Making aid work: institutional thresholds and FDI

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Abstract

Purpose – The purpose of this paper is to analyse the institutional threshold effects of foreign aid on foreign direct investment (FDI).

Design/methodology/approach – This paper develops a theoretical model from an extended Solow model that introduces the conductive effect of institutions in an aid recipient country towards the capacity of attracting FDI. This study evidences threshold effects with the most recent panel threshold models that consider endogeneity issues. The data on economic institutions and foreign aid are decomposed into disaggregated level to reveal the detailed threshold pattern. Several sample subsets are used for a heterogeneity analysis.

Findings – Conducting empirical research on a sample of 62 countries during the period 2003–2016, this study finds robust evidence of the existence of an institutional threshold in the aid–FDI nexus which a country must attain to reap the full attraction of FDI by foreign aid providing financial resources. Furthermore, foreign aid tends to promote FDI in institutions characterized by a right-sized government, a strengthened legal system and an appropriate regulatory environment. On the other hand, aid may crowd out FDI. The results are robust to regional combinations and a subset of low and lower-middle-income countries. In addition, this study finds that aid targeted at social infrastructure and services has a positive effect regardless of institutional threshold.

Originality/value – This paper contributes to the literature by introducing a non-linear and discontinuous effect of aid on FDI, i.e. a threshold effect, highlighting the relevance of legal systems and regulations and the possibility of a crowding-out effect on FDI for specific institutional regimes. The thresholds provide a guide for donor countries to ensure aid effectiveness at the risk of being counterproductive and for recipient countries to better assess the institutional dimensions that need to be improved.

Keywords Foreign direct investment (FDI), Institutional quality, Panel threshold model, Foreign development aid

Paper type Research paper

1. Introduction

The promotion of economic development and welfare of developing countries are well-established objectives of foreign aid (OECD, 2009). Among the aid effectiveness studies, there is a group that analyses the impact of aid on foreign direct investment (FDI). The core of the debate is the complementarity and substitutability of these two sources and their conclusions are not without controversy. Some find that aid has a positive impact on FDI while others find negative or null effects.

A potential cause of these inconclusive results might be the use of heterogeneous data on foreign aid. In early studies, the use of overall aid data might prevent the identification of an effect from a diversity of foreign aid. In recent studies, disaggregated data have been widely used. For instance, Kimura and Todo (2010) classify aid into infrastructure aid and non-infrastructure aid, whereas Selaya and Sunesen (2012) categorize it into aid invested in complementary inputs and aid invested in physical capital. Again, their results are still mixed. In other studies, the authors examine the interaction of aid with other variables that attract FDI, for example, institutional quality. These non-linear models produce inconsistent results.

The ongoing discussion is based on the assumption of continuity in the relationship between aid and FDI. To fill this gap, this paper incorporates institutional qualities as a threshold variable that determines the attraction of aid for FDI. To be more precise, we hypothesize the existence of an institutional threshold that divides the effect into two regimes. In the favourable regime, aid is expected to attract FDI, whereas in the unfavourable regime, aid has a crowding-out effect, which is less evident.

The requirement for a balanced panel of the fixed effect panel threshold model (Wang, 2015) and the dynamic panel threshold (DPT) model (Seo *et al.*, 2019), coupled with data availability limits the sample size to 62 countries between 2003 and 2016. We find that overall aid has a threshold effect on FDI as expected. More specifically, in a restrictive institutional environment, aid tends to crowd out FDI, while in a free environment, its attraction can be fostered. A free environment is defined as one in which there is a right-sized government, a strengthened legal system and an appropriate regulatory environment. Disaggregating by aid categories we find that economic infrastructure and services aid, production sectors aid and commodity and humanitarian aid follow the same threshold pattern, while the attraction of aid in social infrastructure irrespective of institutions. Moreover, the threshold pattern is also found for the subsets of Asian with American countries, Asian with African countries and low and lower-middle-income countries.

Our work contributes to the debate of complementarity and substitutability since we demonstrate that the effect of aid on FDI is not only non-linear but also discontinuous. That is, the results highlight the essentiality of a minimum institutional threshold for aid to facilitate FDI. Furthermore, we provide novel evidence that below the threshold, the crowding-out effect of aid on FDI persists and remains unaffected by improvements in economic institutions.

The paper is structured as follows. Section 2 reviews the literature on aid effectiveness with a particular focus on the aid-FDI nexus. Section 3 proposes the theoretical model which allows us to incorporate our hypothesis of a threshold effect. Section 4 presents the data, sample and econometric model. Section 5 reports the empirical results as well as some discussion. Section 6 concludes the study.

2. The literature on aid effectiveness on foreign direct investment

In this section, we first provide a review of the relevant literature investigating the complementarity and substitutability between aid and FDI. Then, we present a review of

existing works that underly the importance of institutions in attracting FDI. This review shows the necessity of the introduction of threshold models to discuss a non-linear and discontinuous relationship between aid and FDI.

2.1 Foreign direct investment and foreign aid

Regarding those studies finding no significant relationship between aid and FDI, Karakaplan *et al.* (2005) use aggregated data and find that aid has no effect on FDI in low- and middle-income countries. Harms and Lutz (2006) assume that aid has two effects on FDI, the infrastructure effect and the rent-seeking effect. The aid invested in the economic and social infrastructure increases FDI, whereas the rent-seeking effect is caused mainly by the aid allocated in the unproductive sectors which crowds out FDI. Their empirical results suggest that, on average, foreign aid has no effect on FDI. Kosack and Tobin (2006) argue that aid and FDI are uncorrelated, as the former concentrates more on government revenue and human capital while the latter focuses more on physical capital. They suggest that in low-income countries, aid and FDI are neither substitutes nor complements.

Other economists find that foreign aid is negatively correlated to investment. Asiedu *et al.* (2009) apply an empirical study for 28 sub-Saharan African counties and 35 low-income countries over the period 1983–2004. They find that foreign aid has a negative effect on FDI in both sub-Saharan African (SSA) countries and low-income countries. They also suggest that foreign aid is able to mitigate the adverse effect of expropriation risk on FDI. However, it is required to substantially increase the donation of aid to completely neutralize the adverse effect. Similarly, Rao *et al.* (2020) find that, for a sample of South-eastern Asia and South Asia, foreign aid flows negatively impact FDI flows as well as economic growth. Their data shows that economies such as Afghanistan, Pakistan, Thailand, Malaysia, Philippines and Laos have experienced a substantial decline in capital flows despite receiving significant amounts of foreign aid.

There is also a strand of works finding a positive effect of foreign aid. For instance, Kimura and Todo (2010) find that aid has a "Vanguard effect" on FDI. They collect the data of the five major Official Development Assistance (ODA) donor countries and find aid generally has no effect on FDI, but the Japanese ODA can attract FDI from Japan exclusively without affecting FDI from other countries. They suggest that it is because aid can lower the risk for FDI.

Selaya and Sunesen (2012) incorporate the Solow model into their study and conclude that the effect of aid on FDI depends on the composition of aid. Accordingly, the aid invested in physical capital will lower the marginal product of capital (MPK), therefore crowding out other capital flows. When aid is invested in complementary inputs, it increases the total factor productivity (TFP). The improvement in TFP will increase the MPK and therefore attract more FDI. However, in the context of a Solow economy, an increase in domestic saving and investment will again lower the MPK, hence reducing FDI. Their empirical results confirm the positive effect of the aid in complementary inputs and the negative effect of the aid in physical capital. Moreover, they find the overall effect of aid on FDI is positive, as aid improves the absorptive capacity and increases the MPK in the host countries.

Among the contributions in the literature, some scholars explicitly or implicitly discuss the transmission effect of aid on FDI through mediators. Donaubauer *et al.* (2016) suggest that aid in infrastructure improves the endowment in transportation, communication, energy and finance which, in turn, attracts a higher flow of FDI. Meanwhile, Onye *et al.* (2022) conducted a study for a sample of 14 Economic Community of West African States and found that aid contributes positively to water supply and sanitation, energy, transport and Information and Communication Technology (ICT). However, the transmission effect through infrastructure seems unnecessary as

foreign aid might have a direct and positive effect on FDI. Moreover, foreign aid could serve as a risk reduction factor. In this respect, Garriga and Phillips (2014) find that in post-conflict countries where there is a lack of reliable information, receiving aid could encourage investors. Asiedu *et al.* (2009) also suggest that aid serves to reduce the adverse effect of expropriation risk on FDI. Bhavan (2014) finds that aid in both infrastructure and the production sector plays an important role in attracting FDI. Opoku (2015) studies the aid–FDI nexus for Africa over the period 1996 to 2008. He concludes that the total aid positively affects FDI. Pham (2015) uses province-level data to analyse the effect on FDI in Vietnam. He finds that middle- and long-term aid can attract more FDI. The author explains that investors are willing to invest abroad when the aid projects are settled, and a proper infrastructural development is achieved in the host country. Both Opoku (2015) and Pham (2015) stress the importance of institutional quality in conducting aid to attract FDI. Conversely, Herzer and Grimm (2012) find that aid crowds out private investment through financing public investment. Rao *et al.* (2020) suggest that foreign aid could enable governments to allocate funds to finance physical capital and channel direct transfers to the productive sectors, therefore, foreign aid ends up crowding out FDI. Moreover, Wang and Fillat (2024) apply a structural equations model to study the effect of aid on FDI through economic institutions and conclude that economic institutions do not always prove to be significant mediators.

2.2 Foreign direct investment and institutions

Unlike the controversial results of the aid–FDI studies, the importance of other determinants, for instance institutions or government quality, is highlighted by many authors (see; Karakaplan *et al.*, 2005; Walsh and Yu, 2010; Bhavan, 2014; Opoku, 2015; Peres *et al.*, 2018). For example, Asiedu (2006) finds that the legal system, the control of corruption and political stability have a positive effect on attracting FDI. Economic freedom has been confirmed as a determinant of FDI in recent less conventional economic studies. Amendolagine *et al.* (2013) and Ghazalian and Amponsem (2019) underline the role of Economic Freedom in creating a favourable investment environment. Institutions could influence the effect of foreign aid on FDI, for instance, Svensson (2000) suggests that political liberalization should be prioritized by donor communities. Harms and Lutz (2006) conclude that removing institutional friction is the best way to attract foreign investment.

In summary, the debate regarding complementarity and substitutability persists within the framework of continuity. Even in the non-linear models, it is expected that the impact remains continuous as mediating variables vary. However, the results are sensitive to diverse variables and samples. Contributing to this discourse, this paper posits a hypothesis suggesting that the effect of aid on FDI follows a non-linear and discontinuous pattern. Specifically, our hypothesis proposes the existence of an institutional threshold that divides the effect into two regimes, with an attraction in the favourable regime. Additionally, in the less favourable one, it shows a crowding out effect and the substitutability is indifferent to improvements made to institutions.

3. Theoretical analysis of aid, foreign direct investment and institutions

This section discusses the effect of aid on FDI. We extend the model of Selaya and Sunesen (2012) which suggests that, in a Cobb–Douglas production function, foreign aid invested in complementary inputs aid_A improves total factor productivity (TFP), $A = A_0 + aid_A$, whereas the aid invested in physical capital aid_K targets the accumulation of capital and has no effect on TFP:

$$y = Ak^{\alpha} \tag{1}$$

$$A = A_0 + aid_A \cdot C \tag{2}$$

Where, A_O, is the initial level of productivity. By equation (2), we assume that aid_A will not increase TFP one for one, with C $(0 \leq C \leq 1)$ denoting the proportion of the aid of complementary inputs (aid_A) that arrives at the target sectors. If a country has better institutional quality, we assume that the conductive effect is higher and more aid_A will target complementary inputs. Consequently, foreign aid increases TFP.

The accumulation of capital consists of saving share of GDP, FDI and aid invested in physical capital aid_K:

$$\dot{k} = sy + fdi + aid_k - (n + \delta)k \tag{3}$$

Where $\dot{k}$ denotes the accumulation of capital per capita, s denotes the saving rate, y denotes the GDP per capita, n is the population growth rate and δ is the depreciation rate.

According to Caselli and Feyrer (2007), the world real return of capital, r in a frictionless economy is as follows:

$$r = MPK - \delta = A\alpha k^{\alpha-1} - \delta \tag{4}$$

At a steady state, $\dot{k} = 0$, the optimal capital k^* from equation (4) is as follows:

$$k^* = \left[\frac{A\alpha}{r}\right]^{\frac{1}{1-\alpha}} \tag{5}$$

At the steady state, with optimal capital per capita k^* and income per capita y^*, the flow of FDI per capita is determined by:

$$fdi = -aid_k - sy^* + (n + \delta)k^* \tag{6}$$

Additionally, the effect of aid on FDI is as follows:

$$\frac{\partial fdi}{\partial aid} = \frac{\partial fdi}{\partial aid_k} - s\frac{\partial y^*}{\partial aid_A} + (n + \delta)\frac{\partial k^*}{\partial aid_A} \tag{7}$$

In which, foreign aid of complementary inputs tends to attract more FDI through the improvement in marginal product of capital (MPK):

$$\frac{\partial k^*}{\partial aid_A} = \frac{\partial}{\partial aid_A}\left(\left[\frac{A\alpha}{r}\right]^{\frac{1}{1-\alpha}}\right) = \frac{1}{1-\alpha}\left[\frac{A\alpha}{r}\right]^{\frac{\alpha}{1-\alpha}}\frac{L\alpha}{r}C \geq 0 \tag{8}$$

As for saving, on the other hand, at the steady state of capital accumulation, an increase in the saving level will therefore crowd out FDI:

$$-s\frac{\partial y^*}{\partial aid_A} = -s\frac{\partial(Ak^{*\alpha})}{\partial aid_A} = -s\left[CLk^{*\alpha} + A\alpha k^{*(\alpha-1)}\frac{\partial k^*}{\partial aid_A}\right] \tag{9}$$

Substituting equation (8) into equation (9):

$$= -sCLk^{*\alpha} - sA\alpha k^{*(\alpha-1)}\frac{1}{1-\alpha}\left[\frac{A\alpha}{r}\right]^{\frac{\alpha}{1-\alpha}}\frac{L\alpha}{r}C \tag{10}$$

Regarding the aid invested in physical capital:

$$\frac{\partial fdi}{\partial aid_k} = -1 \tag{11}$$

Aid invested in physical capital will always crowd out FDI.

The overall effect then:

$$\frac{\partial fdi}{\partial aid} = -1 - sC\left[Lk^{*\alpha} + A\alpha k^{*(\alpha-1)}\frac{1}{1-\alpha}\left[\frac{A\alpha}{r}\right]^{\frac{\alpha}{1-\alpha}}\frac{L\alpha}{r}\right]$$
$$+(n+\delta)\frac{1}{1-\alpha}\left[\frac{A\alpha}{r}\right]^{\frac{\alpha}{1-\alpha}}\frac{L\alpha}{r}C \tag{12}$$

Equation (13) extends Selaya and Sunesen's model in that the aid invested in complementary inputs will not be fully implemented, instead, its arrival depends on institutional qualities. More specifically, as the institutional qualities improve over a certain threshold value, say, γ, in which more aid will be channelled into the target. We stylize the relationship as follows:

$$\frac{\partial fdi}{\partial aid_{(Ins<\gamma)}} \leq 0 < \frac{\partial fdi}{\partial aid_{(Ins>\gamma)}} \tag{13}$$

There must be an institutional threshold γ that divides the effects of aid on FDI into two institutional regimes. The effect in a free environment is expected to be greater than that in a restrictive institution. Another implication of equation (13) is that the effect within each regime is fixed and remains unaffected by the variation of institutions. Additionally, as institutions evolve beyond the threshold, the effect can be discontinuous and experience a jump rather than a gradual change.

4. Empirical strategy and data
4.1 Econometric model
The empirical strategy comprises two steps. First, we examine the non-linear effect of aid on FDI by including an interactive term of aid and economic institutions in linear regression. Second, we employ the panel threshold models to test the potential threshold effect and estimate the threshold. The linear model is expressed as follows:

$$fdi_{it} = \alpha_0 + \alpha_1 aid_{it_{-1}} + \theta X_{it_{-1}} + \mu_i + \epsilon_{it} \tag{14}$$

Additionally, considering the potential non-linearity, we extend the specification as the following baseline model:

$$fdi_{it} = \alpha_0 + \alpha_1 aid_{it_{-1}} + \alpha_2 Ins_{it_{-1}}$$
$$+ a_3(aid_{it-1} * Ins_{it-1}) + \theta X_{it_{-1}} + \mu_i + \epsilon_{it} \tag{15}$$

Where fdi_{it} is the stock of per capita FDI received by country i in the year t, X is a set of controls, aid is the per capita foreign aid received by the country, Ins denotes the Economic Freedom Index of the Fraser Institute, and we add an interactive term to capture the nonlinearity effect of aid on FDI. All variables are lagged by one year to avoid the reverse effects.

The fixed effects (FE) model is adopted so as to address the individual effects μ. Given that the effect of institutions α_2 is expected to be positive, we have four cases with respect to the signs of α_1 and α_3: (1) When both α_1 and α_3 are positive, institutions strengthen the attractiveness of aid; when both α_1 and α_3 are negative, institutions exacerbate the crowding out effect; when α_1 is positive and α_3 is negative, we have an inverted U-shaped relationship in which institutions tend to suppress the attractiveness of aid; when α_1 is negative and α_3 is positive a U-shaped relationship is expected, and the crowding-out effect declines as institutions improve.

To further test the threshold effect of foreign aid and to estimate the threshold, we have deployed a panel threshold model. Two models are available. The first is the fixed-effects panel threshold (FEPT) model based on the least squared estimation (Hansen, 1999; Wang, 2015). This model requires that the threshold variable and all covariates be exogenous, and our data on foreign aid fails to meet this requirement which leads to an inconsistent estimation. Following Caner and Hansen (2004), we have used the predicted foreign aid from a reduced form to consider the endogeneity issue. The model is as follows:

$$
\begin{aligned}
fdi_{it} = {} & \beta_0 + \beta_1 aid_{it_{-1}}(Ins_{it-1} \leq \gamma) \\
& + \beta_2 aid_{it_{-1}}(Ins_{it-1} > \gamma) + \theta X_{it_{-1}} + \mu_i + \epsilon_{it}
\end{aligned}
\tag{16}
$$

Where γ is the threshold value to be estimated. The coefficients β_1 and β_2 denote the effect of foreign aid on FDI below and beyond the estimated threshold, respectively. According to our hypothesis on the mediator role of institutions, we expect the following relationship to be found: $\beta_2 > 0 = > \beta_1$.

Given the broad coverage of the Economic Freedom Index, we have decomposed the summary index into five indicators and each one is treated as the threshold variable. This raises an endogenous threshold variable issue. We have applied the DPT model using the First Difference Generalized Method of Moments to consider the endogenous explanatory and threshold variables (Seo and Shin, 2016; Seo et al., 2019) [1]. We still consider a static model:

$$
\begin{aligned}
fdi_{it} = {} & \left(\lambda_1 aid_{it_{-1}} + \theta X_{it_{-1}}\right)1 \cdot \left(Ins_{it_{-1}} \leq \gamma\right) \\
& + \left(\delta_1 aid_{it_{-1}} + \sigma X_{it_{-1}}\right)1 \cdot \left(Ins_{it_{-1}} > \gamma\right) + \mu_i + \epsilon_{it}
\end{aligned}
\tag{17}
$$

Where 1(.) is the indicator function. The value is determined from the relationship between the threshold variable *Ins* and the threshold value γ; if true, the value is 1, otherwise 0. λ_1 and δ_1 are the effect of foreign aid associated with different institutional conditions with the same expectation $\delta_1 > 0 > \lambda_1$.

4.2 Sample and data

The construction of the sample is based on the ODA recipient country list of the Development Assistance Committee of the Organization for Economic Co-operation and Development (OECD-DAC). As a technical requirement, the DPT model requires a balanced panel. Therefore, we have discarded observations containing too many missing values and have constructed a balanced panel with 62 countries from 2003 to 2016 (see Appendix A).

The dependent variable is FDI stock per capita taken from the UNCTAD Statistics (Retrieved from: https://unctadstat.unctad.org/datacentre/dataviewer/US.FdiFlowsStock). The aid data have been drawn from the Creditor Reporting System (CRS) of the OECD Statistics (retrieved from https://stats.oecd.org). They contain ODA loans, grants and equity investment through all channels and expressed in per capita terms. We use total disbursement of aid rather than commitment, as it reflects the real flow of aid. According to

Odedokun (2003), these two types of measurement are highly correlated. The donor countries are those of the OECD-DAC members and the recipient countries are those on the DAC list of ODA recipients.

According to the targeted sectors, the OECD Statistics classifies aid data into the following sectors: aid in social infrastructure and services (*aid1*), economic infrastructure and services (*aid2*), production sectors (*aid3*), multi-sectors (*aid4*) and the sum of commodity aid and humanitarian aid (*aid5*) because of the availability of the data. The proportional shares of *aid1* to *aid5* are 40.17%, 18.90%, 7.27%, 8.72% and 5.44%. We have provided a description of the classification of foreign aid by sector with some examples in Table 1.

With regard to the threshold variable, we have applied the Economic Freedom index from the Fraser Institute to proxy the economic institution of the recipient country (retrieved from www.fraserinstitute.org/studies/economic-freedom). The rating varies from 0 to 10, indicating the most restrictive to the freest economic institution. Moreover, its five main indicators, namely, government size, legal system, property rights, sound money, freedom to trade internationally and regulations are treated individually as the threshold variable. According to the methodology, a free institutional environment in comparison to a restrictive one is when governments intervene less in the economy, the legal system is less affected by powerful groups, the inflation level is more stable, the movement of capital and people is less controlled and the number of the business regulatory restrictions is limited. We have summarized the measurements of freer institutions in Table 2.

The control variables are GDP per capita, saving rates, trade openness and population growth. All variables are collected from the database World Development Indicators of the World Bank (Retrieved from https://data.worldbank.org). For all numerical variables log transformations are taken (Table A1). In all estimations, we also control for year-fixed effects.

5. Empirical results

In this section, we first test the threshold hypothesis under different specifications. Then, we decompose the data on foreign aid and the economic freedom to reveal more detailed threshold effects. In addition, we classify the sample into different subsets to examine the robustness.

Average per capita FDI experiences a constant rise during the period, increasing from $470m to $1,870m. In contrast, the average flow of per capita aid experiences fluctuations, averaging around US$26m.

Sectors	Variables	Examples
Social infrastructure and services	*aid1*	Teacher training, basic health care, reproductive health care, employment creation, women's rights
Economic infrastructure and services	*aid2*	Road transport, ICT, energy research, business development services
Production sectors	*aid3*	Food crop production, forestry and fishery research, fertilizer, trade policies
Multi-sector/cross-cutting	*aid4*	Biodiversity, disaster risk reduction, food security
Commodity aid + Humanitarian aid	*aid5*	General budget support, food assistance, emergency response

Table 1.
Classification of
foreign aid by sectors

Note: Examples are selected from the five-digit coded subsectors of the database CRS of the OECD. Stats
Source: Authors' own elaboration

Indicators	Variables	Measurements of freer institutions (higher scores)
Size of government	EF1	Lower level of government spending, lower marginal tax rates and less government investment and state ownership of assets
Legal system and property rights	EF2	Higher level of independence and impartiality of legal system and property protection
Sound money	EF3	A country follows policies and adopts institutions that lead to low and stable rates of inflation and avoid regulations that limit the ability to use alternative currencies
Freedom to trade internationally	EF4	Lower tariffs, easy clearance and efficient administration of customs, a freely convertible currency and few controls on the movement of physical and human capital
Regulations	EF5	Less regulatory restraints that limit the freedom of exchange in credit, labor and product markets

Source: Authors' own elaboration

Table 2.
Economic freedom
and indicators

The correlation analysis in Table 3 provides a first insight into the relationships between FDI and foreign aid. In general, the correlation is rather weak for the overall aid (0.027), *aid1* (0.026), *aid2* (0.175), *aid3* (0.008) and *aid4* (0.132). Instead, *aid5* (−0.401) is negatively correlated with FDI while positively correlated with the rest of types of aid [2]. The weak correlation between FDI and aid raises the possibility of a non-linear or threshold effect.

Table 4 first reports the results when we exclude and include an interactive term of foreign aid and institutions in Columns 1 and 2, respectively. When only foreign aid is included in the model, as shown in Column 1, it has a negative but insignificant effect on FDI. Column 2 shows that after the inclusion of institutions and the interactive terms, foreign aid has a negative effect on FDI and that 1% of aid per capita received tends to crowd out about 0.41% of FDI per capita. In addition, we find that both economic institutions and the interactive term have a positive and significant effect which suggests a U-shaped relationship. As institutions improve over a certain level, or threshold, foreign aid tends to attract FDI instead of crowding it out. In Columns 3 and 4, we report the results of the FEPT. The results of the lower regime and upper regime are shown in Columns 3 and 4. The estimated threshold is 5.3879 and when *Economic Freedom* is below this, 1% of aid per capita tends to crowd out about 0.12% of FDI per capita, whereas when *Economic Freedom* exceeds 5.3879, the effect becomes positive that 1% of aid per capita attracts 0.14% of FDI

Var.	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) FDI	1.000						
(2) Total aid	0.027	1.000					
(3) *aid1*	0.026	0.940	1.000				
(4) *aid2*	0.175	0.604	0.460	1.000			
(5) *aid3*	0.008	0.764	0.737	0.529	1.000		
(6) *aid4*	0.132	0.771	0.701	0.514	0.694	1.000	
(7) *aid5*	−0.401	0.575	0.477	0.223	0.404	0.346	1.000

Notes: The aid variables denote aid in social infrastructure and services (*aid*1), economic infrastructure and services (*aid*2), production sectors (*aid*3), multi-sectors (*aid*4) and the sum of commodity aid and humanitarian aid (*aid*5)
Source: Authors' own elaboration

Table 3.
Correlation matrix

Model	(1) FE Linear	(2) FE Interaction	(3) FEPT (Ins ≤ γ)	(4) FEPT (Ins > γ)	(5) DPT (Ins ≤ γ)	(6) DPT (Ins > γ)
Threshold (γ)			5.3879*** (0.0192)		5.5158*** (0.0610)	
Foreign aid	−0.0315 (0.1358)	−0.4106* (0.2122)	−0.1194** (0.0534)	0.1401*** (0.0444)	−1.0814*** (0.1028)	1.0298*** (0.1140)
EF		0.3298* (0.1718)			0.6837*** (0.1529)	−0.1710 (0.1664)
Foreign aid × EF		0.0301*** (0.0106)				
GDP	0.9046*** (0.1070)	0.7568*** (0.1031)	0.8497*** (0.0857)		0.8131*** (0.1039)	0.1048 (0.0913)
Savings	0.0048 (0.0052)	0.0030 (0.0050)	0.0036 (0.0031)		0.0055 (0.0042)	−0.0177*** (0.0051)
Openness	0.0039 (0.0025)	0.0037 (0.0025)	0.0031** (0.0013)		0.0407*** (0.0045)	−0.0440*** (0.0047)
Population	−0.1869** (0.0855)	−0.1429 (0.0949)	−0.1688** (0.0620)		0.5190*** (0.1802)	−0.0440*** (0.0047)
Constant	−0.4262 (0.9150)	−0.9262 (1.3266)	−0.4078 (0.6932)		1.9581 (1.4278)	
Number of i	62	62	62		62	
Year fixed effects	Yes	Yes	Yes		Yes	

Notes: Columns 1 and 2 apply the fixed-effect estimation (*FE*), first in the traditional way with only the effect of foreign aid and second, considering the effect of EF and an interaction effect. Columns 3 and 4 apply the fixed-effect panel threshold model (*FEPT*), and Columns 5 and 6 apply the dynamic panel threshold model (*DPT*). *Ins*≤γ and *Ins*>γ denote the lower and upper regimes, respectively. The FEPT model only treats foreign aid as the threshold-dependent variable and assumes all control variables have a linear effect on FDI. It does not report the result of the threshold variable. The results of the control variables are common for Columns 3 and 4. The DPT model assumes all variables, including the threshold variable, are threshold-dependent variables, yielding two totally differentiated regimes; standard errors in parentheses; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Source: Authors' own elaboration

Table 4.
Threshold effect of overall aid and economic freedom

per capita. Applying the DPT model, we report the results of the lower and upper regimes in Columns 5 and 6, respectively. The estimated threshold is 5.5158, and foreign aid tends to crowd out FDI in the lower regime while in the upper regime, the effect becomes positive.

The empirical results of Table 4 confirm our hypothesis that foreign aid has a threshold effect on FDI and that economic institutions must reach a minimum threshold to effectively conduct foreign aid. Table 5 shows the results when the indicators of *Economic Freedom* are considered as the threshold variable.

Table 5 shows that the indicators of *government size*, *legal system*, *trade freedom* and *regulations* are significant threshold variables and that foreign aid tends to attract FDI when the institutional quality exceeds the threshold. This is particularly the case when the *legal system* is considered as the threshold variable, as we find that foreign aid invested in the lower regime tends to crowd out FDI. Column 3 reports a threshold of 9.6072 for the indicator *sound money*, and we find it is economically irrelevant given that the maximum value is 9.8084. Likewise, in Column 4, the estimated threshold for *trade freedom* is 8.3466 which also approximates its maximum value of 8.7100, although the effect of attracting FDI does exist below the threshold.

The findings confirm our theoretical model whereby in a favourable environment, institutions effectively conduct foreign aid leading to an overall crowding-in effect. However, in countries with irregular government size and regulatory burdens, foreign aid fails to yield a significant effect. Theoretically, this could be attributed to the counterbalance of attractive and crowding-out effects. Practically, such an environment may undermine profitability, while a legal system characterized by high dependence and partiality could destabilize the entire market.

In previous tables, we have provided empirical evidence that foreign aid has the expected threshold relationship regarding the summary index of *Economic Freedom* and the indicator *legal system*, i.e. foreign aid tends to crowd out FDI when institutions are below the threshold while when institutions reach the threshold, foreign aid starts to attract FDI. In the next steps, in Table 6 we decompose the aid data into the sectoral categories, applying *Economic Freedom* as the threshold variables so as to discuss the more detailed threshold effects.

Based on the target sectors, the OECD classifies foreign aid into aid in social infrastructure and services (*aid1*), economic infrastructure and services (*aid2*), production sectors (*aid3*), multi-sectors (*aid4*) and the sum of commodity aid and humanitarian aid (*aid5*). The threshold variable is the summary index of *Economic Freedom*, and the outcomes are reported in Table 6. The results of Column 1 show that the aid in social infrastructure and services (*aid1*) has a positive and significant effect when the institutions are below the threshold (7.3103), while the effect becomes statistically insignificant when the institutions are above the threshold. This means that the aid targeted towards social infrastructure and services has a positive effect on FDI, and its effect is independent of economic institutions. The threshold relationship is found for the aid in economic infrastructure and services (*aid2*), production sectors (*aid3*) and the sum of commodity aid and humanitarian aid (*aid5*) in Columns 2, 3 and 5. We also find that aid in multi-sectors has no significant effect on FDI. Specifically, the threshold effect is promising for aid in production sectors (*aid3*) as it contributes directly to productive sectors. It crowds out the largest proportion of FDI (-0.26%) when institutions are below the threshold of 4.7769, while it also has a greater attraction (0.26%) for FDI among other sectoral aid once the institutions exceed the threshold.

The results of decomposing aid data addressed the contrary findings of previous studies such as those of Selaya and Sunesen (2012), Bhavan (2014) and Opoku (2015). The attraction of different sectoral aid is also conditioned by the specific institutional environment.

Thre. Var.	(1) Government size	(2) Legal system	(3) Sound money	(4) Trade freedom	(5) Regulations
Thre. Value (γ)	6.2343*** (0.2309)	2.7270*** (0.0564)	9.6072*** (0.0146)	8.3466*** (0.0437)	6.1576*** (0.1657)
Upper regime (Ins>γ)					
Foreign aid	0.3107*** (0.0475)	0.8256*** (0.2101)	1.4502** (0.7099)	1.3216*** (0.3388)	0.2343** (0.0972)
EF	−0.3345*** (0.1259)	−0.6898*** (0.1032)	−26.9991** (11.1408)	3.2117** (1.2837)	−0.7650*** (0.0993)
GDP	0.5758*** (0.1096)	0.7600*** (0.1164)	2.5375** (1.1036)	0.6763* (0.4031)	0.7033*** (0.1277)
Savings	0.0033 (0.0051)	0.0174** (0.0074)	−0.1343 (0.0991)	0.0146 (0.0221)	0.0267*** (0.0029)
Openness	−0.0215*** (0.0024)	−0.0265*** (0.0032)	−0.0408* (0.0231)	0.0356*** (0.0110)	−0.0020 (0.0022)
Population	0.0308 (0.0911)	−2.3718*** (0.2515)	0.3586 (0.3012)	−1.8544*** (0.5540)	1.0304*** (0.1344)
Lower regime (Ins≤γ)					
Foreign aid	−0.0228 (0.0553)	−1.0510*** (0.1926)	0.0025 (0.0209)	0.3835*** (0.0258)	−0.1275 (0.0811)
EF	0.5090*** (0.0780)	0.7180*** (0.0944)	0.2977*** (0.0299)	−0.1172** (0.0554)	0.9459*** (0.0896)
GDP	0.5765*** (0.0880)	0.3789*** (0.1256)	1.2976*** (0.0597)	0.9460*** (0.0339)	0.6157*** (0.1307)
Savings	−0.0138*** (0.0039)	−0.0281*** (0.0065)	−0.0044*** (0.0007)	−0.0003 (0.0011)	−0.0259*** (0.0026)
Openness	0.0130*** (0.0020)	0.0276*** (0.0031)	0.0033*** (0.0005)	−0.0020*** (0.0006)	0.0044*** (0.0015)
Population	0.0059 (0.0949)	2.3748*** (0.2520)	−0.0028 (0.0123)	0.0328 (0.0336)	−1.0559*** (0.1406)
Constant	−2.4026 (1.5147)	3.2288** (1.2640)	238.8428*** (100.0543)	−39.0629*** (13.5478)	−3.7238*** (1.2730)
Number of i	62	62	62	62	62
Year fixed effects	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors in parentheses; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Source: Authors' own elaboration

Table 5.
Results of
endogenous EF and
foreign aid

Aid Var.	(1) aid1	(2) aid2	(3) aid3	(4) aid4	(5) aid5
Thre. Value (γ)	7.3103*** (0.0903)	5.5861*** (0.0829)	4.7769*** (0.0398)	5.1287*** (0.0691)	5.6565*** (0.0597)
Upper regime (Ins>γ)					
Foreign aid	0.0042 (0.1112)	0.1362*** (0.0296)	0.2588*** (0.0964)	−0.0354 (0.0930)	0.0588** (0.0261)
EF	−2.6126*** (0.6506)	−0.7448*** (0.2110)	1.5121** (0.6945)	2.0476*** (0.5619)	−2.9680*** (0.2482)
GDP	−0.5726*** (0.1183)	0.2390*** (0.0914)	0.9297*** (0.2109)	0.9970*** (0.1692)	0.0183 (0.0611)
Savings	0.0205** (0.0088)	−0.0383*** (0.0062)	0.0731*** (0.0238)	0.0189*** (0.0050)	0.0234*** (0.0042)
Openness	0.0033 (0.0030)	−0.0186*** (0.0032)	−0.0117** (0.0053)	−0.0231*** (0.0051)	−0.0026 (0.0018)
Population	0.3203*** (0.1002)	0.3069** (0.1440)	3.7555*** (0.7814)	2.7606*** (0.3199)	−0.0244 (0.0516)
Lower regime (Ins≤γ)					
Foreign aid	0.1750*** (0.0409)	−0.1085*** (0.0349)	−0.2606** (0.1017)	−0.0038 (0.0979)	−0.0982*** (0.0237)
EF	0.5233*** (0.1306)	1.5535*** (0.1576)	−1.2468* (0.6846)	−1.5253*** (0.5375)	3.0180*** (0.2076)
GDP	1.0120*** (0.0638)	0.5695*** (0.0627)	−0.0624 (0.1956)	−0.1393 (0.1546)	0.9895*** (0.0667)
Savings	−0.0104*** (0.0012)	0.0304*** (0.0053)	−0.0741*** (0.0239)	−0.0266*** (0.0046)	−0.0282*** (0.0036)
Openness	0.0003 (0.0005)	0.0172*** (0.0029)	0.0123** (0.0052)	0.0232*** (0.0051)	0.0024 (0.0018)
Population	0.0151 (0.0179)	−0.3160** (0.1466)	−3.7534*** (0.7807)	−2.7618*** (0.3187)	0.0262 (0.0509)
Constant	22.3549*** (4.4849)	2.4855* (1.3022)	−23.0984*** (5.8814)	−22.0591*** (4.0178)	15.4345*** (1.5490)
Number of i	62	62	62	62	62
Year fixed effects	Yes	Yes	Yes	Yes	Yes

Notes: The aid variables denote aid in social infrastructure and services (*aid1*), economic infrastructure and services (*aid2*), production sectors (*aid3*), multi-sectors (*aid4*) and the sum of commodity aid and humanitarian aid (*aid5*); standard errors in parentheses; ***$p < 0.01$; **$p < 0.05$, *$p < 0.1$
Source: Authors' own elaboration

In Table 7 we present a heterogeneity analysis. The primary intention is to categorize countries based on their regions, as does most of the literature. However, we do not find the expected threshold patterns for each individual region. This could be because of the restricted number of recipients, specifically 27 from Africa, 16 from Asia and 19 from the Americas in our sample. Consequently, to enhance the statistical power and draw meaningful insights, we have aggregated the data from pairs of regions, and the results are reported in Columns 1–3. Additionally, we present the outcomes of a regression analysis focusing on a subset comprising low and lower-middle-income countries in Column 4, leaving apart the upper-middle-income countries which constitute the rest of the DAC recipient countries and our sample. A detailed classification is available in Table A2.

In Column 1, encompassing African and American countries, the model estimates a threshold of 7.7963, although closely approaching the upper limit of economic freedom of 8.1476. This suggests a potential linearity in the relationship between foreign aid and FDI where aid shows an attractive effect in the lower regime. Columns 2 and 3 report the results of the combinations of Asian with American countries and Asian with African countries, respectively. The anticipated threshold effects are consistent, with threshold values of 6.8510 and 5.8693. Beyond these thresholds, foreign aid tends to attract FDI. These findings are in line with the positive effect of aid on FDI found for African countries by Opoku (2015), and a negative one for Sub-Saharan and low-income countries in Asiedu *et al.* (2009) and for South East and South Asia in Rao *et al* (2020).

Likewise, in the subset of low and lower-middle-income countries in Column 4, the expected threshold pattern persists. An estimated threshold of 5.8316 indicates that in the lower regime, foreign aid displaces FDI, whereas in the upper one, the attraction is guaranteed. Our evidence could explain other results such as those of Harms and Lutz (2006) who find no effect of aid on FDI. Their linear estimations may hide the existence of different regimes that are found in our results for similar countries.

In summary, this section provides empirical evidence confirming that the attraction of foreign aid for FDI is contingent on economic institutions. The results are robust to different specifications, alternative variables and different subsets of sample. As the theoretical model explains, the attraction of aid can be significantly realized only in a free institutional environment to surpass the substitutability between aid invested in physical capital and FDI resulting in an overall crowding in effect. Moreover, the crowding out effect does not diminish gradually as institutions improve, instead, it remains unaffected unless a minimum threshold is reached, at which point the overall effect turns positive.

6. Conclusions

The existing studies on the relationship between foreign aid and FDI emphasize the context of continuity and produce inconclusive results, indicating the possibility of the existence of a threshold effect of foreign aid on FDI with respect to economic institutions. The panel threshold model enables us to test this hypothesis. We find robust empirical evidence that the attraction for FDI depends on *economic freedom*, *government size*, the *legal system* and *regulations*. That is, when they are incorporated as the threshold variable and when the institutional quality is found to be above the threshold, foreign aid attracts FDI. Furthermore, we can underline the importance of *economic freedom*, *legal system* and *regulations*, as foreign aid works against FDI when the three variables are found to be below the threshold. As for the more disaggregated data, *economic freedom* yields a threshold pattern for aid in economic infrastructure and services, production sector aid and commodity and humanitarian aid. In addition to the threshold effect, we find that aid in social infrastructure and services has a positive effect on FDI regardless of the economic

Countries	(1) AF&AM	(2) AS&AM	(3) AS&AF	(4) LLMI
Thre. Value (γ)	7.7963*** (0.0111)	6.8510*** (0.1203)	5.8693*** (0.0920)	5.8316*** (0.2319)
Upper regime (Ins>γ)				
Foreign aid	−3.1952 (2.5954)	0.6460*** (0.1834)	0.9342*** (0.1815)	0.8128*** (0.1551)
EF	−9.4462 (9.1192)	1.0644*** (0.3516)	−2.4261*** (0.5805)	−0.621(0.5306)
GDP	−21.3574 (14.2469)	−0.4994 (0.3267)	−0.585 (0.3837)	0.291(0.3266)
Savings	−0.2971 (0.1891)	0.0184 (0.0177)	0.0440*** (0.0083)	0.0332*** (0.0125)
Openness	0.142 (0.1610)	−0.0184*** (0.0044)	−0.0396*** (0.0063)	−0.0319*** (0.0064)
Population	−27.1317 (23.1833)	0.5285** (0.2395)	0.4673 (0.4075)	0.9332** (0.4447)
Lower regime (Ins≤γ)				
Foreign aid	0.2857*** (0.0345)	−0.2865*** (0.1073)	−1.0946*** (0.1318)	−0.7832*** (0.2158)
EF	0.5012*** (0.1400)	−0.2307 (0.2312)	3.1636*** (0.5220)	1.4246*** (0.5165)
GDP	0.9721*** (0.0880)	1.1769*** (0.1742)	1.6903*** (0.3463)	1.0268*** (0.2568)
Savings	−0.0159*** (0.0012)	−0.0095 (0.0097)	−0.0466*** (0.0065)	−0.0213* (0.0123)
Openness	0.0039*** (0.0005)	0.0070*** (0.0013)	0.0360*** (0.0052)	0.0281*** (0.0065)
Population	0.1276 (0.2724)	−0.7228*** (0.2370)	−0.4756 (0.3993)	−0.9368** (0.4772)
Constant	285.3077 (197.3577)	−3.8307 (3.0397)	15.3047*** (4.5505)	−2.088 (5.0613)
Number of *i*	45	35	43	36
Year fixed effects	Yes	Yes	Yes	Yes

Notes: AF, AM and AS denote African, American and Asian countries, respectively. Albania is grouped into Asian country in this study. LLMI denotes low and lower-middle-income countries. Standard errors in parentheses; ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$
Source: Authors' own elaboration

Table 7.
Results of country
groups and economic
freedom

institutions. Regarding the sample subsets, the results are consistent for the samples of Asia and America, for Asia and Africa and for the low and lower-middle-income countries.

While the constraints imposed by data availability have limited our sample size, this paper contributes by advancing the discourse on complementarity and substitutability in a non-linear and discontinuous manner. The empirical evidence offers valuable insights for countries engaged in promoting aid transfers to overcome financial constraints. Given the costly process of institutional improvements, prioritizing the independence and impartiality of the legal system and property protection is recommended, followed by the consideration of reducing government spending, tax rates, government investment and the state ownership of assets and lowering regulatory restraints in the credit, labor and product markets.

For donor countries, the implications highlight the importance of transferring technical assistance and capacity-building initiatives to enhance institutional quality and foster an investment-friendly climate. This aligns with the recent emphasis by the OECD (2022). The focus of subsequent development endeavours should be directed towards low and lower-middle-income countries. Furthermore, this study highlights the equal significance of focusing aid on sectors such as education and health.

Notes

1. Stata 17.0 has been used for both methodologies of estimation.

2. Kimura and Todo (2010) theoretically assume that aid in commodity and humanitarian aid have a negative non-infrastructure effect, undermining the total factor productivity, thus crowding out FDI. However, they also agree that foreign aid is fungible; that is, aid designed for a specific purpose might be used interchangeably for different purposes, and the negative effect is not always empirically observed. Another possible explanation for the negative effect might be the rent-seeking effect; however, more research and empirical evidence on this issue is needed.

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Appendix. Description statistics

Var. Name	Obs.	Mean	SD	Min.	Max.
FDI pc (*log*)	868	6.1408	1.6689	−0.0406	9.3090
Foreign aid pc (*log*)	806	2.8182	1.0251	−0.1415	5.3728
Economic Freedom	806	6.4544	0.7353	4.4257	8.1476
Size of government	806	6.9020	1.2527	2.3627	9.4917
Legal system	806	4.3921	1.1226	1.3490	7.0690
Sound money	806	7.6155	1.2778	3.1935	9.8067
Trade freedom	806	6.7937	0.9017	3.5996	8.7100
Regulation	806	6.5686	0.8447	4.3300	8.6557
GDP pc (*log*)	806	7.6088	1.0829	4.7324	9.7395
Savings (%)	806	21.864	10.899	−12.8807	57.4749
Population (%)	806	1.7185	1.1566	−9.0806	7.7860
Openness (%)	806	74.3122	33.4318	21.4469	210.3738

Table A1.
Descriptive statistics

Source: Authors' own elaboration

Albania[d]	Costa Rica[c]	India[a,d]	Nicaragua[a,c]	Uruguay[a,c]
Algeria[b]	Côte d'Ivoire[a,b]	Indonesia[a,d]	Niger[a,b]	Vietnam[a,d]
Argentin[ac]	Democratic Republic of the Congo[a, b]	Jamaica[c]	Nigeria[a, b]	
Armenia[a, d]	Dominican Republic[c]	Jordan[a,b]	Pakistan[a,d]	
Azerbaijand	Ecuador[c]	Kenya[a,b]	Panama[c]	
Bangladesh[a,d]	Egypt[a,b]	Madagascar[a,b]	Paraguay[c]	
Benin[a,b]	El Salvador[c]	Malawi[a,b]	Peru[c]	
Bolivia[a,c]	Gabon[b]	Malaysia[d]	Philippines[a,d]	
Botswan[ab]	Georgia[a,d]	Mali[a,b]	Senegal[a,b]	
Brazilc	Ghana[a,b]	Mauritius[b]	Sierra Leone[a,b]	
Burundi[a,b]	Guatemala[c]	Mexicoc	Sri Lanka[d]	
Cameroon[a,b]	Guinea-Bissau[a,b]	Morocco[a,b]	Thailand[d]	
China (People's Republic of)[d]	Guyana[c]	Mozambique[a,b]	Tunisia[a,b]	
Colombi[ac]	Haiti[a,c]	Namibi[ab]	Turkey[d]	
Congo[a,b]	Honduras[a,c]	Nepal[a,d]	Uganda[a,b]	

Notes: [a]Low and lower-middle income countries; [b]African countries; [c]American countries; [d]Asian countries The classification is made in accordance with the World Bank. Countries are grouped into low, lower-middle, upper-middle and high income. Income is measured using gross national income per capita. For instance, Albania has one superscript of 4, meaning it has been classified as Asian country but not low and low-middle-income country; Egypt has two superscripts of 1 and 2, meaning it has been classified as low and lower-middle-income country and African country
Source: Authors' own elaboration

Table A2.
Country sample