fungicides, herbicides and fertilisers have been used with consequent pollution of the downstream waters, loss of biodiversity and emissions of nitrous oxide (UNEP, 2011). The loss of forests and pastures increases carbon dioxide emissions. Further, large scale acquisitions have been shown to put pressure on natural resources, especially in terms of water use, with water pollution, diminished access to clean water and high rates of extraction from rivers (Dell'Angelo et al., 2018). The United Nations Environment Program (UNEP) recommends that developing countries implement and enforce environmental regulations in order to mitigate the potentially negative environmental externalities of FLA (UNEP, 2011).

However, the stringency of environmental regulations in developing countries may itself affect FLA. According to the so-called pollution-haven effect (PHE), to reduce costs firms from countries with stronger environmental regulations locate production in countries with less stringent environmental regulations.[1] A well-developed literature has analysed the relationship between foreign direct investments (FDI) and environmental stringency (see Erdogan, 2014 for a review of this literature) and test empirically the validity of the pollution-haven effect with controversial results.

Do differences in environmental stringency play any role in determining the geographical pattern of FLA? If the pollution-haven effect applies to FLA, then developing countries have to face a trade-off between attracting foreign investments to foster agricultural development and ensuring environmental sustainability. This may create a 'race to the bottom' in environmental standards in the pursuit of foreign investments in agriculture. Environmental stringency could be an important determinant of the worldwide geography of agricultural and food production.

We provide empirical evidence on the impact of environmental stringency on the geographical pattern of FLA. In fact, the few empirical studies on FLA we are aware of have not considered environmental policies as a determinant of FLA (e.g., Arezki et al., 2015; Bujiko et al., 2016; Lay & Nolte, 2017; Raimondi & Scoppola, 2018).

We draw on the pollution-haven effect literature to investigate whether differences in environmental stringency between the investor and the target country affect FLA. The literature

[1] A wide literature has investigated the so-called 'pollution-haven-hypothesis' occurring when the relocation of production in low-standard countries is induced by a trade liberalisation (see, among others, Erdogan, 2014 and Cherniwchan et al., 2017, for a review of this literature). We here limit our discussion to the pollution-haven effect, namely whether more stringent environmental policy adversely affects comparative advantage; indeed, FLA seem driven mostly by factors other than trade liberalisation (Arezki et al., 2015).

has shown that available indicators of environmental stringency may capture different 'dimensions' of the environment (Millimet & Roy, 2016); in our empirical exercise, therefore, we consider different measures of environmental stringency. We use an unbalanced panel of bilateral land acquisitions data including 66 investor countries, 70 target countries, over 9 years. Following the literature analysing the determinants of FDI, we estimate a panel gravity-like equation using the Poisson Pseudo-Maximum-Likelihood estimator (PPML) proposed by Santos Silva and Tenreyro (2006). We base our empirical specification on Bergstrand and Egger (2010, 2013a, 2013b) and Kleinert and Toubal (2010) who provide a rationale for estimating time-varying gravity equations of FDI.

The paper is organised as follows. The next section provides the background on the relationship between environmental regulation stringency and FLA. Section 3 illustrates our empirical strategy and the econometric issues. The fourth section describes the data used for the dependent and the explanatory variables. Section 5 presents and discusses the results of our estimations, and the final section concludes.

2 | ENVIRONMENTAL STRINGENCY AND FOREIGN LAND ACQUISITIONS

Previous works consider FLA as a type of FDI, hence the pattern of FLA draws on the literature on FDI (Arezki et al., 2015; Arezki et al., 2015; 2018; Lay & Nolte, 2018; Raimondi & Scoppola, 2018).[2] FDI are international transfers of capital through which a firm based in one country controls the ownership of an economic activity in another. Land acquisitions often occur through ownership transfers and, thus, typically qualify as FDI. In African countries, long-term land leases prevail, but because of the duration of the contractual arrangements and the frequent commitments of the foreign investors, they are considered, by and large, equivalent to FDI (Cotula et al., 2009; UNCTAD, 2009; World Bank, 2011).

General equilibrium trade models explain both horizontal FDI —the firms' choice of replicating the same activities in different countries—and vertical FDI, that is, the geographical fragmentation of production stages (Antràs & Yeaple, 2014). Whereas horizontal FDI are mostly driven by the need to produce in close proximity to other markets and to save on trade costs, vertical FDI are motivated by the need to reduce the production costs and/or to access natural resources; in the latter case, raw materials and intermediates are produced abroad and then shipped back to the country of origin ('pure' vertical FDI) or to third countries (export-platform FDI) where they are further processed. Empirical specifications used to test general equilibrium models often include, as determinants of FDI, countries' size, factor cost and endowment, trade policies, trade costs and potential sources of friction, such as weak institutions in the host country. The literature has also shown that a gravity equation for FDI could be derived from general equilibrium models of trade and FDI. Bergstrand and Egger (2007, 2010, 2013a, 2013b) and Kleinert and Toubal (2010) proposed a theoretically founded panel gravity equation to estimate the determinants of FDI. Their empirical specification considers three groups of explanatory variables. The first includes bilateral economic size and economic similarity. They are both expected to positively affect FDI, in particular, horizontal FDI; the larger the size of markets, the greater is multinational firms' opportunity to exploit economies of scale. Further, models predict that horizontal FDI also rise with countries' size similarity. The second group consists of the usual gravity covariates (distance, contiguity and language) and trade costs. Although distance is expected to negatively affect vertical FDI, language and contiguity are expected to exert a positive influence. Overall trade costs positively influence the choice of firms to make horizontal FDI, whereas they negatively

[2]A review of the theoretical and empirical literature on the determinants of FDI is, among others, in Antras and Yeaple (2014).

affect vertical FDI. The third group includes variables measuring relative factor endowment, which is expected to positively influence vertical FDI and not to exert any role in driving horizontal FDI.

As for FLA, Arezki et al., (2018) derived a bilateral gravity specification that includes in the right-hand side of the equation, besides the gravity variables, land endowment, labour cost, agricultural productivity and a measure of country's remoteness from agricultural markets. They found empirical evidence that FLA are generally motivated by the desire to access natural resources and to produce products that are then re-exported to the investor country (vertical FDI). Other empirical studies on FLA have also used gravity equations (e.g., Arezki et al., 2015; Lay & Nolte, 2018; Raimondi & Scoppola, 2018) and included land investment drivers, such as land and water endowment, agricultural productivity and land tenure. They confirmed that water and land endowment play a role in determining the pattern of FLA and that foreign investments in land are mostly driven by resource-seeking motives. FLA originate from water and land scarce countries and are located in countries relatively abundant in land and water (Arezki et al., 2015; Lay & Nolte, 2018). More controversial is the effect of the quality of institutions on FLA. Although the general expectation is that weak institutions negatively affect FDI,[3] the relationship between FLA and the quality of institutions may follow a partially different pattern. Indeed, it has often been argued that unlike general FDI, poor governance in the destination countries fosters FLA. The argument is that the weaker the governance, the easier it becomes for the investor to acquire large-scale portions of land. Available evidence shows that institutional quality in the target country (measured in terms of governance indicators and corruption) does not affect the decision about where to invest in land (e.g., Arezki et al., 2015; Arezki et al., 2015, 2018). Rather, institutional distance seems to be more important. Raimondi and Scoppola (2018) found that the greater the gap in governance and democracy between the investor and the target countries, the lower is FLA.

Whether environmental standards influence FLA is an open question that, to the best of our knowledge, has been not addressed to date by this literature. Indeed, none of the abovementioned studies includes measures of environmental stringency among the explanatory variables.

The literature on FDI has widely investigated the validity of the pollution-haven effect (PHE), that is, whether firms locate production activities in countries with less stringent environmental regulations (Erdogan, 2014; Cole et al., 2017). Indeed, asymmetric environmental policies may induce first-order effects, that is, changes in production costs, and second and third order-effects, that is, responses by firms in terms of output, price or foreign investment (Dechezlpretre & Sato, 2017). Firms decide to produce at home or abroad by comparing relative costs. Environmental policies may significantly affect the cost of production abroad vis-à-vis production at home. Thus, everything else being equal, firms are expected to offshore production because of the home country's more stringent environmental policy (Cherniwchan et al., 2017). Do similar mechanisms also apply to foreign investments in land?

In the case of FLA, it might be that foreign firms choose to locate production in countries with weak environmental regulations and few restrictions on deforestation, so that large-scale, highly polluting monoculture can be easily expanded. Forestry protection may be a barrier for FLA (Carter et al., 2017); stringent environmental regulations—for example, limits on the use of fertilisers—reduce yields and increase variable production costs. Because of different environmental regulations, barriers to entry and variable costs vary across target countries; this may well affect the decision both on where and how much to invest, especially when the acquisition of land is driven by the need to access natural resources and to produce raw materials, which are then shipped back home or to third countries for processing (vertical or

[3]There is rough consensus that good governance in the target country, by improving the overall investment climate, does increase FDI (see among others, Bénassy-Quéré et al., 2007; Globerman & Shapiro, 2002).

export-platform FLA). These effects may be amplified by the environmental stringency of the investor country. Firms originating from countries with strict environmental standards are more likely to be attracted to countries with weak standards. Hence, everything else being equal, the wider the gap in environmental stringency between the investor and the target country, the higher the number and size of land acquisitions is expected to be.

The literature testing the PHE has found rather conflicting results (see Erdogan, 2014 for a review). Indeed, most early cross-country and cross-industry studies do not find empirical evidence of the PHE and actually find some counter-intuitive results. More recent studies have investigated the reasons for these mixed results. New theoretical models suggest that firms may prefer to relocate to relatively higher-regulation countries because the benefit of lower environmental costs could be more than offset by pull factors, such as agglomeration economies, raw material supplies, skilled labour, availability of capital and infrastructure (Cole et al. 2017). A number of factors contribute to explain the lack of clear-cut evidence.

First, environmental stringency is likely to be endogenous, being correlated with other unobserved factors (such as corruption, weak governance or agglomeration effects). Smarzynksa and Wei (2003) controlled for the level of corruption in the target country because a high level of corruption may prevent firms from locating production in that country, despite the laxity of environmental regulations. As corruption and environmental laxity are likely to go hand in hand, the omission of corruption may be a reason for the lack of empirical confirmation of the PHE. Kalamova and Johnstone (2011) investigated a similar issue, by checking a quadratic relationship between the gap in environmental stringency and FDI. In their view, environmental regulations serve as a signal of the investment climate. Above a certain threshold, the higher the gap in environmental stringency, the lower the FDI; very weak environmental regulation in the target country may deter investors, because it is a signal of a poor investment climate. This could reasonably hold for FLA as well. Indeed, target countries are mostly developing countries and corruption is, by and large, considered an important determinant of land investments (e.g., Arezki et al., 2015; Lay & Nolte, 2018). Kalamova and Johnstone (2011) also found that characteristics of the investor country could influence the relationship between environmental stringency and FDI. In the specific case of FLA, only about half of investments originate from advanced countries; it is likely that the other half involving firms from low-middle income countries may well behave differently.

Furthermore, Cole et al., (2006) investigated the effect of FDI on local environmental policy and found that inward FDI has a positive impact on the stringency of environmental regulations when the level of corruptibility is low.[4] This highlights a further reason for endogeneity, that is, reverse causation, in that FDI can influence environmental regulations. On one hand, dirtier foreign firms may exert pressure on local governments to lower the stringency of their environmental regulation; on the other hand, greener firms might lobby governments for higher environmental standards to reduce competition in the target country (Poelhekke & Ploeg, 2015; Cole et al., 2017). This potential source of endogeneity cannot be excluded for FLA and needs to be addressed.

Second, measuring environmental stringency is a challenging task, because of the multidimensionality and complexity of the environment (Brunel & Levinson, 2016). Environmental stringency cannot be captured by a single measure; further, the measurement used should match the policy issue addressed. In such circumstances, measurement errors are highly likely to occur (Millimet & Roy, 2016).

Third, ignoring factor endowment differentials may be one of the reasons for the insufficiency of PHE evidence. Indeed, if capital intensive industries are also more polluting, then firms wishing to reduce costs will locate production in countries with a relatively high capital/labour ratio and weak environmental standards. When controlling for factor endowments, the PHE turns out to be empirically verified (Cole & Elliott, 2005). In the case of FLA, it is very

[4]They also found that at higher levels of corruption this impact is lessened and eventually becomes negative.

likely that intensive exploitation of natural resources will be located in countries relatively abundant in natural resources and with weak environmental protection.

In our empirical exercise we take into account the above issues and check three main hypotheses: (a) Do differences in the stringency of environmental regulations between the investor and the target country affect the decision to invest abroad and the size of investments? (i.e., does the PHE hold for FLA?); (b) Does the effect depend on the characteristics of the investor country? (c) Does this impact depend on the level of corruption in the target country?

3 | EMPIRICAL STRATEGY

To assess the impact of differences in countries' environmental stringency, we use a gravity model. Unlike previous studies using cross-sectional data (e.g., Arezki et al., 2015, 2018), we use a panel gravity framework to explain FLA. The main reason is that, as shown in the next section, the data cover a long period, and time-varying factors are likely to significantly influence the pattern of FLA. We build our empirical specification on the theoretically founded panel gravity equation to estimate the determinants of FDI (Bergstrand & Egger, 2007, 2010, 2013a, 2013b; Kleinert & Toubal, 2010), and consider land-specific drivers of foreign investments by including countries' relative land endowment and agricultural productivity.

Our dependent variable is somewhat different from the usual measures of FDI. As explained in Section 4, data on FLA provide the number of contracts and the amount of land acquired. We use both measures of FLA as dependent variables, because they provide us with different information on FLA; whereas the number of contracts proxies the number of investing firms, the amount of land proxies the size of investments. In this way, we can distinguish the effect of the environmental stringency on the number of investing firms (i.e., on the decision to invest, the so-called extensive margin) from the impact on the size of the investments (the intensive margin).[5]

Our basic equation is:

$$\ln fla_{ij,t} = \beta_0 + \beta_1 \boldsymbol{X}_{ij,t} + \beta_2 \boldsymbol{Z}_{ij} + \beta_3 I_{ij,t} + \alpha_{it} + \alpha_{jt} + \varepsilon_{ij,t} \quad (1)$$

where $fla_{ij,t}$ is the stock of contracts signed (or of hectares acquired) by country i, in country j at time t; $\boldsymbol{X}_{ij,t}$ denotes a vector of control variables (i.e., relative factor endowment, economic size, agricultural productivity and institutional distance);[6] $\boldsymbol{Z}_{ij}$ is a vector of gravity covariates including the geographical distance, and two dummies equal to one if countries share a common language, or have previous colonial relationships, and zero otherwise; and $I_{ij,t}$ is a measure of the differences in environmental stringency between the two countries. More specifically, $I_{ij,t}$ is the gap between the investor and the target country, with respect to the level of environmental stringency in the former. A positive and significant β_3 suggests that the greater the difference in environmental stringency among investor and target countries, the higher the FLA.

A key issue of gravity specifications is how to control for multilateral price terms (see Anderson & van Wincoop, 2003; Baier & Bergstrand, 2007). In a panel data setting, the multilateral price terms tend to be time-variant, and so the gravity equation should include time-varying country dummies to account for time-varying multilateral-resistance terms as well as to eliminate the bias from the 'gold-medal error' identified by Baldwin and Taglioni, (2006).[7]

[5] It is worth noting that, although the impact of the stringency of environmental regulations of FLA may well vary with the type of agricultural production, information about the type of agricultural production on the land acquired is poor; hence, we follow previous studies and use aggregated FLA data.

[6] As explained in the data section, we do not include in our specification economic similarity because of collinearity.

[7] The gold medal error refers to estimation biases arising from the exclusion of the time-varying multilateral resistance term: in that case, residuals are correlated with trade costs.

Thus, in our specification, we include investor country-year (α_{it}) and target country-year (α_{jt}) fixed effects, which capture the impact of all time and country-time-varying factors on FLA, such as the shocks in international agricultural markets.[8]

Finally, in order to check our third hypothesis, we estimate a second specification of the gravity equation, checking whether the environmental stringency impact depends on the level of corruption in the target country. Hence, we interact our environmental stringency gap indexes with a measure of the level of corruption in the target country (CPI_{jt}).[9]

$$\ln fla_{ij,t} = \beta_4 + \beta_5 \boldsymbol{X}_{ij,t} + \beta_6 \boldsymbol{Z}_{ij} + \beta_7 \boldsymbol{I}_{ij,t} + \beta_8 \boldsymbol{I}_{ij,t} * CPI_{j,t} + \alpha_{it} + \alpha_{jt} + \varepsilon_{ij,t} \quad (2)$$

A negative and significant β_8, (with $\beta_7 > 0$), suggests that a high corruption in the target country reduces the pollution-haven mechanism.

From an econometric point of view, the main issue in estimating the gravity equations above is related to the choice of the best estimator to identify the effect of the gap in environmental stringency on FLA. The first question to take into account is the selection bias, as defined by Heckman (1979), arising from the high number of zeros in our dataset.[10] The second issue concerns heteroscedasticity, which leads to biased estimates when the gravity equation is log-linearised, rather than estimated in levels (Santos-Silva & Tenreyro, 2006). These problems are tackled in the literature by applying either the Heckman selection correction (Helpman et al., 2008) or the PPML estimator proposed by Santos Silva and Tenreyro (2006). Due to the panel structure of our dataset, we prefer to use the latter estimator to avoid the incidental parameter problem at the first stage (probit) Heckman model. Moreover, Santos Silva and Tenreyro (2006, 2011) have shown that this estimator, robust to different patterns of heteroscedasticity and measurement error, is particularly suitable in the presence of many zeros.

The third issue concerns the potential endogeneity of environmental stringency. Baier and Bergstrand (2007) have shown that a panel approach, including appropriate fixed effects, considerably reduces the risk of endogeneity bias due to selection and omitted variables. However, as mentioned before, we cannot exclude that, in this specific context, endogeneity may also arise from reverse causality (i.e., FDI influence environmental stringency). Our policy variable is bilateral (measured as the relative difference in countries' stringency) and this may partially offset this source of endogeneity bias. Nevertheless, we check the robustness of our results by using instrumental variables estimations as well.

4 | THE DATA

4.1 | Foreign land acquisitions

Our data on FLA are drawn from Land Matrix.[11] Among other aspects this database reports, for each recorded deal, target country, investor name and country of origin, the size of the area, the nature of the deal (sale, lease or concession), and type of data. Data come from a variety of sources including research papers and policy reports by international, local organisations and NGOs; personal information contributed through the Global Observatory

[8]We also checked the hypothesis of a non-linear relationship by using a quadratic functional form, as suggested by Kalamova and Johnstone (2011). However, our results, available upon request, do not confirm this hypothesis.

[9]Note that the $CPI_{j,t}$ term is omitted from the equation as it is captured by the target country time dummy (α_{jt}).

[10]Overall, in the panel used for our estimations, 92% of our country-pair-year data is zero.

[11]The Land Matrix Global Observatory is a database compiled by NGOs and research institutes coordinated by the International Land Coalition (Anseeuw et al., 2012). Our dataset is the one used by Raimondi and Scoppola (2018); the source and the amount of hectares have been verified for each deal downloaded from Land Matrix (until October 2015); more details can be found there.

website; field-based research projects; official government records; company websites; media reports. Because our focus is on land acquisitions by foreign firms, we have only considered deals where at least one foreign firm is involved. Our database covers 1050 deals overall.[12]

By using the investor-country origin and the target-country destination information reported by the Land Matrix dataset, the hectares acquired and the number of contracts have been aggregated at country level and cumulated over the analysed period.[13] The final (bilateral) country level dataset includes the stock of FLA from one investor country to a target country, during the period 2000–2015, and considers 109 different countries. Accordingly, squaring the dataset, our unbalanced panel of bilateral data includes 66 investor countries, 70 target countries and a period of 16 years. The idea behind the selection of countries included in the sample is that all 66 countries reporting at least one contract with one of the 70 target countries are considered as potential investors over the analysed period. This implies a considerable number of zeros, mainly concentrated in the years 2000–2006, as the majority of contracts were made after the 2007 crisis. Because of this high percentage of zeros in the first period and because the time series of our environmental regulation indexes starts from 2007, we limit the analysis to the period 2007–2015.[14] Overall, OECD investors account for almost 50% of contracts and 60% of the hectares of land acquired, whereas they play a negligible role as target countries in terms of both the number of deals and hectares.

The quality of Land Matrix data is a major issue for empirical analyses. These data have been criticised because a large part comes from non-governmental sources, such as media reports (e.g., Oya, 2013). Thus, following Raimondi and Scoppola (2018), we check the robustness of our results by considering only the most reliable data sources. In the context of FLA, official data released by governments are, by and large, reliable. In addition, information released by firms is usually likely to be reliable as well, because it is generally verified by government agencies, for example, for tax purposes; furthermore, with public companies, shareholders have an interest in checking the accuracy of the information released by firms. Hence, we check the robustness of our results through the use of reliable sources, namely governments and firms.

4.2 | Gravity and control variables

Data on country distance, and the other gravity variables used in similar exercises such as dummies for common language and colonial relationship, come from CEPII (Centre d'Etude Prospectives et d'Informations Internationales). Dummies are equal to one if two countries speak a common language or if countries were once in a colonial relationship, and zero otherwise.

Bilateral economic size is measured by the log of the sum of the countries' GDP (Bergstrand & Egger, 2010, 2013a, 2013b). GDP data come from the World Development Indicators (WDI) of the World Bank.[15]

[12]As only concluded deals were considered, for sake of simplicity, from now on we will refer to them as 'contracts'.

[13]As is the case for overall FDI, in principle the country of origin of firms investing in land may be biased. This mostly occurs when the investor locates headquarters in tax havens for fiscal purposes. In the specific context, this potential bias seems to be negligible. Out of 1050 land deals, only two originate from one of the countries (Cayman Islands) considered as a potential tax haven by the EU (https://www.consilium.europa.eu/en/policies/eu-list-of-non-cooperative-jurisdictions/). As suggested by a reviewer, it is anyway important to take into consideration that the investors' headquarter location is here assumed to represent the point of reference, although there might be multinational investors.

[14]The list of investor and target countries included in the dataset is reported in the Appendix S1 (Table A1).

[15]We have also included a measure of the GDP similarity, measured as log $[(GDP_i)*(GDP_t)/(GDP_i + GDP_t)^2]$. However, we cannot include both GDP variables (bilateral economic dimension and economic similarity) because of collinearity. There is no change in all the estimated results when the GDP sum is used rather than GDP similarity.

As for the relative factor endowment, drawing on relevant literature (see Section 2), we consider two variables: the relative endowment in land (*RLE*) and the relative endowment in skilled labour (*RSE*).

We compute *RLE* as the difference between the share of the investor's agricultural land, in logarithm, and the share of the investor's non-agricultural land, in logarithm:[16]

$$RLE = \ln\left[Al_i/(Al_i + Al_j)\right] - \ln\left[NAl_i/(NAl_i + NAl_j)\right] \quad (4)$$

Al being agricultural land and *NAl* non-agricultural land. Data on agricultural land are from WDI and include arable, under permanent crops and permanent pasture areas. A low (high) *RLE* implies that the investor (target) country is relatively scarce in agricultural land. We expect *RLE* to have a negative influence on FLA. This reflects the idea that countries with relatively poor endowment in agricultural land are more likely to embark on FLA (and less likely to host FLA) than relatively well-endowed countries.

As for the relative endowment in skilled labour (*RSE*), we use the percentage of secondary school enrolment sourced from WDI.[17] Countries with relatively high shares of unskilled labour will be attractive locations for foreign firms due to lower wages (Bergstrand & Egger, 2010). We hence expect that the difference in skilled labour endowment between the investor and the target country positively affects FLA because firms from countries relatively abundant in skilled labour, by investing abroad, may reduce the cost of unskilled labour. Agricultural productivity is here measured by the value added per worker at constant price sourced from the WDI database. We expect differences in the agricultural productivity between the investor and the target country to be positively related with FLA. The main reason is that countries with a high productivity are likely to originate more multinational firms investing abroad in land (Arezki et al., 2015, 2018).

As for the differences in institutional quality, we use a democracy index published by Polity IV (*Polity*).[18] This provides a single regime score that ranges from +10 (full democracy) to −10 (full autocracy) and reflects the openness and the competitiveness of the political process. Following Bénassy-Quéré et al., (2007) and Aleksynska and Havrylchyk (2013), we construct a measure of institutional 'distance' as the absolute difference between the origin and the destination country.

To check robustness, we run estimations by substituting *Polity* with an alternative proxy of institutional distance—a measure of political rights sourced from Freedom House[19]—and by including additional bilateral-time variant variables measuring the overall investment climate that is considered to influence the pattern of FLA. In particular, we consider two variables. The first is *Business regulation* from Fraser which is a composite index of six sub-components measuring, among others, bureaucratic costs, extra-payments for bribes and the cost of tax compliance.[20] The second is the *Ease of doing business* index from the World Bank. All variables are computed as the absolute difference between the origin and the destination country.

[16]Non-agricultural land is measured as the difference between a country's total area and agricultural land. Both data come from WDI database by the World Bank

[17]Both RSE and agricultural productivity variables are computed as the investor and target country difference with respect to the investor level.

[18]See http://www.systemicpeace.org/inscrdata.html. In particular, we use the Polity2 variable, a modified version of the Polity variable, in order to facilitate the use of the measure in time-series analyses.

[19]https://freedomhouse.org/report-types/freedom-world

[20]http://www.freetheworld.com

TABLE 1 Impact of environmental stringency differences on the number of contracts.

	Total investor countries				OECD investor				Non-OECD investor			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
EPI	1.61				6.07**				1.29			
	(1.18)				(3.09)				(2.07)			
EH		−0.89				1.38				−5.11***		
		(0.67)				(2.08)				(1.03)		
EV			4.39***				−2.62				11.83***	
			(0.94)				(2.94)				(1.69)	
WEF				8.19***				11.92***				3.82***
				(1.56)				(3.05)				(1.47)
Log Distance	−1.42***	−1.44***	−1.40***	−1.53***	−1.08***	−1.07***	−1.08***	−1.25***	−2.19***	−2.32***	−2.15***	−2.34***
	(0.06)	(0.06)	(0.05)	(0.06)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.12)	(0.10)	(0.12)
Common Language	0.85***	0.83***	0.85***	1.01***	1.00***	1.01***	1.00***	1.26***	0.36**	0.32*	0.46***	0.16
	(0.08)	(0.09)	(0.08)	(0.10)	(0.11)	(0.11)	(0.11)	(0.13)	(0.17)	(0.17)	(0.16)	(0.21)
Colonial Relation	0.40***	0.40***	0.39***	0.28***	0.42***	0.41***	0.41***	0.27**	0.49*	0.69***	0.34	−0.03
	(0.10)	(0.10)	(0.10)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.27)	(0.25)	(0.25)	(0.38)
GDPSum	0.31***	0.35***	0.34***	0.40***	0.03	0.05	0.06	0.05	0.96***	1.27***	1.10***	1.16***
	(0.06)	(0.07)	(0.06)	(0.07)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)	(0.11)	(0.10)
RLE	0.40***	0.41***	0.40***	0.25**	0.44***	0.45***	0.45***	0.53***	0.88***	0.93***	0.88***	−0.01
	(0.08)	(0.07)	(0.08)	(0.12)	(0.15)	(0.15)	(0.16)	(0.20)	(0.17)	(0.19)	(0.17)	(0.10)
RSE	2.88***	3.43***	2.81***	1.72***	0.43	0.83	1.07	0.41	6.68***	7.46***	6.41***	4.85***
	(0.39)	(0.35)	(0.41)	(0.37)	(1.38)	(1.31)	(1.40)	(1.26)	(0.81)	(0.72)	(0.78)	(0.48)
Agr. Productivity	−0.00***	−0.00*	−0.00***	−0.00	0.06***	0.06***	0.06***	0.06***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.02)	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)
Institutional dist.	−0.97***	−1.03***	−0.99***	−0.87***	−0.88	−0.99	−1.67	−1.10	−1.35***	−1.43***	−1.47***	−0.76***
	(0.13)	(0.12)	(0.13)	(0.13)	(1.31)	(1.67)	(1.21)	(1.45)	(0.22)	(0.21)	(0.21)	(0.14)
Obs.	26,308	26,308	26,308	22,929	10,564	10,564	10,564	9530	9631	9631	9631	7927
Pseudo R^2	0.54	0.54	0.54	0.55	0.40	0.40	0.40	0.40	0.70	0.70	0.70	0.72

Notes: EPI (Environmental Performance Index), *EH* (Environmental Health), EV (Ecosystem vitality), and *WEF* (World Economic Forum index on the perceived stringency of environmental regulations) are computed as the investor and target countries' differences with respect to the investor level (see text). Robust standard errors in parentheses. All regressions use the PPML estimator and include investor-year and target-year fixed effects not reported. ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

TABLE 2 Impact of environmental stringency differences on the hectares acquired.

	Total investor countries				OECD investor				Non-OECD investor			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
EPI	−11.32***				10.27**				−20.91***			
	(2.08)				(4.46)				(3.26)			
EH		−7.57***				−4.26**				−10.44***		
		(1.04)				(1.91)				(1.44)		
EV			−2.45				10.99				−4.91	
			(2.24)				(6.77)				(3.45)	
WEF				2.19				25.20***				8.94**
				(3.12)				(8.00)				(3.57)
Log Distance	−1.22***	−1.24***	−1.15***	−1.19***	−0.44**	−0.50**	−0.42**	−0.66***	−2.12***	−2.25***	−1.95***	−2.14***
	(0.10)	(0.10)	(0.10)	(0.10)	(0.21)	(0.21)	(0.20)	(0.17)	(0.16)	(0.18)	(0.13)	(0.15)
Common Language	0.48***	0.42***	0.50***	0.69***	0.07	0.04	0.03	0.16	1.32***	1.27***	1.18***	0.96***
	(0.15)	(0.14)	(0.15)	(0.20)	(0.19)	(0.20)	(0.19)	(0.21)	(0.27)	(0.27)	(0.28)	(0.28)
Colonial Relation	0.28	0.31	0.29	0.10	0.41*	0.41*	0.46**	0.48**	1.94***	1.49***	1.40***	1.02***
	(0.24)	(0.24)	(0.23)	(0.25)	(0.21)	(0.21)	(0.20)	(0.21)	(0.31)	(0.26)	(0.34)	(0.31)
GDPSum	0.25**	0.30***	0.15	0.12	0.47***	0.50***	0.44***	0.24	0.48***	0.84***	−0.03	0.64***
	(0.10)	(0.11)	(0.11)	(0.12)	(0.16)	(0.16)	(0.16)	(0.17)	(0.16)	(0.19)	(0.19)	(0.15)
RLE	−1.28***	−1.33***	−1.26***	−1.58***	−2.23***	−2.23***	−2.22***	−1.64***	0.64***	0.73***	0.64***	0.22
	(0.26)	(0.28)	(0.25)	(0.46)	(0.25)	(0.26)	(0.25)	(0.38)	(0.10)	(0.10)	(0.13)	(0.30)
RSE	3.49***	3.49***	1.05	−1.48**	−4.88*	−2.64	−4.24	−9.49***	11.51***	12.18***	9.14***	1.68**
	(1.02)	(0.89)	(1.17)	(0.68)	(2.81)	(2.73)	(2.76)	(2.87)	(1.75)	(1.70)	(2.04)	(0.73)
Agr. Productivity	0.00	0.01**	−0.00	0.00***	0.03	0.09***	0.05**	0.06**	0.02***	0.03***	0.01***	0.02***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.03)	(0.02)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)
Institutional dist.	−1.54***	−1.53***	−1.41***	−2.04***	−1.05	−5.87**	−3.32	3.82	−3.45***	−3.56***	−3.55***	−2.67***
	(0.27)	(0.24)	(0.29)	(0.33)	(2.61)	(2.43)	(2.53)	(2.96)	(0.45)	(0.45)	(0.47)	(0.43)
Obs.	26308	26308	26308	22929	10564	10564	10564	9530	9631	9631	9631	7927
Pseudo R^2	0.63	0.63	0.62	0.58	0.64	0.64	0.64	0.58	0.77	0.78	0.76	0.74

Notes: EPI (Environmental Performance Index), *EH* (Environmental Health), *EV* (Ecosystem vitality), and *WEF* (World Economic Forum index on the perceived stringency of environmental regulations) are computed as the investor and target countries' differences with respect to the investor level (see text). Robust standard errors in parentheses. All regressions use the PPML estimator and include investor-year and target-year fixed effects not reported.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

4.3 | Environmental stringency variables

Many sources provide cross-country measures of environmental stringency, but most come with limitations (Booth, 2017). One of the main drawbacks of the available databases is their poor country coverage. Most databases include OECD countries and a limited number of non-OECD countries. In our case this severely limits the empirical analysis, because FLA typically involve many non-OECD countries. The time coverage of the data is also an important issue in panel gravity analysis, and the limited frequency of most databases is another serious drawback. Moreover, a number of databases mostly provide qualitative information, which is hard to use in empirical analysis. Finally, databases differ significantly also in terms of the policies considered, and provide measures of environmental policies that might not be particularly relevant for FLA.

Taking all this into account, we use the environmental performance index (*EPI*),[21] which offers considerable advantages. First, the country coverage is wide, including 180 countries, both developing and developed. Second, time series data are available for the whole period considered (2007–2015). Third, these composite indexes take into account the multidimensional nature of environmental regulations (Brunel & Levinson, 2016). *EPI*, constructed through the calculation and aggregation of more than 20 indicators reflecting environmental data at national level, measures how well countries perform on high-priority environmental issues under two broad policy areas: Environmental Health (*EH*—measuring the protection of human health from environmental harm) and Ecosystem Vitality (*EV*—measuring ecosystem protection and resource management).[22] The two components of the environmental performance index, *EV* and *EH*, capture different dimensions. *EV* includes various aspects (e.g., protection of biodiversity and forests) that are likely to influence directly and negatively the costs of large-scale intensive monoculture. This is not the case for the *EH*; indeed, a higher *EH*—which means, for example, more drinking water or less exposure to particle pollution—is not likely to imply higher agricultural costs for firms. Hence, we expect *FLA* to be positively or uninfluenced by *EV* distance, depending on whether a pollution-haven mechanism is or is not in place. Conversely, FLA could, in theory, even be negatively affected by greater *EH* distance, in that *EH* could be considered as an indicator of a specific dimension of countries' investment climate, that is, the overall environmental quality of the location where firms do invest abroad.

To check our results, we also use another index of environmental stringency sourced from the World Economic Forum 'Executive Opinion Survey' (*WEF*).[23] The *WEF* index ranges from 1 (lax environmental regulation) to 7 (most stringent environmental regulations). Unlike the *EPI* indexes, this index is a measure of the *perceived* stringency of environmental regulations by business managers.[24]

[21]The Environmental Performance Index is a project led by the Yale Center for Environmental Law and Policy (YCELP) and the Yale Data-Driven Environmental Solutions Group at Yale University (Data-Driven Yale), the Center for International Earth Science Information Network (CIESIN) at Columbia University, in collaboration with the Samuel Family Foundation, McCall MacBain Foundation, and the World Economic Forum (http://epi.yale.edu/data).

[22]More specifically, the *EH* index is based on 6 indicators measuring air quality, water and sanitation, and heavy metals, whereas the *EV* index is based on 18 indicators related to biodiversity and habitat, forests, fisheries, climate and energy, air pollution, water resources and agriculture. Although *EH* 'rises with economic growth and prosperity, *EV* comes under strain from industrialization and urbanization' (https://epi.envirocenter.yale.edu). The *EPI* indicators use a 'proximity-to-target' methodology that assesses how close a country is to a high-performance benchmark. Scores are then converted to a scale of 0–100, with 100 being the highest environmental performance (closest to the target).

[23]https://www.weforum.org/

[24]Respondents (usually CEOs) were requested to indicate the 'stringency' of a country's overall environmental regulation performance, using a Likert scale: 1 = lax compared with that of most other countries; 7 = among the world's most stringent.

Figure A1 (Appendix S1) plots the size of the investments against the environmental stringency gap—measured as the difference in the *EPI* between investor and target country with respect to the level of the investor country—for two groups of investor countries, OECD and non-OECD. Several factors influence FLA, thus the absence of a clear-cut pattern in the bivariate relationship is hardly surprising. Nevertheless, the data seem to suggest that the origin of the investor may matter. Indeed, for OECD investors the gap in stringency seems to be generally associated with larger investments, whereas this is not the case with non-OECD investors.[25] This confirms the importance of investigating the issue of the PHE and FLA for the two groups of investors.

To check whether the impact of the environmental stringency depends on the level of corruption in the target country we use a measure of corruption, *CPI*, provided by Transparency International.[26] This composite index is a combination of surveys and assessments of corruption collected by a variety of reputable institutions, and measures the perceived level of corruption in a given country's public sector. *CPI* ranges from 0 to 10, with 0 corresponding to the highest level of corruption. We normalise and reverse the index between 0 and 1, with 1 being the highest level of corruption. Figure A2 (Appendix S1) plots the size of the investments against the level of corruption of the target countries, for countries involved in FLAs. At first glance, it seems that the relationship is positive for both groups of countries; the impact of corruption on the likelihood of the pollution-haven mechanism will be empirically checked through the econometric analysis.

5 | RESULTS

Table 1 and Table 2 report the results obtained by estimating Equation (1), when the dependent variable is the number of contracts and the amount of acquired land, respectively. As mentioned, the number of contracts reasonably proxies the number of firms; in our database, for any country-pair, each firm is involved in just one project. Hence, results in Table 1 may be interpreted as the impacts on the 'extensive' margin of FLA (the decision of firms on whether to acquire land). Hectares measure the size of the investments; so results in Table 2 may be interpreted as the impacts on the decision of firms on how much land to acquire. We estimate Equation (1) also by splitting the dataset in OECD investors (Columns 4 to 8) and non-OECD investors (Columns 9 to 12). As mentioned, it is likely that firms from developed countries react in a different manner with respect to those from developing countries (Kalamova & Johnstone, 2011).[27]

The traditional gravity variables, by and large, influence FLA and present the expected signs across all estimations. Geographical distance exerts a negative impact on both dependent variables across all our estimations, suggesting the prevalence of vertical FDI. Common language positively affects FLA, showing that country pairs sharing a common language tend to invest more in each other, than otherwise. Conversely, the coefficient of 'colonial relation' has a significant positive impact in a number of estimations and, more specifically, it turns out to influence the number of contracts when the investor is from an OECD country, and the hectares of land when the investor is from a non-OECD country.

[25]The correlation between the number of contracts and the gap in *EPI*—which is not reported because of space constraints—confirms that the two groups of countries show a different pattern.

[26]http://www.transparency.org/research/cpi/

[27]To check whether parameters of one group (OECD investors) are equal to those of the other group (non-OECD investors), we performed the Chow Test. The test results show that the null hypothesis of equal slope and intercept (data can be pooled) is rejected, and the use of the two groups of the data is preferable (e.g. Table 1, columns 1, 5, and 9: $F = 23.69$).

TABLE 3 The impact of environmental stringency differences and corruption (number of contracts).

	OECD investor				Non-OECD investor			
	EPI **(1)**	***EH*** **(2)**	***EV*** **(3)**	***WEF*** **(4)**	***EPI*** **(5)**	***EH*** **(6)**	***EV*** **(7)**	***WEF*** **(8)**
Env. Stringency	40.51***	26.68***	6.97	11.20***	−7.97***	−9.62***	18.70***	15.36***
	(7.93)	(5.80)	(5.50)	(2.98)	(3.09)	(1.20)	(3.99)	(1.83)
Env. Str.*CPI_target	−63.85***	−43.76***	−14.22**	−22.55***	17.27***	7.99***	−13.79**	−28.86***
	(11.90)	(8.10)	(6.47)	(4.65)	(4.41)	(1.60)	(6.73)	(2.56)
Log Distance	−1.17***	−1.08***	−1.12***	−1.27***	−2.20***	−2.33***	−2.15***	−2.38***
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.12)	(0.10)	(0.10)
Common Language	0.87***	0.91***	0.95***	1.19***	0.30*	0.27	0.42**	0.20
	(0.13)	(0.12)	(0.12)	(0.13)	(0.17)	(0.18)	(0.17)	(0.22)
Colonial relation	0.58***	0.49***	0.48***	0.35***	0.29	0.54**	0.36	−0.11
	(0.13)	(0.12)	(0.11)	(0.12)	(0.29)	(0.25)	(0.25)	(0.38)
GDPSum	0.16**	0.11	0.08	0.15*	0.95***	1.24***	1.09***	1.22***
	(0.08)	(0.08)	(0.10)	(0.09)	(0.10)	(0.11)	(0.11)	(0.10)
RLE	0.50***	0.25*	0.55***	0.67***	0.87***	0.90***	0.89***	0.03
	(0.17)	(0.14)	(0.17)	(0.23)	(0.17)	(0.19)	(0.17)	(0.09)
RSE	−1.03	−0.16	0.45	−0.17	6.69***	7.45***	6.26***	4.56***
	(1.21)	(1.08)	(1.40)	(1.21)	(0.79)	(0.74)	(0.78)	(0.46)
Agr. Productivity	0.05***	0.06***	0.06***	0.06***	0.01***	0.01***	0.01***	0.01***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Institutional dist.	6.62***	12.07***	−1.44	0.42	−1.32***	−1.42***	−1.51***	−0.48***
	(1.61)	(3.09)	(1.24)	(1.53)	(0.24)	(0.23)	(0.22)	(0.13)
Obs.	10155	10155	10155	9342	9177	9177	9177	7755
Pseudo R^2	0.41	0.41	0.40	0.41	0.70	0.70	0.70	0.72
Environmental stringency effect with CPI at								

(Continues)

TABLE 3 (Continued)

	OECD investor				Non-OECD investor			
	EPI **(1)**	***EH*** **(2)**	***EV*** **(3)**	***WEF*** **(4)**	***EPI*** **(5)**	***EH*** **(6)**	***EV*** **(7)**	***WEF*** **(8)**
Mean −1 Std. Dev.	4.81*	2.21	−0.98	−1.41	1.64	−5.17***	11.02***	−0.72
	(2.74)	(1.82)	(2.88)	(2.52)	(2.15)	(0.99)	(1.68)	(1.48)
Mean	−2.39	−2.73*	−2.58	−3.95	3.60	−4.27***	9.46***	−3.98***
	(2.66)	(1.48)	(2.65)	(2.74)	(2.25)	(1.04)	(1.89)	(1.57)
Mean +1 Std. Dev.	−9.50***	−7.67***	−4.19	−6.50**	5.55**	−3.37***	7.90***	−7.24***
	(3.20)	(1.65)	(2.61)	(3.03)	(2.46)	(1.12)	(2.35)	(1.70)

Notes: EPI (Environmental Performance Index), *EH* (Environmental Health), *EV* (Ecosystem vitality), and *WEF* (World Economic Forum index on the perceived stringency of environmental regulations) are computed as to the investor and target countries' differences with respect to the investor level (see text). One standard deviation from the CPI sample mean is used to measure the three environmental stringency semi-elasticities reported on the bottom of the table. Robust standard errors in parentheses. All regressions use the PPML estimator and include investor-year and target-year fixed effects not reported.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

TABLE 4 The impact of environmental stringency differences and corruption (hectares acquired).

	OECD investor				Non-OECD investor			
	EPI **(1)**	***EH*** **(2)**	***EV*** **(3)**	***WEF*** **(4)**	***EPI*** **(5)**	***EH*** **(6)**	***EV*** **(7)**	***WEF*** **(8)**
Env. Stringency	128.78***	56.10***	33.03**	46.59***	−43.93***	−24.15***	−21.94***	31.54***
	(15.22)	(8.99)	(13.79)	(8.65)	(6.40)	(3.78)	(4.77)	(5.93)
Env. Str.*CPI_target	−183.69***	−88.94***	−36.37**	−104.04***	37.11***	19.61***	48.45***	−41.43***
	(21.65)	(13.09)	(16.53)	(13.64)	(8.58)	(4.95)	(9.83)	(7.32)
Log Distance	−1.07***	−0.75***	−0.60***	−0.84***	−2.07***	−2.17***	−1.94***	−2.25***
	(0.21)	(0.26)	(0.18)	(0.12)	(0.15)	(0.16)	(0.14)	(0.15)
Common Language	−0.17	−0.25	0.03	0.15	1.46***	1.39***	1.25***	1.02***
	(0.19)	(0.23)	(0.19)	(0.18)	(0.29)	(0.27)	(0.28)	(0.29)
Colonial relation	0.61**	0.56**	0.46**	0.53**	1.59***	1.30***	0.83**	0.85**
	(0.24)	(0.23)	(0.20)	(0.22)	(0.36)	(0.30)	(0.39)	(0.38)
GDPSum	0.56***	0.53***	0.47***	0.57***	0.45***	0.96***	−0.06	0.67***
	(0.12)	(0.14)	(0.16)	(0.14)	(0.17)	(0.20)	(0.21)	(0.16)
RLE	−2.19***	−2.57***	−2.09***	−1.54***	0.67***	0.72***	0.77***	0.35
	(0.25)	(0.25)	(0.30)	(0.36)	(0.11)	(0.11)	(0.13)	(0.30)
RSE	−8.38***	−4.74*	−5.76**	−10.13***	9.95***	10.40***	8.50***	1.26
	(2.64)	(2.53)	(2.71)	(2.64)	(1.68)	(1.59)	(2.02)	(0.77)
Agr. Productivity	0.00	0.02	0.05**	0.04*	0.02***	0.03***	0.01***	0.02***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)
Institutional dist.	20.71***	25.38***	−0.27	6.64*	−3.24***	−3.33***	−3.30***	−2.40***
	(4.56)	(5.24)	(2.78)	(3.74)	(0.40)	(0.40)	(0.43)	(0.38)
Obs.	10155	10155	10155	9342	9177	9177	9177	7755
Pseudo R^2	0.67	0.66	0.64	0.61	0.77	0.78	0.76	0.75
Environmental stringency effect with CPI at								

(Continues)

TABLE 4 (Continued)

	OECD investor				**Non-OECD investor**			
	EPI **(1)**	***EH*** **(2)**	***EV*** **(3)**	***WEF*** **(4)**	***EPI*** **(5)**	***EH*** **(6)**	***EV*** **(7)**	***WEF*** **(8)**
Mean −1 Std. Dev.	26.07***	6.37**	12.70*	−11.58*	−23.26***	−13.22***	5.05	8.46*
	(5.16)	(2.67)	(7.39)	(6.20)	(3.50)	(1.63)	(3.59)	(4.42)
Mean	5.35	−3.66	8.59	−23.32***	−19.07***	−11.01***	10.52**	3.78
	(4.57)	(2.29)	(6.93)	(6.72)	(3.46)	(1.48)	(4.27)	(4.52)
Mean +1 Std. Dev.	−15.38**	−13.70***	4.49	−35.06***	−14.87***	−8.79***	15.50***	−0.90
	(5.19)	(2.78)	(6.95)	(7.53)	(3.69)	(1.52)	(5.10)	(4.76)

Notes:: EPI (Environmental Performance Index), *EH* (Environmental Health), *EV* (Ecosystem vitality), and *WEF* (World Economic Forum index on the perceived stringency of environmental regulations) are computed as to the investor and target countries' differences with respect to the investor level (see text). One standard deviation from the CPI sample mean is used to measure the three environmental stringency semi-elasticities reported on the bottom of the table. Robust standard errors in parentheses. All regressions use the PPML estimator and include investor-year and target-year fixed effects not reported.

***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

Control variables show the expected signs: the sum of countries' GDP coefficient is positive, in line with the empirical literature on FDI, but significant only in some estimations. Relative land endowment (*RLE*) is confirmed to be a major determinant of FLA; indeed, our results confirm that the greater the difference in agricultural land endowments the greater the number of contracts in all estimations; when the hectares acquired is used as the dependent variable, the coefficient of *RLE* is positive and significant for non-OECD investors, but negative and significant for OECD investors. These results overall confirm previous evidence about the important role played by land endowment in driving FLA, although suggesting a specific pattern when firms originate from an OECD country, where the greater the gap in land endowment, the greater the number of firms investing abroad (extensive margin), but the smaller the size of the investment.

As for the relative endowment in skilled labour (*RSE*), we find that this influences the decisions of non-OECD investors (coefficients are positive and significant across all estimations for both dependent variables), but they do not affect the number of contracts and the size of investments when firms come from an OECD country. This suggests that labour cost issues drive investments in land only by firms from non-OECD countries.

As for agricultural productivity, results confirm previous studies; indeed, for both groups of investors, the agricultural productivity gap positively affects FLA. Finally, the coefficient of institutional distance is always negative and significant, which confirms general findings obtained by previous literature on FDI (Aleksynska & Havrylchyk, 2013; Bénassy-Quéré et al., 2007; Cezar & Escobar, 2015; Demir & Hu, 2016) and on FLA (Raimondi & Scoppola, 2018). Everything else being equal, the greater the gap in governance and democracy, the lower the number of contracts and the amount of land acquired.

Turning to the environmental stringency measures, when the dependent variable is the number of contracts for the whole sample (Table 1, Columns 1–4), the coefficient is positive for all but one measure of the environmental stringency. It is worth noting the opposite effects of the two *EPI* components. Indeed, though the coefficient of the *EH* component is negative—although not significant—the *EV* coefficient is significant and positive. With hectares as the dependent variable (Table 2, Columns 1–4), we find negative but significant coefficients for *EPI* and its health component *EH* only. In this case, the *EH* component drives the result for the global *EPI* index. As mentioned, *EH* is likely to capture environmental features, which are unlikely to affect agricultural costs but could negatively contribute to the overall investment climate. This might explain the negative sign of the *EH* coefficient and, consequently, results for the *EPI* index.

Results in Tables 1 and 2 also show that the responsiveness of investment to differences in environmental stringency differs slightly between the two groups of countries. FLA from non-OECD countries generally confirms previous results: differences in the environmental stringency measured by *EV* and *WEF* affect positively the number of contracts, whereas differences in *EH*, and accordingly of *EPI*, negatively affect FLA. Conversely, this is not the case for FLA originating from OECD countries; the *EPI* and *WEF* indexes turn out to positively affect both the number and size of FLA, but the *EH* coefficient is not significant. Hence, the impact of *EH* differs across the two groups of investors. Investments from non-OECD countries are negatively affected by differences in the *EH* in terms of both number of contracts and hectares (Column 10), whereas this is not the case for firms from OECD countries (Column 6).

To control the robustness of previous results, we run additional estimations to address three different issues: potential omitted variable bias; dependent variable measurement error bias; and endogeneity bias due to reverse causation. Specifically, with respect to potential omitted variable bias, we first use an alternative proxy of institutional distance, a measure of political rights.[28] Further, we add additional bilateral-time variant variables measuring the overall in-

[28]Estimations results are reported in Tables A3 and A4 in the Appendix S1.

vestment climate (*Business regulation* and *Ease of doing business*) influencing FLA, to control whether any bilateral difference, not previously included in the regression, might affect these flows.[29] Results generally confirm our main findings.

Regarding the second issue—dependent variable measurement error bias—the quality of the Land Matrix data is a major problem for empirical analyses, mainly because a part of the data comes from unofficial sources. To check the robustness of our results to this potential bias, we run estimations by using FLAs data from more reliable sources only, that is, governments and firms. Again, the results largely confirm our main findings.[30]

Finally, to check the potential endogeneity bias due to reverse causation, a two-stage least square regression (2SLS) is used. The *EPI* country gap is treated as endogenous and instrumented by using an *EPI* gap obtained by considering, for the target country, the (average) environmental stringency in adjacent countries,[31] as state-level environmental regulations have been shown to be strongly related to the regulatory stringency of neighbouring states (Fredriksson & Millimet, 2002).[32] Changes in the estimation procedure do not change the sign and significance of results.[33] Thus, although reverse causality bias may represent a problem, our results and conclusions do not appear to be undermined by endogeneity issues.

5.1 | Does corruption in target countries matter?

As mentioned, the literature has highlighted that the empirical validity of the PHE may be concealed by the fact that the choice over where to invest could be affected by the level of corruption in the target country (Smarzynska & Wei, 2003). We therefore check whether the impact of the differences in the environmental stringency on the pattern of FLA depends on the level of corruption in the target country. The results obtained by estimating Equation (2) are reported in Tables 3 and 4.

When the investor comes from an OECD country (Columns 1–4), the coefficient of the interaction term is negative and significant, whereas the coefficient of the environmental stringency gap (β_7) is positive and significant, across almost all estimations. This confirms that the impact is affected by corruption in the target country. A higher corruption level in the target country, corresponding to a higher *CPI* index, reduces the effect of the environmental stringency gap. The overall impact of the environmental stringency variables depends on the values of corruption in the target country. Tables 3 and 4 (see rows at bottom) report the environmental stringency semi-elasticities of FLA, (post) estimated for three values of CPI: CPI sample mean, and CPI sample mean plus and minus the standard deviation. Results show that in a number of cases the direction of the impact may change with the *CPI* value. For instance, for OECD investors, the gap in the *EPI* index turns out to positively influence FLA when corruption is weak, whereas its impact is negative for higher values of *CPI* (Column 1, Tables 3 and 4).

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[29]Results are reported in Tables A5 and A6 in the Appendix S1.

[30]Results are reported in Tables A7 and A8 of the Appendix S1.

[31]The estimation results are reported in Table A9 of the Appendix S1. The table reports second-stage results of the IV regressions and shows, on the bottom, the endogeneity test statistic (Hausman, 1978) for the null hypothesis that the specified endogenous regressor (*EPI*) can be treated as exogenous. The null hypothesis is rejected. Moreover, under-identification and weak identification tests confirm, respectively, that excluded instruments used in the first stage are correlated with the endogenous regressor and that the risk of weak instruments is rejected. We perform IV regressions using the ivreghdfe STATA command.

[32]The high number of fixed effects included in our specification forced us to run the IV regression using a least squares estimator, instead of the PPML, due to the convergence problem. Thus, these estimations include only positive FLA observations (the logarithm of zero is undefined) and are then compared with the PPML results obtained with positive FLA observations.

[33]Note that the magnitude of the (IV) estimated effect shows that previous results tend to be only slightly biased upward when the dependent variable is the number of contracts; differently, the EPI gap impact on the hectares acquired tends to be biased downward when reverse causality is not controlled for.

Conversely, when investors come from non-OECD countries (Columns 5–8 of Tables 3 and 4) the role played by corruption is less clear. Findings suggest that a higher corruption level in the target country reduces the effect of the environmental stringency gap—on both the number of contracts and the size of investments—when the *WEF* index is used, but not when the *EPI* index is used. This is probably because of the opposite impacts of the *EH* and *EV* components. In particular, the sign of the coefficients of *EV* and of its interacted term (Column 7) suggests that a higher corruption level in the target country reduces the (positive) impact on the decision to invest abroad (Table 3), although expanding the size of investments (Table 4). These findings—which are confirmed for a broad range of *CPI* values—provide support to the widespread idea that more corruption favours few large-size land acquisitions. It is worth emphasising that this holds only for investors from non-OECD countries and only when the *EV* index is used.

6 | CONCLUSIONS

Our aim is to provide cross-country evidence on the impact of environmental stringency on foreign land acquisitions (FLA). This issue is addressed using a panel gravity equation to deal with endogeneity and unobserved heterogeneity. A variety of indexes of environmental stringency have been used. Moreover, we use two measures of FLA (number of contracts and hectares acquired) for insights into the effect on the choice to invest abroad (the extensive margin) and on the size of investment. Then, we check whether the responsiveness of FLA depends on the investor country of origin and the level of corruption in the target country. Finally, we check the robustness of our results with regard to potential omitted variable bias, dependent variable measurement error bias, and endogeneity bias due to reverse causation.

Our results confirm that environmental stringency does play a role in determining the pattern of FLA, though it depends on the origin of the investing firms. Most of the indicators of environmental stringency affect positively the number of contracts and negatively the size of investments for non-OECD investors, whereas for FLA originating from OECD countries we find a positive impact (both on the number of contracts and on the size of investment) when we use the *EPI* and *WEF* indexes.

The inclusion of a variable controlling for corruption provides additional findings. Our results suggest that a lower level of corruption in the target country enhances the impact of environmental stringency variables on the choice to invest abroad and on the size of the investment when firms originate from OECD countries. This confirms our expectations as well as the findings in previous work on FDI (e.g., Kalamova & Johnstone, 2011; Smarzynska & Wei, 2003). However, we do not find a robust evidence that this holds when the firms originate from non-OECD countries, as results vary with the index of environmental stringency used; actually, we find that more corruption favours few large-size land acquisitions when the *EV* index is used.

These findings have a number of implications. First, they add a new perspective on the determinants of the geographical pattern of FLA. Indeed, besides the key factors based on the lack (abundance) of land and water in the investing (target) countries already underlined in the literature, we find that weak environmental standards may also be an important driver. This result has important policy implications. Policies aimed at mitigating the potential negative externalities of FLA may become a deterrent for foreign investors; hence, developing countries may find it convenient to maintain lower standards in order to attract foreign investors. The objective of limiting the environmental damage caused by large-scale FLA, as recommended by the UN Environment Programme, may be thus partly undermined by this mechanism. A sort of environmental competition—analogous to the tax competition among developing countries to attract multinationals—may arise with serious environmental implications for the ecosystem of developing countries.

Second, our findings suggest that the potential 'race to the bottom' as for environmental regulation may produce differentiated impacts across developing countries. Indeed, an increase in the environmental stringency gap in a high corruption level (target) country may result in a weak impact on foreign investments in land.

Third, our findings also show the importance of using a range of indexes to measure environmental stringency. The available indexes capture different dimensions of environmental regulations and often provide results which may be due, besides the environmental regulations, to other factors (Brunel & Levinson, 2016; Millimet & Roy, 2016). In order to address this issue, our choice has been to use a variety of indicators, differing in terms of methodology, to measure the environmental stringency. Although in several cases the results are robust to the use of different indexes, in a number of estimations they change with the index employed. This confirms that the choice of measurement of environmental stringency turns out to be an important factor in econometric analysis and hence it should match the policy issue addressed.

In conclusion, our results provide a number of insights into an issue that has not been previously explored in the literature, in particular, the impact of environmental stringency on the geography of land investments at global level. The findings of this paper highlight the fact that, in order to improve understanding of the PHE in land, there is the need to improve and widen the empirical analysis, especially in terms of the indexes of environmental stringency.

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