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How do Climate Shocks Affect the Impact of FDI, ODA and Remittances on Economic Growth?

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Abstract

The three main financial inflows to developing countries have largely increased during the last two decades, despite the large debate in the literature regarding their effects on economic growth which is not yet clear-cut. An emerging literature investigates the dependence of their effects on some country characteristics such as human and physical capital constraint, macroeconomic policy and institutional capacity. This paper extends the literature by arguing that climate shocks may undermine the effect of Foreign Direct Investment (FDI), official development assistance (ODA) and migrants' remittances on economic expansion. Based on neoclassical growth framework, the theoretical model indicates that FDI, ODA, and remittances improve economic growth, and the size of the effect increases with good absorptive capacity. However, climate shocks reduce this positive effect of financial flows in developing countries. Using a sample of low and middle-income countries from 1995 to 2018, the empirical investigation confirms the theoretical conclusions. Developing countries should build strong resilience to climate change. Actions are also needed at global level to reduce greenhouse gases emissions, and build strong structural resilience to climate shocks especially in developing countries.

JEL Classification Numbers: F3, F4, 04, Q5.

Keywords: Financial flows, Climate shock, economic growth, absorptive capacity

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I. INTRODUCTION

In many developing countries, external financial inflows remain important sources of financing development because of their increasing quantity and the low ability of domestic resources mobilization in these countries to face their growing needs.

Beyond the trends and the analysis of the factors attracting these resources, their contribution to the economic prosperity of the host countries remains a critical question in development economics. Climate shocks may reduce the impact of financial inflows, particularly for countries with low absorptive capacity, through at least three mechanisms:

- Climate shocks can deteriorate the absorptive capacity (destruction of the infrastructures; degradation of human capital, deterioration of macroeconomic environment and some institutions quality through violence, political unrest and civil war), decreasing the threshold of maximum financial inflows the country is able to effectively manage, and negatively impacting the returns of additional inflows.
- Extreme weather events generally create emergency situations, and thus favor the mobilization for more aid and remittances. They can therefore increase the level of financial inflows beyond the ability of the absorption capacity of the country.
- In case of climate shocks, the financial inflows can be diverted from their initial productive purpose to non-production activities.

Researchers diversely investigated the impact on Foreign Direct Investment (FDI), official development assistance (ODA) and Remittances on economic growth and poverty reduction using different methodologies, samples and time periods. Despite the growing interest, the question of the effect of these financial inflows remains open and debatable. Although, the focus on these financial flows differs from across studies, there is a lack of consensus on their effect. Indeed, some studies conclude that these capital flows improve economic growth in host countries, mainly through input accumulation and/or productivity growth.[2] Other papers find either no effect or an adverse impact of these inflows on economic growth.[3] Besides, the large and most significant part of the literature suggest that the impact on growth of these capital flows is conditional on the characteristics of host economy, and features that determine the ability of destination countries to absorb these financial flows.[4]

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[2] These results are found for FDI (see among others Makiela and Ouattara, 2018; Iwasaki and Tokunaga, 2014; Chakraborty and Nunnenkamp, 2008), for ODA (Chauvet and Ehrhart, 2018; Arndt et al, 2015; Civelli, et al, 2018), and for migrants' remittances (Imai et al 2014, Lim and Basnet 2017; Makun, 2018).

[3] See Goh et al, 2017; Gunby et al, 2017; Herzer et al, 2008 for FDI, Easterly, 2003; Rajan and Subramanian, 2008 for ODA, and Amuedo-Dorantes and Pozo, 2004, Acosta et al. 2009, for the remittances

[4] These local capacities include internal and macroeconomic stability (Alguacil et al, 2011; Beugelsdijk, 2008; Burnside and Dollar, 2000), regulations (Adams and Opoku, 2015), financial development (Alfaro et al 2004, Durham et al 2004; Ahamada and Coulibaly, 2011;), quality of institutions (Kadozi, 2019; Catrinescu el al 2009; Ogunniyi et al, 2020), export capacity (Aurangzeb and Stengos, 2014), Economic freedom (Azman-Saini et al. 2010), Infrastructural improvements (Bende-Nabende and Ford,1998), human development (Li and Liu, 2005;

(continued…)

For a given host country, the absorptive capacity may change from time to time according to the modifications of its characteristics due to factors under or out of its control. Moreover, for developing countries where the absorptive capacity is relatively low, the effect of financial inflows may be different according to the exposure to some external shocks, such as climate shocks. In the existing literature linking financial flows and growth, authors generally focus on one type of financial inflows to analyze absorptive capacity. Furthermore, researchers only investigate whether the absorptive capacity exists and the variables constituting it. They do not go further to explore and analyze factors modifying the effect of financial inflows through the absorptive capacity. Regarding the climate change literature, it generally posits that climate shocks negatively affect economic outcomes, and considered the reduction of financial inflows as an important channel mediating the performance worsening when climate shocks occur.[5]

This paper attempts to bridge this gap in the literature by investigating how climate shocks may affect the impact of selected external capital inflows (FDI, ODA and remittances) with regard to economic expansion.

Our theoretical model based on neoclassical framework indicates that financial inflows improve economic growth and the effect depends on the absorptive capacity. Moreover, climate shocks mitigate the positive effect of financial flows in developing countries. The empirical investigation applied to 63 low and middle-income countries from 1995 to 2018 confirms these results.

The reminder of the paper is organized as follows. Section 2 develops the theoretical model of the impact of capital flows on economic growth based on the neoclassical framework. Section 3 provides a detailed literature review on the effect of climate shocks on economic growth. It also shows how financial flows affect economic growth. The next section explains the empirical design and section 5 presents the empirical results. In section 6, some robustness are checked and section 7 concludes.

II. THEORETICAL BACKGROUND: CAPITAL FLOWS AND CLIMATE SHOCKS IN NEOCLASSICAL GROWTH MODEL

Theoretically, at least four frameworks are available to assess the effect of capital flows on economic performance: the dualistic growth model (Aurangzeb and Stengos, 2014), the Augmented-Solow growth (1956) model (Ketteni and Kottaridi, 2019), the endogenous growth models (Pham and Pham, 2020) and the overlapping Generation models (Benhamou and Cassin, 2021). Each of these models can be adapted to the present paper. However, a modified endogenous model with the inclusion of capital flow as a component of total factor productivity (similar to the theoretical one developed by Pham and Pham, 2020) is more appropriate for our empirical study since it directly provides elements for the absorptive capacity of host countries,

Su and Liu, 2016; Kadozi, 2019), exposure to external shocks (Guillaumont and Chauvet, 2001) and structural handicaps (Dalgaard et al., 2004)

[5] See for example Burke et al (2015); Li et al (2021), Acevedo et al (2020)

which is at the core of our analysis. We will thus adapt this model and use it as background to our empirical framework.

In their model, Pham and Pham (2020) analyze the effect of foreign aid on economic growth in recipient's countries by paying more attention to some country characteristics determining the absorptive capacity such as development level, domestic investment, public investment, etc. The paper shows that "the effect of foreign aid depends strongly on the manners in which aid is used in recipient countries and on the absorptive capacity of these countries as well as the initial development level of the recipient countries" (Pham and Pham, 2020, pp. 64). Their model is an extension of the neoclassical growth model with endogenous determination of the total factor productivity. Our empirical model is partly inspired by this theoretical framework. To make it explicit for econometric regression, the model is also built on the derivation of the empirical model of Su and Liu (2016) on the impact of FDI on economic growth. The model consists of the augmented-Solow model à la Mankiw, Romer and Weil (MRW) (1992) with endogenous determination of the technology, total factor productivity or efficiency. Let consider the following production function.

$$Y_t = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta} \tag{3.1}$$

Where Y, K, H, L and A represent respectively the GDP, the stock of physical capital, the stock of human capital, the labor and total factor productivity or technical progress, and t denotes the time indexes. This production function is of constant returns to scale and diminishing marginal product regarding each input.

The labor and technology evolution are made possible according to the following equations:

$$L_t = L_0 e^{nt} \tag{3.2}$$

$$A_t = A_0 e^{gt} F^{\theta} \tag{3.3}$$

With n and g denoting respectively the growth rate of the labor force and the exogenous rate of technical progress. F is the part of A that is related to the external capital inflow (FDI, ODA or remittances). As it is largely explained in the literature, these capitals mainly improve economic development through total factor productivity. All the three types of financial flows considered here are documented to be determinants of total factor productivity. Romer (1990) argued that the growth rate of factor productivity depends on the skilled content of human capital and remittances, ODA and FDI are largely shown in the literature to be sources of education improvement and training. As explained by Udah (2011), the inclusion of remittances in endogenous growth model should be done through the total factor productivity. External capital inflows, thus, improve the total factor productivity directly or indirectly via human capital (as in Su and Liu (2016)), public investment and initial development (as in Pham and Pham (2020)), human development (as in Udah, 2011) and other country characteristics explaining the absorptive capacity. To consider this phenomenon, θ is written as a function of human capital and other country characteristics X.

$$\theta = \theta_0 + \theta_1 f(h) + \theta_2 f(k) + \theta_j f\left(X_j\right) \tag{3.4}$$

In conformity with our theoretical arguments, climate shocks may impact economic growth through changes in the amount of F and the modification of the country characteristics. This effect may modify the total factor productivity as follows:

$$A_t' = A_0 e^{gt} (\omega_1 F)^{(\omega_2 \theta)} \quad (3.5)$$

Where ω_1>0 is the modification of the part of A related to the external capital inflow and $0 \leq \omega_2 \leq 1$ is the effect due to changes in country features. It is important to note that ω_1 can exceed 1 since the occurrence of the shock generally leads to increasing inflows of ODA and remittances or to decreasing inflows of FDI. However, increasing inflows may reduce their effect by emphasizing the absorptive capacity issue.

In accordance with MRW (1992), the accumulation of physical and human capitals is provided by the following equations:

$$\dot{K} = s_k Y_t - \delta K \quad (3.6)$$

$$\dot{H} = s_h Y_t - \delta H \quad (3.7)$$

Sk and Sh are respectively the share of income invested in physical and human capital and δ is their depreciation rate. These equations can be rewritten by effective unit of labor:

$$\dot{k} = s_k y_t - (n + g + \delta) k_t \quad (3.8)$$

$$\dot{h} = s_h y_t - (n + g + \delta) h_t \quad (3.9)$$

At the steady state, k and h are constant and their variation equals 0, thus:

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n+g+\delta} \right)^{\frac{1}{1-\alpha-\beta}} \quad (3.10)$$

$$h^* = \left(\frac{s_k^{1-\alpha} s_h^{\alpha}}{n+g+\delta} \right)^{\frac{1}{1-\alpha-\beta}} \quad (3.11)$$

When we substitute the steady state values in the production function and we use the logarithm form of the equation we obtain the steady state income per capita as:

$$log\left(\frac{Y_t}{L_t}\right) = logA_t' - \frac{\alpha+\beta}{1-\alpha-\beta}\log(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\log(s_k) + \frac{\beta}{1-\alpha-\beta}\log(s_h) \quad (3.12)$$

When we replace the elasticity of technological progress, we obtain:

$$log\left(\frac{Y_t}{L_t}\right) = logA_0 + gt + \theta'_0 \log(F') + \theta'_1 \log(F') * \log(h) + \theta'_2 \log(F') * \log(k) + \theta'_j \log(F') * \log(X_j) - \frac{\alpha+\beta}{1-\alpha-\beta}\log(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\log(s_k) + \frac{\beta}{1-\alpha-\beta}\log(s_h) \quad (3.13)$$

Where F'=$\omega_1 F$, $\theta'_0 = \omega_2\theta_0$, $\theta'_1 = \omega_2\theta_1$, $\theta'_2 = \omega_2\theta_2$ and $\theta'_j = \omega_2\theta_j$

The equation obtained corresponds to the production function of the economy at the steady state. However, it is generally applied to developing countries, which have not yet reached their steady state. It is thus relevant to examine the transition dynamics toward the steady state. If y^* is the steady state value of per capita gross domestic product (GDP), we have the following relation.

$$\frac{dlogy}{dt} = \eta(logy^* - logy_t) \quad (3.14)$$

With η=(n+g+δ)(1-α-β).

Integrating this equation from 0 to period t gives:

$$logy_t = (1 - e^{-\eta t})logy^* + e^{-\eta t}logy_0 \quad (3.15)$$

Then replacing logy* in the production function gives:

$$log\left(\frac{Y}{L}\right)_t - log\left(\frac{Y}{L}\right)_0 = -(1 - e^{-\eta t})log\left(\frac{Y}{L}\right)_0 - (1 - e^{-\eta t})\frac{\alpha+\beta}{1-\alpha-\beta}\log(n + g + \delta) + (1 - e^{-\eta t})\frac{\alpha}{1-\alpha-\beta}\log(s_k) + (1 - e^{-\eta t})\frac{\beta}{1-\alpha-\beta}\log(s_h) + logA_0 + gt + \theta'_0(1 - e^{-\eta t})\log(F') + \theta'_1(1 - e^{-\eta t})\log(F') * \log(h) + \theta'_2(1 - e^{-\eta t})\log(F') * \log(k) + \theta'_j(1 - e^{-\eta t})\log(F') * \log(X_j) \quad (3.16)$$

This equation shows that along the transition path, economic growth is determined by the initial GDP per capita, population growth, physical capital accumulation, the stock of human capital, external capital inflows and their interactions with the country characteristic variables. External capital inflows appear to increase economic performance and their impact is affected by climate shocks through changes in their level and their interaction with the country features.

This equation can be rewritten for the purpose of empirical estimation to obtain the following econometric model:

$$\log(y_{it}) - \log(y_{i0}) = \gamma_0 + \gamma_1\log(y_{i0}) + \gamma_2\log(n_{it} + g + \delta) + \gamma_3\log(s_{k_{it}}) + \gamma_4\log(h_{it}) + \gamma_5\log(Flow_{it}) + \gamma_6\log(Flow_{it}) * \log(h_{it}) + \gamma_7\log(Flow_{it}) * \log(s_{k_{it}}) + \varepsilon_{it} \quad (3.17)$$

III. FINANCIAL FLOWS, ECONOMIC GROWTH AND CLIMATE SHOCKS

This section first explains how climate shocks influence the effect of financial flows on economic growth. Then, other mechanisms through which climate change impacts economic growth are developed.

A. How climate shocks may affect the financial inflows-economic growth nexus

We argue in this paper that climate change may modify the impact of selected external financial inflows (FDI, ODA and remittances) with regard to economic expansion.

Many arguments can be put forward to anticipate the alteration of the effect of these external financial inflows in case of climate shocks. Firstly, extreme weather events may modify the features of a country in terms of local productive capacities and therefore reduce its ability to absorb the flow of capital coming from the rest of the world (absorptive capacity). In fact, climate shocks generally damage the infrastructures; degrade human capital, deteriorate macroeconomic environment and may weaken institutions quality through violence, political unrest and civil war, among others (Hendrix and Salehyan, 2012; Burke et al. 2015; Harari and Ferrara, 2018; Helderop and Grubesic, 2019). Helderop and Grubesic (2019) state that extreme weather events significantly degrade human capital and infrastructures. This destruction of the absorptive capacity may reduce the economic returns of existing and additional capital, especially, financing coming from abroad. In the literature, some authors investigate the association between climate variables, foreign financing and economic growth (Guillaumont and Chauvet, 2001; Dalgaard, 2004). Dalgaard (2004) finds that foreign aid is less effective in tropical zone. We assess the effect of climate shocks and extreme climate events, which is different from permanent weather conditions only changing from one geographical position to another as done in Dalgaard (2004). Guillaumont and Chauvet (2001) show that development aid is more effective in countries more exposed to external vulnerability. Climate measure in their paper is expressed through the volatility of agricultural production which is different from climate shocks and extreme weather events we consider.

Secondly, even when it is assumed that the absorptive capacity is not affected by these climate shocks, their occurrence generally leads to large and significant inflow of capitals mainly in the form of ODA and remittances that need additional absorptive capacity and preparedness to be effective. More people migrate from areas with frequent climate shocks, and may send money back to their relative in case of economic shocks. Licuanan et al (2015) demonstrate that the diaspora is more responsive to natural disasters by sending remittances.

Thirdly, these shocks may lead to the diversion of the capital flows from initial productive objectives to emergency ones not really prepared and thus more likely to fail. FDI may be reduced because of the low return environment, and ODA and remittances may be directed to less productive objectives. The additional flows are generally provided for humanitarian purpose rather that productive investment, and are likely less effective in terms of economic growth.

B. Climate shocks and economic growth

Beyond its influence on the impact of financial flows on economic growth, climate shocks affect economic expansion through other mechanisms. There is a growing literature assessing the association between climate variables and economic activities. The majority of these articles show that climate variability and extreme weather events negatively affect economic performance (Dell, Jones, and Olken, 2012; Burke et al., 2015; Li et al, 2021, Acevedo et al, 2020; Felbermayr and Gröschl, 2013, International Monetary Fund (IMF), 2016, 2020). Li et al (2021) demonstrate that hot temperatures have persistent adverse effect on firm's production output in China. Acevedo et al (2020) confirm this negative effect for low-income countries. For other authors, the effect of climate change depends on the size and the type of the event. At low temperature, an increase in temperature may improve growth in contrary to high temperature (Loayza et al 2012, Burke et al. 2015).

Some studies posit that climate shocks may improve economic growth, generally using natural disasters as climate change measure. Klomp and Hoogezand (2018) claim that the exposition to extreme weather events increases the protection of production and improve productivity, but only in developed countries. Guo et al (2015) find no significant impact of natural disasters on economic growth in China.

The effect of climate shocks on economic outcomes depends on a number of factors that magnify or mitigate the impact. These factors include the characteristics of the disasters in terms of severity, frequency and duration. They also include the country characteristics such as the share of population and country area at risk, the preparedness and resilience, the reliance and dependence to activities largely exposed to climate shocks (high share of rain-fed agriculture), and the reaction of the country after the shocks. Many developing countries are worse off in these factors, leading to more disastrous effects of natural disasters (IMF, 2016, 2019).

Recently, authors working on this topic have been mainly interested in the channels through which climate shocks affect economic growth. At least five channels are explored through which the effect of climate shocks are mediated (IMF, 2016). First, the occurrence of the shocks is detrimental to economic activities through its adverse impact on physical and human capital. The impact on investment and capital accumulation seems a commonly channel found in the literature. For Li et al (2021), hot temperatures reduce firm's productions through their impact on firm's investment and capital. Acevedo et al (2020) show that the negative effect of temperature on output is transmitted through reduction in investment. For Khan et al. (2020), extreme weather events negatively affect economic growth through a reduction in foreign direct investment. Climate shocks also lead directly and indirectly to reduction in human factors both in terms of quality and quantity, reducing the productivity and economic performance (Dell et al. 2012, Li et al. 2021, Acevedo et al 2020). Directly they increase the mortality rate and the morbidity. Indirectly they destroy education and health infrastructures, and reduce the access to these facilities through reduction in income.

Second, the exposition to climate shocks negatively affects economic growth through the deterioration of the external sector. In fact, these shocks reduce the productive capacity and thus the export capacity. They also increase the demand for foreign production for reconstruction and emergencies. Li et al. (2021) find that hot temperatures decrease firm's exports.

Third, the occurrence of disasters reduces the government revenue and increases the expenditure needs for emergencies and reconstruction, leading to more fiscal deficit, and low public investment in productive activities (IMF, 2016).

Fourth, the financial sector may be largely and negatively affected by the consequences of the disasters on the real sector. This exposes the country to the risk of low financial intermediation such as fewer credits to the economy and low access to insurances (IMF, 2016).

Finally, climate shocks are assessed in the literature to affect economic activity through reduction in economic activities, mainly agricultural production (Burke and Emerick 2016, Acevedo et al 2020). Agricultural activities in many developing countries depend on the weather, and shocks are sources of unemployment, low human capital, and lower long-term production.

IV. Empirical investigation

A. Empirical Models

Let recall that our objective is to assess the impact of climate shocks on the effect of three selected capital inflows (FDI, ODA and remittances) in developing countries. The methodology for this analysis follows three steps corresponding to the hypotheses we are investigating.

First, the effect of each inflow on economic growth is estimated using the following growth model.

$$growth = Constant + \gamma_1 \log(initial\ GDP_{it}) + \gamma_2 \log(population\ growth_{it}) + \gamma_3 \log(physical\ investment_{it}) + \gamma_4 \log(human\ capital_{it}) + \gamma_5 \log(Flow_{it}) + vt + \varepsilon_{it} \quad (4.1)$$

Where the dependent variable "growth" is the GDP per capita growth rate, "initial GDP" is the GDP per capita at the beginning of the period, "population growth" is the population growth rate, physical investment" is the gross fixed capital formation", "human capital" is the indicator of human capital, "Flow" is the financial inflow variables, "v_t" is the time dummy to control for common time-variant shocks happening in all countries of the sample, and "ε" is the error terms.

This equation obtained from our theoretical model is similar to the augmented Solow model with the addition of financial inflow. The variable of interest in the model is the financial inflow which is expected to have a positive coefficient.

Second, we include into the previous model the interaction of the financial inflow variables with the indicator of absorptive capacity variables (human capital, infrastructures, institutions quality) to assess the dependence to the absorptive capacity. The absorptive capacity used here is a composite index obtained from the combination of human capital, infrastructures and the quality of political institutions. It measures the ability of recipient countries to use effectively international financial inflows (Feeny and de Silva, 2012).

$$growth = Constant + \gamma_1 \log(initial\ GDP_{it}) + \gamma_2 \log(population\ growth_{it}) + \gamma_3 \log(physical\ investment_{it}) + \gamma_4 (absoptive\ capacity_{it}) + \gamma_5 \log(Flow_{it}) + \gamma_6 (absoptive\ capacity_{it}) X \log(Flow_{it}) + vt + \varepsilon_{it} \quad (4.2)$$

This equation is similar to those existing in the literature to test the role of host country ability to effectively use the amount of financial flows entering in form of development aid (Askarov and Doucouliagos, 2015), FDI (Azman-Saini et al. 2010) and remittances (Ogunniyi et al., 2020). The human capital variable disappears from the model because it is already included in the absorptive capacity. A positive coefficient of the interaction of absorptive capacity and financial inflow indicates the importance of improved recipient countries characteristics to take more advantage from financial inflows.

Third, the variables of climate shocks are included in the model as well as their interaction with the external financial inflow variables to assess how they change the effect of the external capital inflows.

$$growth = Constant + \gamma_1 \log(initial\ GDP_{it}) + \gamma_2 \log(population\ growth_{it}) + \gamma_3 \log(physical\ investment_{it}) + \gamma_4 (human\ capital_{it}) + \gamma_5 \log(Flow_{it}) + \gamma_4 (climate\ shock_{it}) + \gamma_6 (climate\ shock_{it}) X \log(Flow_{it}) + vt + \varepsilon_{it} \quad (4.3)$$

The coefficient of the financial inflows should have a positive coefficient while the climate shock variable and its interaction with financial inflows are expected to have a negative impact on economic growth. The negative coefficient of the interaction term shows the detrimental role of climate shocks on the effect of financial inflows on economic growth. This model is estimated with and without the human capital variable.

B. Estimation strategy

These econometric models inspired from the theoretical framework are dynamic panel equations because of the presence of the lag of the GDP per capita within the explanatory variables. Two problems may arise concerning the estimation of these models. First, if the time dimension is limited, the fixed effect estimator may be biased and inconsistent (Nickell, 1981; Kiviet, 1995). Nickel (1981) shows that when estimating the dynamic model with fixed effects estimation technique, the coefficient may be biased at about 1/T, with T indicating the time dimension.

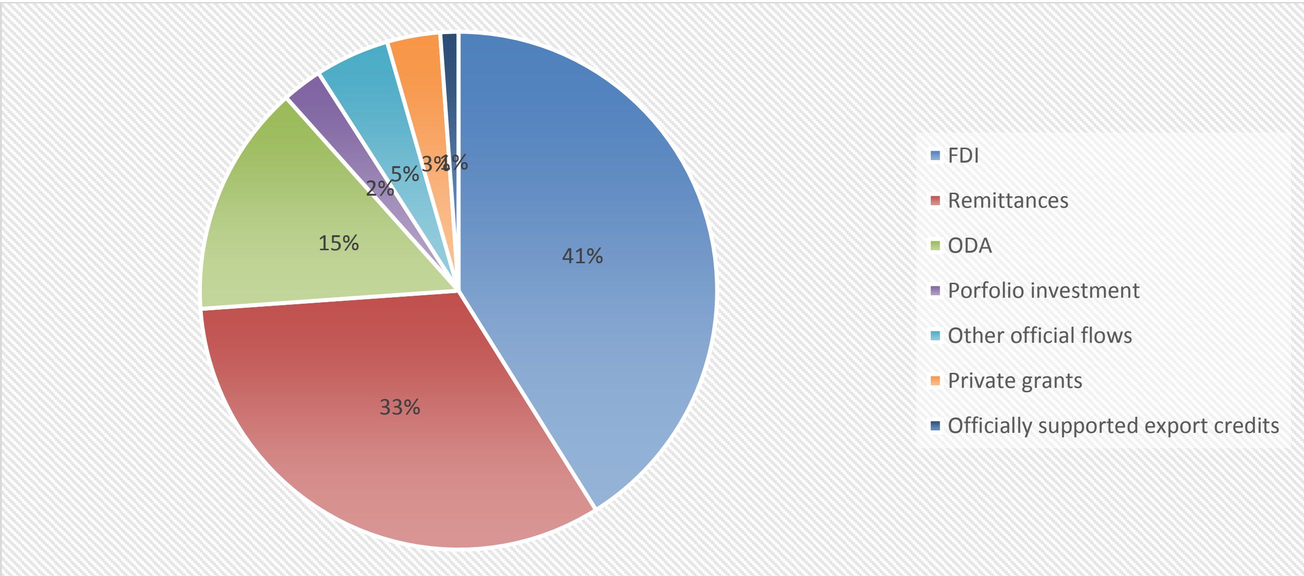
Second, the inflow variables are also shown in the literature to be endogenous because of the reverse causality. We thus estimate these models using Blundell and Bond (1998) system-GMM (generalized method of moments) estimator and take stock of the internal instruments. Many papers use the Blundell and Bond (1998) system-GMM estimator to estimate growth models, especially the impact of financial flows (Ogunniyi et al, 2020). More precisely, we use the two-step robust System-GMM estimator with the Windmeijer (2005) correction for finite sample bias.

C. Data

We estimated these models with data from 64 low and middle-income countries (25 Low-Income Countries (LICs), 22 Lower Middle-Income Countries (LMICs) and 17 Upper Middle-Income Countries (UMICs)) for the 1995-2018 period (see Table A1 Appendix 1). The data are divided into non-overlapping five-year periods to reduce the influence of business cycles. Our first data source is the IMF World Economic Outlook. The GDP per capita, its growth rate and the foreign direct investment are taken from this database. The general government investment data are obtained from the IMF Investment and Capital Stock Dataset. The human capital indicator is taken from the Penn World Table of the Groningen Growth and Development Centre. The human capital use is based on the average year of schooling from Barro and Lee (2013) and the rate of return in education in Caselli (2005), linearly interpolated (Feenstra et al 2015). The third data source is the World Bank World Development Indicator (WDI) from which we use the population growth, trade and remittances data. As official development assistance (ODA), data from the Organisation for Economic Co-operation and Development (OECD) are used, and we choose ODA total net as in the existing literature (Chauvet and Ehrhart, 2018).

According to OECD data[6], the total net flows from Development Assistance Committee (DAC) countries to developing countries amounted to 433,467.56 million of United States Dollars (USD) in 2017 including 34% of net Official Development Assistance (ODA) and 31.5% of direct investment. At the same year, the total foreign direct investment (FDI) invested in developing countries reached 536,824 million USD (41% of total flows), the personal remittances was at 428,645 million USD (33% of total flows) and the official Development Assistance was at 189,682 million USD (15% of total flows) (see Figure 1 for more details).[7] These three funds represented 89% of total financial inflows to developing countries.

Figure 1. Financial Flows to Developing Countries in 2017



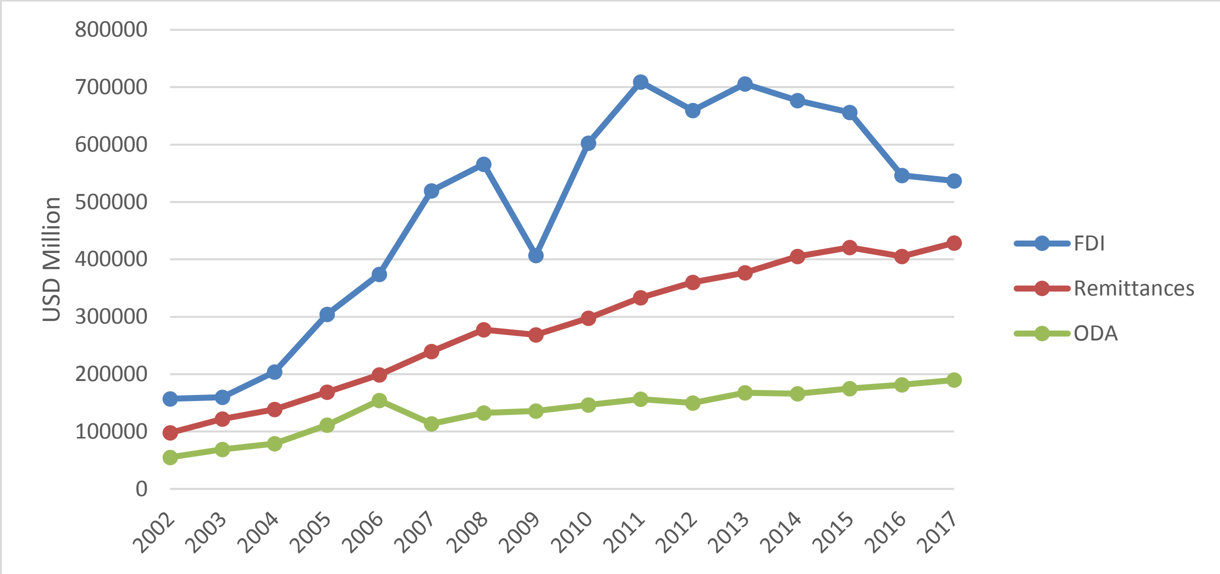
Source: Author's construction based on data from OECD.

Figure 2 shows the trends of the three financial flows (FDI, ODA and remittances) from 2002 to 2017. Both of them have increasing trends, even though FDI inflows are decreasing since early 2010 decade. Figures 3 and 4 present these financial inflows for the year 2000, 2010 and 2018 by income group (Figure 3) and geographical region (Figure 4). It appears that ODA decreases with the income level, which is part of its allocation criteria. Lower middle-income countries are slightly more benefiting from remittances than low-income countries, and upper middle-income countries are receiving low rate of remittances. The comparison for FDI depends on the year considered. Regarding the geographical break down, Sub-Saharan African countries received more ODA than other regions, while Middle East and North Africa, and

[6] http://www.oecd.org/dac/financing-sustainable-development/development-finance-data/statisticsonresourceflowstodevelopingcountries.htm
[7] https://public.tableau.com/views/Bigpictureoftotalresourcereceiptsbyyear/Byyear?:embed=y&:display_count=yes&publish=yes&:showVizHome=no#1

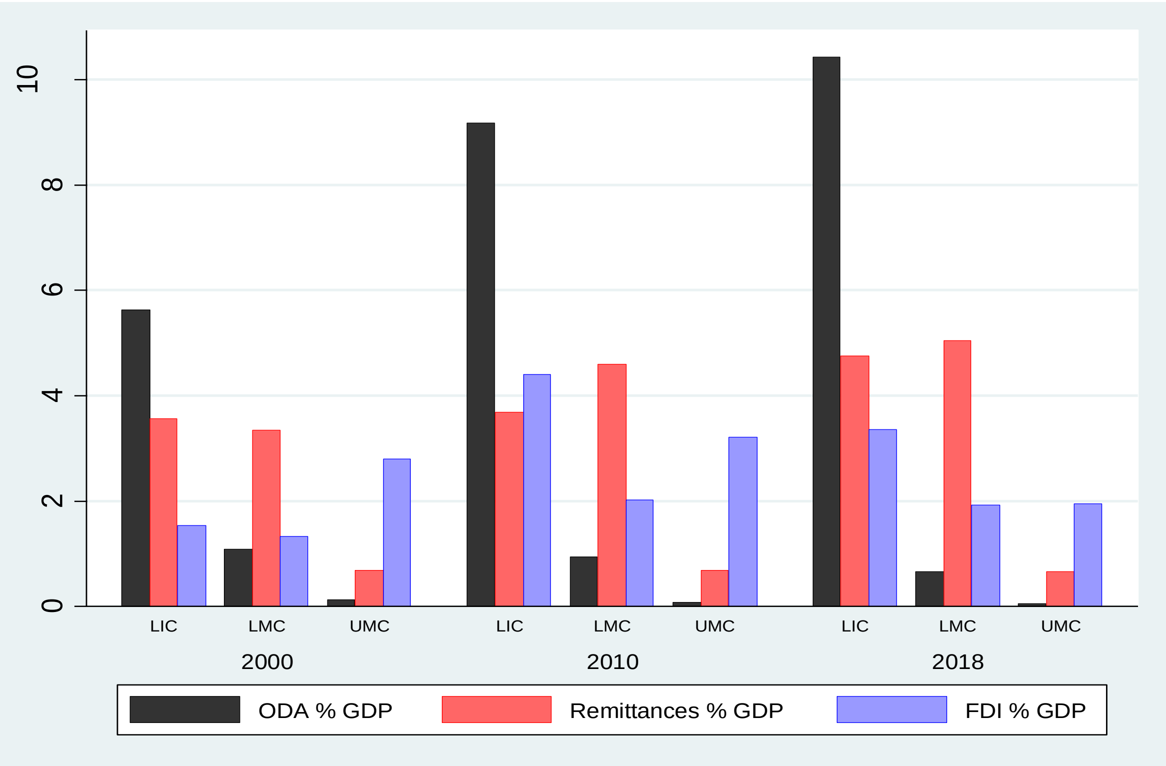
South Asia regions are the most beneficiaries of remittances. East Asia and Pacific region attracted more FDI as GDP ratio than other regions.

Figure 2. Financial Flows Trends in Developing Countries in 2002-2017



Source: Author's construction based on data from OECD.

Figure 3. Financial Flows in Developing Countries by Income Group



Source: Author's construction based on data from WDI.

Figure 4. Financial Flows in Developing Countries by Region

Source: Author's construction based on data from OECD.

The climate variable is at the core of this study. When measuring climate change, three categories of indicators should be kept in mind. The first group is the emissions and the stock of greenhouse gases. These indicators are generally used when assessing the causes of climate change, and are pertinent as climate change mitigation policy target. The second category are constituted of changes observed directly in climate indicators such as temperature variations and changes in precipitations. These indicators are commonly accepted as the consequences of the first category. The third group contains extreme weather events such floods, droughts, and other natural disasters. Even though the scientific community is largely and increasingly accepting that climate could worsen natural disasters through the alteration of the frequency, intensity, duration, area covered, and timing, they are not totally accepted as climate change indicators (The Intergovernmental Panel on Climate Change (IPCC), 2014). The two last categories are mainly used to assess the consequences of climate change. As we are assessing the impact of climate change, we use indicators from these two categories. We assess the effect of changes in temperature, precipitation, and the occurrence of natural disasters. For both precipitation and temperature, we first computed the average[8] and the standard deviation for each country and each month from 1950 to 2018. Then, we consider as monthly climate shocks the deviation of the temperature or precipitation to the long-term monthly average divided by the long-term monthly standard deviation. Our first indicator is the annual average of the absolute value of these monthly deviations.

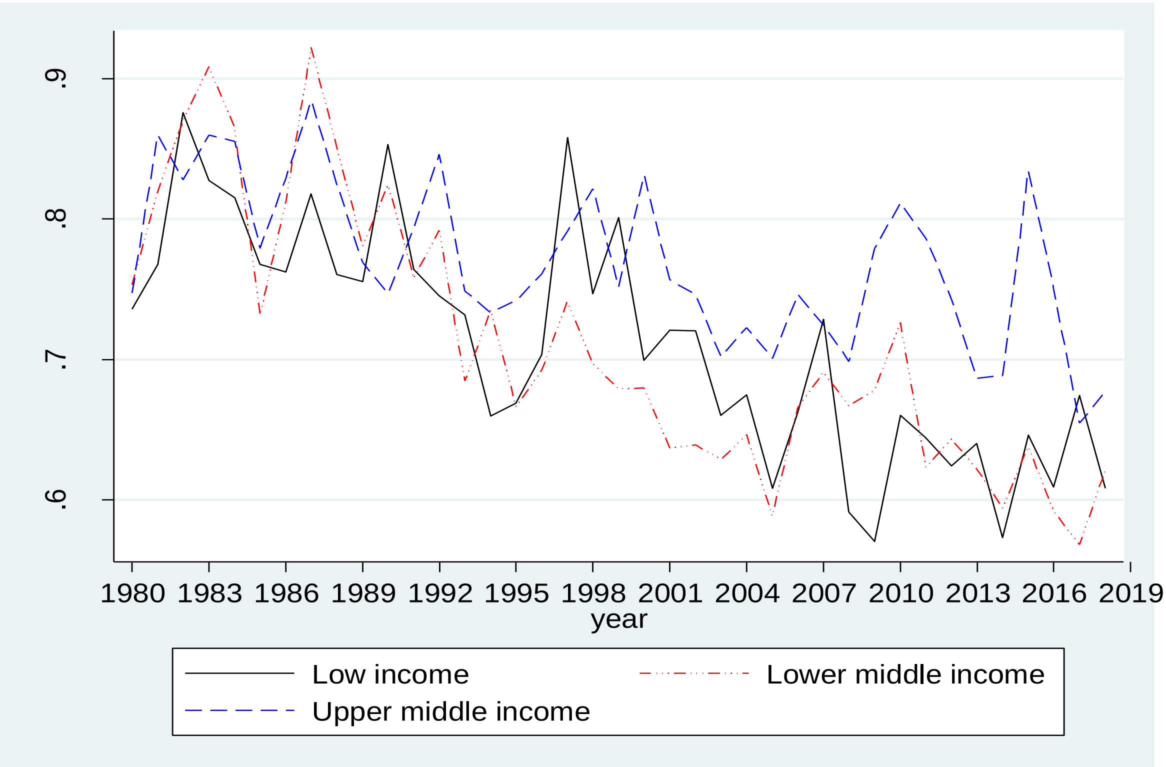
[8] For each month, we computed the simple average from 1950 to 2018.

$$\text{Climate shocks average}_{it} = \frac{1}{12}\sum_{k=1}^{12}\left(absolute\ value\ \frac{Monthly\ climate_{kit} - long\ term\ average_{ki}}{long\ term\ standard\ deviation_{ki}}\right) \quad (4.4)$$

Where $Monthly\ climate_{kit}$ is climate (temperature or precipitation) value observed for country i in month k and year t. $long\ term\ average_{ki}$ and $long\ term\ standard\ deviation_{ki}$ are respectively the average and the standard deviation for each country and each month for the period 1950-2018. We prefer this measure and its square to the annual climate value because they provide the deviations to the normal situation captured by the long-term monthly average. We choose the monthly long-term average as trend to take into account the different seasons. The precipitations and temperature data are taken from the Climate Research Unit (CRU)[9].

Figures 5 and 6 describe precipitations and temperature shocks by income group and region. Precipitations deviations are experiencing downward evolution whereas temperature shocks are rising, especially since the mid-1990s.

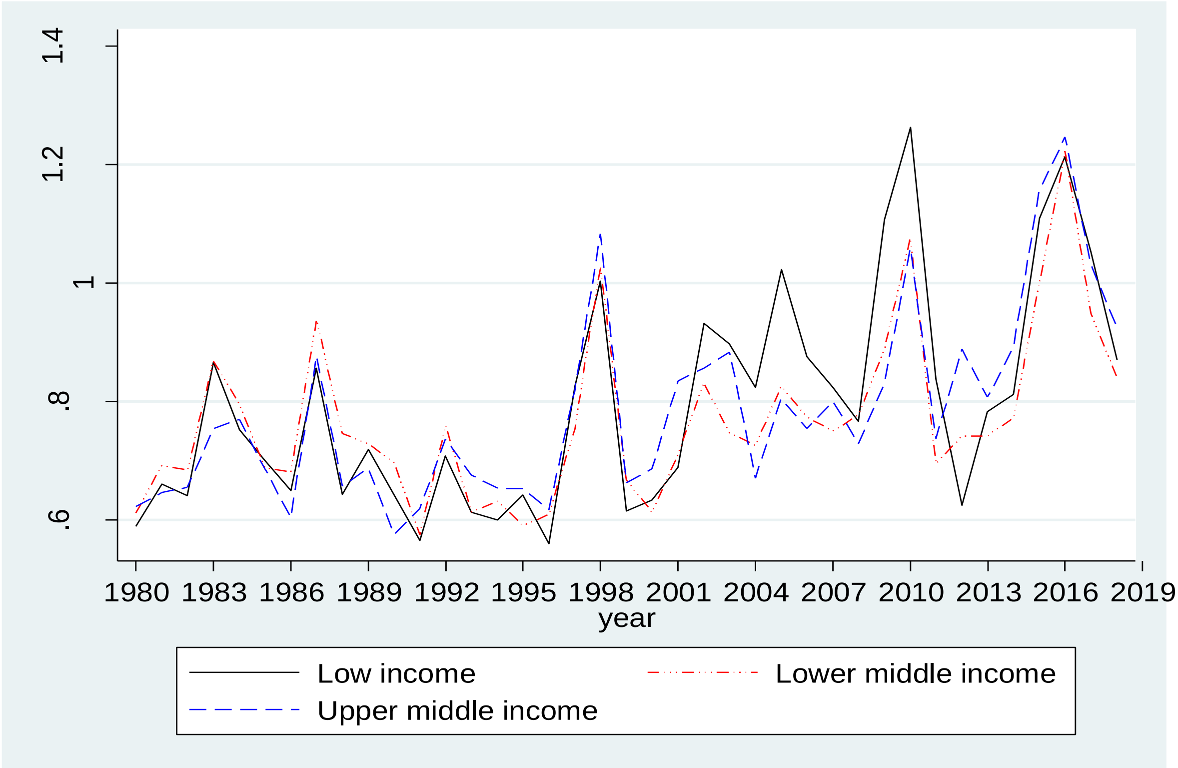
Figure 5. Evolution of Precipitation Shocks Per Income Group



Source: Author's construction based on data from the Climate Research Unit

Figure 6. Evolution of Temperature Shocks Per Income Group

[9] The data are available at : https://crudata.uea.ac.uk/cru/data/hrg/



Source: Author's construction based on data from the Climate Research Unit

Following Feeny and de Silva (2012) and (Combes et al 2016) we construct an index of absorptive capacity based on two dimensions and three variables using principal components analysis method: capacity constraints (human capital and infrastructure) and governance constraint (political institutions). The infrastructure variables are taken from the World Bank, and measures the paved road density in the country and the use of telephone line. As political institution, we use all the dimensions of the World Governance Indicators (WGI) (Voice and Accountability, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption). The definition and source of the indicators used are available in Table A2 Appendix 1.

V. Results

To assess the role of climate shocks on the effect of financial flows in developing countries, we estimate successively the three econometric models with the system-GMM estimator. The results obtained from the estimation of Equation (4.1) corresponding to the assessment of the effect of financial inflows on economic growth are presented in Table 1. The dependent variable is per capita GDP growth and three financial inflow indicators are used as variables of interest, each included in one estimation. The estimation is ran with a sample of 64 low and middle income countries for the period 1995-2018 subdivided into 5 five-year sub-periods. Two specification tests check the validity of the instruments. The first is the Hansen test of over-identifying restrictions. The second test examines the hypothesis that there is no second-order serial correlation in the first-difference residuals. Moreover, the number of instruments should be fewer than the number of countries. The results for these tests, the number of countries and the number of instruments are shown at the bottom of the table. All these conditions are fulfilled and the results are validated. In column (1), the coefficient of foreign aid is positive and statistically significant, suggesting that official development assistance increases the GDP per capita growth rate. Regarding the variables of control, the investment rate and the human capital have the anticipated positive sign even if the latter is not statistically significant. The coefficients of initial GDP and the population growth rate are not statistically significant. The coefficient of trade is statistically significant, but with wrong sign.

Table 1. Effect of ODA, FDI and Remittances on Economic Growth

	(1)	(2)	(3)
	GDP per capita growth		
Log initial GDP per capita	-0.770	-1.586	-2.323
	(0.50)	(1.10)	(1.55)
Log population growth	5.105	2.970	-3.175
	(0.44)	(0.31)	(0.27)
Log Fixed Gross Capital Formation	2.091**	2.085**	0.608
	(1.98)	(2.30)	(0.81)
Log Human capital	6.695	7.953*	5.673
	(1.40)	(1.80)	(1.30)
Trade of goods and services	-1.663**	-1.563**	-0.696
	(2.49)	(2.40)	(1.17)
Log ODA per capita	2.000**		
	(2.00)		
Log FDI per capita		1.593*	
		(1.74)	
Log Remittances per capita			0.459**
			(1.97)
Constant	-13.300	3.144	25.904
	(0.35)	(0.10)	(0.82)
Observations	310	310	293
Countries	64	64	63
AR(1):p-value	0.022	0.022	0.046
AR(2):p-value	0.400	0.401	0.561
Hansen:p-value	0.481	0.582	0.587
Instruments	24	28	44

Note: Robust *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.

Columns (2) and (3) show the results when foreign direct investment and remittances are respectively used as indicators of financial inflow. The positive and statistically significant coefficients of these variables show that they contribute to economic growth in developing countries.

Table 2 shows the results when the absorptive capacity and its interaction with financial inflows are included in the model to test the dependence of the effect of financial inflows on the capacity and policy environment of the country (Equation 4.2). The Hansen over-identification test and the absence of second-order serial correlation in the first-difference residuals condition are validated for the three columns. The number of instruments are also less than the number of countries in each regression. The coefficients of the interaction terms of financial inflows and the absorptive capacity indicators are positive and statistically significant suggesting that the effects of the three financial inflows on economic growth improve with good quality of human capital, the increase availability of infrastructure and progress in the quality of the institutions.

Table 2. Absorptive Capacity Conditional Effect of ODA, FDI and Remittances on Economic Growth

	(1)	(2)	(3)
	GDP per capita growth		
Log initial GDP per capita	0.536	0.867	-0.271
	(0.17)	(0.29)	(0.14)
Log population growth	-11.013	5.255	6.502
	(1.12)	(0.35)	(0.47)
Log Fixed Gross Capital Formation	2.586*	0.897	1.053
	(1.77)	(0.55)	(0.78)
Trade of goods and services	-0.579	-1.372	-2.113***
	(0.57)	(1.47)	(2.71)
Absorptive Capacity	-5.651	-3.366	0.975
	(1.58)	(1.33)	(0.69)
Log ODA per capita	3.239*		
	(1.70)		
(Absorptive Capacity)x(ODA)	1.104*		
	(1.72)		
Log FDI per capita		2.358**	
		(2.03)	
(Absorptive Capacity)x(FDI)		1.295**	
		(2.43)	
Log Remittances per capita			1.149*
			(1.87)
(Absorptive Capacity)x(Remittances)			0.237*
			(1.85)
Constant	18.708	-23.089	-11.262
	(0.42)	(0.35)	(0.24)
Observations	195	195	185
Countries	61	61	60
AR(1):p-value	0.090	0.065	0.075
AR(2):p-value	0.140	0.449	0.368
Hansen:p-value	0.734	0.509	0.231
Instruments	23	36	25

Note: Robust t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.

The results obtained from the estimation of the Equation (4.3) are presented in Table 3. The aim of this model is to examine whether climate shocks influence the effect of financial inflows on economic growth in developing countries. It consists in the addition of climate variable and the interaction its square with financial inflow variables in model (4.1). Temperature and precipitation shocks are used as indicators of climate shocks. The results of the GMM estimations are validated by the Hansen over-identification test, the second order serial correlation in the first-difference residuals condition, and the number of instruments. In the two first columns, official development assistance is interacted with precipitation (column 1) and temperature (column 2) shocks. The coefficients of ODA are positive and statistically significant, confirming that ODA increase economic growth. However, the coefficients of the interaction terms are negative and statistically significant, suggesting that extreme climate events at least mitigate the positive effect of ODA on economic growth, and confirming our theoretical expectation. Similarly, both precipitation and temperature shocks reduce the effect of FDI on economic expansion, as shown in columns (3) and (4), and migrant's remittances impact on economic growth presented in columns (5) and (6). Table A3 Appendix 1 presents the results when Equation (4.3) is estimated without the human capital variable. The coefficients of the interaction terms are higher than those obtained when the human capital is taken into account (Table 3), except the interaction of precipitation shocks with FDI. These results suggest that climate shocks affect economic growth through a weakening of human capital. Similar results are obtained when an aggregate indicator of financial flows is considered (see Table A4 Appendix 1).

VI. Robustness checks

To test the robustness of our climate shock indicators, we include three alternative measures. First, let recall that we use as climate indicators the annual average of monthly precipitations and temperature deviation to monthly long-term average. Even though this measure takes into account the seasonality through the monthly deviation instead of annual deviation, it is possible to include in the computation of the annual average the difference of precipitation and temperature from one month to another. We therefore calculate a weighted average climate shock with each monthly deviation weighted by the ratio of the monthly long-term average to the annual average as follows.

$$\text{Climate shocks weighted average}_{it} = \sum_{k=1}^{12}\left(absolute\ value\left(\frac{Monthly\ climate_{kit} - long\ term\ average_{ki}}{long\ term\ standard\ deviation_{ki}}\right) x \left(\frac{long\ term\ average_{ki}}{annual\ average_{it}}\right)\right)$$

Where $annual\ average_{it}$ is the annual average precipitations or temperature. Table 4 presents the results when climate shocks indicator is replaced by this measure in model 3.

The results confirm the role of climate shocks, namely, it reduces the growth impact of ODA, FDI and remittances.

Table 3: Role of Average Climate Shocks on the Effect of ODA, FDI and Remittances on Economic Growth

	(1)	(2)	(3)	(4)	(5)	(6)

	GDP per capita growth					
Log initial GDP per capita	-5.349	-7.506**	0.887	1.744	-1.170	1.671
	(1.45)	(2.15)	(0.55)	(0.51)	(0.68)	(1.25)
Log population growth	-9.956	8.542	4.594	30.251***	17.588**	4.909
	(0.72)	(0.90)	(0.40)	(3.19)	(2.33)	(0.54)
Log Fixed Gross Capital Formation	2.022	-0.067	1.518*	3.103*	1.603	1.476
	(0.95)	(0.05)	(1.76)	(1.91)	(1.23)	(1.38)
Log Human capital	14.660*	-7.883	-0.193	14.768	16.486*	-1.032
	(1.86)	(0.92)	(0.04)	(0.87)	(1.68)	(0.28)
Trade of goods and services	-0.801	-0.934*	-1.320*	-1.588**	-0.423	-1.739
	(0.67)	(1.91)	(1.78)	(2.16)	(1.04)	(1.10)
Average month precipitation shock	12.488		7.840		-2.571	
	(0.74)		(0.51)		(0.25)	
Average month precipitation square	11.957		18.209		9.963	
	(1.06)		(1.39)		(1.34)	
Average month temperature shock		-13.310***		-2.962		-14.310***
		(2.83)		(0.46)		(2.88)
Average month temperature square		8.996***		6.452		10.255***
		(3.52)		(1.37)		(2.78)
Log ODA per capita	2.718*	4.949**				
	(1.70)	(2.21)				
(Average month precipitation shock square)x(ODA)	-4.204*					
	(1.94)					
(Average month temperature square)x(ODA)		-0.611*				
		(1.74)				
Log FDI per capita			3.392**	3.014***		
			(2.17)	(3.30)		
(Average month precipitation square)x(FDI)			-6.839*			
			(1.83)			
(Average month temperature square)x(FDI)				-1.450*		
				(1.72)		
Log Remittances per capita					1.322*	0.584*
					(1.68)	(1.82)
(Average month precipitation square)x(Remittances)					-2.420**	
					(2.52)	
(Average month temperature shock square)x(Remittances)						-0.914**
						(1.97)
Constant	51.382		-28.297	-102.713***	-45.510**	-15.212
	(0.86)		(0.74)	(3.31)	(2.28)	(0.49)
Observations	310	302	310	310	293	293
Countries	64	64	64	64	63	63
AR(1):p-value	0.028	0.032	0.015	0.024	0.072	0.042
AR(2):p-value	0.272	0.187	0.335	0.683	0.845	0.540
Hansen:p-value	0.557	0.441	0.650	0.531	0.581	0.448
Instruments	39	38	44	29	53	33

Note: Robust t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.

Table 4. Role of Weighted Average Climate Shocks on the Effect of ODA, FDI and Remittances on Economic Growth

	(1)	(2)	(3)	(4)	(5)	(6)
	GDP per capita growth					
Log initial GDP per capita	-2.756	-1.611	-1.429	4.463	-1.628*	0.234
	(0.62)	(0.37)	(0.56)	(1.26)	(1.71)	(0.49)
Log population growth	7.650	12.867	20.761*	14.907	-0.665	-4.767
	(0.81)	(0.52)	(1.82)	(1.30)	(0.07)	(0.66)
Log Fixed Gross Capital Formation	1.481	2.880*	1.992*	0.609	4.124***	1.890**
	(0.76)	(1.77)	(1.77)	(0.33)	(3.82)	(2.40)
Log Human capital	11.516	13.696	20.403	-10.627	5.263*	-0.623
	(0.96)	(1.52)	(1.52)	(1.13)	(1.73)	(0.23)
Trade of goods and services	-1.343	-2.501**	-1.056***	2.861	-1.375***	-0.577
	(0.80)	(2.03)	(2.80)	(0.97)	(4.85)	(1.23)
Average weighted precipitation shock	0.189		0.179		-0.212	
	(0.25)		(0.21)		(0.62)	
Average weighted precipitation shock square	0.106		0.087		0.052	
	(1.30)		(1.50)		(1.59)	
Average weighted temperature shock		-0.003		-0.006		-0.024
		(0.14)		(0.24)		(0.54)
Average weighted temperature shock square		0.047		0.018		0.012**
		(1.63)		(1.61)		(2.01)
Log ODA per capita	2.244*	3.608**				
	(1.68)	(2.11)				
(Average weighted precipitation shock square)x(ODA)	-0.023*					
	(1.77)					
(Average weighted temperature shock square)x(ODA)		-0.008*				
		(1.66)				
Log FDI per capita			3.179**	2.968*		
			(2.10)	(1.88)		
(Average weighted precipitation shock square)x(FDI)			-0.026**			
			(2.26)			
(Average weighted temperature shock square)x(FDI)				-0.004*		
				(1.67)		
Log Remittances per capita					1.542**	0.632*
					(1.98)	(1.75)
(Average weighted precipitation shock square)x(Remittances)					-0.011*	
					(1.66)	
(Average weighted temperature shock square)x(Remittances)						-0.004*
						(1.70)
Constant	-11.275	-38.911	-61.595	-73.682	21.174	17.384
	(0.24)	(0.40)	(1.57)	(1.31)	(0.83)	(0.81)
Observations	310	310	310	310	293	293
Countries	64	64	64	64	63	63
AR(1):p-value	0.019	0.015	0.039	0.069	0.083	0.050
AR(2):p-value	0.392	0.555	0.696	0.280	0.742	0.601
Hansen:p-value	0.183	0.328	0.372	0.998	0.991	0.450
Instruments	17	23	54	29	32	52

Note: Robust t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.

Second, the measures of climate shocks we use do not consider the difference between negative and positive deviation of climate variables. To disentangle the effect of increase in climate indicator value to that of a negative deviation, we also use the annual maximum and minimum climate shocks as two separate additional indicators.

$$\text{Climate shocks max}_{it} = Maximum \frac{Monthly\ climate_{kit} - long\ term\ average_{ki}}{long\ term\ standard\ deviation_{ki}}$$

$$\text{Climate shocks min}_{it} = Minimum \frac{Monthly\ climate_{kit} - long\ term\ average_{ki}}{long\ term\ standard\ deviation_{ki}}$$

These indicators capture the maximum and minimum variation of climate indicators relatively to the monthly long-term average in a given year. The results obtained with system-GMM estimator are summarized in Table A5 Appendix 1. Once again, both positive and negative deviation negatively affect the impact of financial flows on economic growth in developing countries.

Third, beyond temperature and precipitation deviations, extreme weather events are increasingly recognized by scientists (IPCC, 2014) as consequences of increasing temperature caused by greenhouse gases emissions. It is thus interesting to use disaster indicators since they measure long term and most extreme consequences of climate change. We thus use natural disasters, drought and flood as additional extreme weather events in model 3 and the data are taken from the international disaster database of the Centre for Research on the Epidemiology of Disasters (EM-CRED). Table A6 Appendix 1 presents the results from the System-GMM regression. The coefficients of the interaction terms of natural disaster indicators with ODA, FDI and remittances are negative while those of the financial flows are positive and statistically significant, confirming the mitigation role of disasters on the growth effect of foreign financial inflows.

Fourth, the results are obtained using five-year period panel data structure from our discretion. To assess their sensitivity to the choice of the period, the same model is estimated using three-year periods. The results obtained are shown in Table A7 Appendix 1. They are not sensitive to the choice of the length of period.

Fifth, the effect of financial flows may be different according to the development level. Poor countries receive generally more development aid, while upper middle-income countries receive more foreign investment. Moreover, middle income countries are more resilient to climate shocks and have better absorptive capacity. To assess whether the results change according to the development level, we interact climate shocks with financial flows and initial development level of each period. Table A8 in the Appendix 1 presents the results. It clearly appears that the coefficients of the interaction are positive and statistically significant for all financial flows and climate shocks considered, suggesting that more relative development level mitigate the negative effect of climate shocks on the growth return of capital flows.

Sixth, to take into account the variation of the results according to the period considered, we interact climate shocks, financial flows and period dummies in the model 3. The results obtained are summarized in Tables A9 and A10 Appendix 1. The coefficients of the interaction are generally not statistically significant, except in two cases.

- The precipitation shock and FDI in 1995-1999 with positive and significant coefficient indicating that precipitation shocks in this period less attenuated the effect of FDI relatively to other periods.
- The temperature shocks and FDI in 2010-2014 with negative coefficient suggesting that temperature shocks reduced more the effect of FDI in this period compared to other periods.

These two exceptions are likely due to the commodity prices and the Asian financial crisis in these periods. In low income countries where FDI are largely linked to the agricultural and extractive sectors, high commodity prices increase the returns to these investments. The effect of climate shocks is thus more pronounced in 2010-2014 because of the very high commodity prices[10], high FDI and very high temperature shocks compared to other periods. In 1995-1999, the minerals and fuels prices were very low with oil prices at less than 20 dollars, mitigating the effect of climate shocks. Moreover, the Asian financial crisis in 1997 and 1998 reduced the returns to FDI and thus the potential effect of climate variability during this period.

Seventh, in the paper we argue that climate shocks affect the impact of financial flows on economic growth mainly through the absorptive capacity. In countries with low absorptive capacity the effect of financial flows is expected to be relatively low due to climate shocks. To test this assumption, we included in Equation (4.3) a variable of low absorptive capacity and its interaction with both capital flows and climate shocks. To ease the interpretation, the low absorptive capacity variable used is a dummy variable taking the value 1 when the absorptive capacity index is less than the median of the sample, and 0 otherwise. The results of this estimation are shown in Table A11 Appendix 1. All the coefficients of the interaction terms of the financial flow variable with climate shocks and the low absorptive capacity indicator are negative and statistically significant, meaning that the negative effect of climate change on the financial flows-economic growth nexus is higher in countries with low absorptive capacity.

VII. CONCLUDING REMARKS

Foreign direct investment, foreign aid and migrants' remittances are the main financial inflows to developing countries. Beside factors determining their attractiveness and allocation, a large literature exists on ability of these inflows to expand economic activities and reduce poverty. The researchers generally focus on a single type of financial inflow and investigate its effect on economic activities. An observation of the literature shows that the studies on each of them follow similar patterns. They are first found to be important determinants of economic growth. Then, their positive impact is contested by some authors. And, the debate is focused on some conditions determining their contribution to economic growth. The effect of these capital flows is thus dependent to host countries characteristics (human and physical constraint, macroeconomic policy and institutional capacity), and sending countries behaviors.

[10] For the commodity evolution see : https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx

We analyze the impact of these financial flows in a single framework. We also argue that some factors beyond the control of sending and recipient countries such as climate shocks may affect the impact of ODA, FDI and remittances.

Our theoretical model and empirical investigations show that that ODA, FDI and remittances improve economic growth and the size of the effect depends on the ability of the host countries to effectively absorb these resources. Moreover, climate shocks reduce the positive effect of financial inflows.

These foreign resources are important for developing countries not only because they bring capital in the areas in most need, but also because of the improvement in the conditions allowing more productive investment. Recipient countries should build strong resilience. Government should thus create the best conditions for high skilled and experienced human capital availability. Good political and economic institutions, and the compliance with the rules of law are essential for economic development and should guide every action of the development stakeholders. Most importantly, sound macroeconomic policies should be implemented to create a sustainable development context. In addition to attracting more financial flows, these policies ensure their economic growth return, and build their resilience in case of climate shocks. In their policy implementations and actions, they should take into account how to adapt their reactions in case of climate events.

In addition to their direct impact on economic activities, climate shocks lead to reduction in the returns of foreign financing in developing countries. Actions are needed at global level to mitigate the greenhouse gases emissions through for example carbon taxes and green investment. These mitigation policies should be complemented with adaptation and transition policies. Developing countries should build more resilience to cope with the effects of climate shocks.

To overcome these negative consequences, some climate vulnerable countries are building structural resilience to climate shocks . In the aftermath of cyclone Winston in 2016, Fiji set up a “build back better” campaign. Madagascar, Malawi, and Mauritius have improved their construction standards to face storms. Lesotho, Madagascar, and Mozambique have established flood resistant infrastructure, and some countries such as Dominica, are devoting large share of their public investment to disaster-resilient projects (IMF, 2019).

The findings should not be considered as an argument to reduce foreign financings to countries experiencing more climate shocks. These countries need more international interventions to help then build and consolidate their absorptive capacity to effectively take stock of the finance they receive from abroad.

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APPENDIX 1: TABLES

Table A1. List of Countries

Country		Country		Country		Country
Argentina		El Salvador		Mali		Philippines
Bangladesh		Eswatini		Mauritania		Rwanda
Benin		Ethiopia		Mauritius		Senegal
Bolivia		Gambia, The		Mexico		Serbia
Botswana		Ghana		Mongolia		Sierra Leone
Burkina Faso		Guatemala		Morocco		South Africa
Burundi		Haiti		Mozambique		Sri Lanka
Cambodia		Honduras		Myanmar		Tanzania
Cameroon		Jordan		Namibia		Thailand
Central African Republic		Kenya		Nepal		Togo
Colombia		Lao PDR		Nicaragua		Tunisia
Congo, Dem. Rep.		Lesotho		Niger		Turkey
Costa Rica		Liberia		Pakistan		Uganda
Cote d'Ivoire		Madagascar		Panama		Vietnam
Dominican Republic		Malawi		Paraguay		Zambia
Egypt, Arab Rep.		Malaysia		Peru		Zimbabwe

Table A2. Data Sources

Data	Sources
GDP per capita	IMF WEO
Foreign direct investment	IMF WEO
Investment	IMF Investment and Capital Stock Dataset
Human capital index	Penn World Table
Infrastructure	World Bank World Development Indicator (WDI)
Population growth	World Bank World Development Indicator (WDI)
Remittances	World Bank World Development Indicator (WDI)
Official development assistance (ODA)	OECD
Temperature	Climate Research Unit (CRU)
Precipitations	Climate Research Unit (CRU)
Natural disasters, flood, drought	EM DAT
Institutions quality	World Governance Indicators (WGI)

Table A3. Role of Climate shocks on the Effect of Financial Flow on Economic Growth Without Human Capital

	(1)	(2)	(3)	(4)	(5)	(6)
			GDP per capita growth			
Log initial GDP per capita	-1.570	-6.094*	0.959	2.941*	-0.111	1.159
	(0.65)	(1.73)	(1.44)	(1.88)	(0.08)	(1.19)
Log population growth	-0.060	17.547***	5.128	17.166	2.343	3.465
	(0.00)	(2.86)	(0.95)	(1.38)	(0.22)	(0.42)
Log Fixed Gross Capital Formation	4.889**	1.180	0.790	3.219***	1.628	1.323
	(2.06)	(0.91)	(1.31)	(3.44)	(1.31)	(1.45)
Trade of goods and services	0.710	-1.091**	-1.005***	-1.477	-0.209	-1.823
	(0.55)	(2.08)	(4.10)	(1.60)	(0.39)	(1.24)
Average month precipitation shock	14.677		4.092		-2.587	
	(0.88)		(0.68)		(0.31)	
Average month precipitation shock square	51.051*		15.734*		13.791**	
	(1.90)		(1.94)		(2.16)	
Average month temperature shock		-21.285**		-7.766		-14.535***
		(2.45)		(1.54)		(2.91)
Average month temperature shock square		14.353***		9.766**		10.685***
		(3.09)		(2.41)		(2.79)
Log ODA per capita	5.857*	3.509				
	(1.70)	(1.22)				
(Average month precipitation shock square)x(ODA)	-12.346*					
	(1.81)					
(Average month temperature shock square)x(ODA)		-0.827*				
		(1.81)				
Log FDI per capita			2.350**	2.276*		
			(2.20)	(1.82)		
(Average month precipitation shock square)x(FDI)			-5.152**			
			(2.22)			
(Average month temperature shock square)x(FDI)				-1.751*		
				(1.76)		
Log Remittances per capita					2.051**	0.789**
					(2.24)	(2.09)
(Average month precipitation shock square)x(Remittances)					-3.362**	
					(2.33)	
(Average month temperature shock square)x(Remittances)						-1.018**
						(2.08)
Constant	-3.730	4.615	-28.128	-62.677	-4.869	-8.864
	(0.07)	(0.13)	(1.52)	(1.32)	(0.13)	(0.31)
Observations	325	325	325	325	307	307
Countries	67	67	67	67	66	66
AR(1):p-value	0.005	0.019	0.014	0.015	0.051	0.041
AR(2):p-value	0.696	0.224	0.320	0.407	0.817	0.576
Hansen:p-value	0.958	0.445	0.880	0.365	0.798	0.459
Instruments	16	34	38	25	41	29

Note: Robust *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.

Table A4. Role of Climate Shocks on the Effect of Aggregate Financial Flow on Economic Growth

	(1)	(2)	(3)
	GDP per capita growth		
Log initial GDP per capita	-2.698**	-0.311	-2.451
	(2.54)	(0.21)	(1.07)
Log population growth	-2.206	2.418	2.958
	(0.21)	(0.22)	(0.16)
Log Fixed Gross Capital Formation	1.118	0.141	-0.314
	(0.59)	(0.15)	(0.28)
Log Human capital	7.897**	1.009	10.039*
	(2.23)	(0.22)	(1.78)
Trade of goods and services	-1.568**	0.388	-1.086***
	(2.23)	(0.30)	(2.74)
Financial flow	5.159**	10.120*	6.379**
	(2.35)	(1.66)	(2.31)
(Precip. shock square)x(Financial flow)		-20.117*	
		(1.85)	
Average month precipitation shock		2.517	
		(0.21)	
Average month precipitation shock square		44.697**	
		(2.07)	
(Temp. shock square)x(Financial flow)			-4.841**
			(2.15)
Average month temperature shock			-12.347**
			(2.53)
Average month temperature shock square			17.055***
			(2.73)
Constant	15.835	-26.139	-2.263
	(0.51)	(0.63)	(0.03)
Observations	293	293	293
Countries	63	63	63
AR(1):p-value	0.059	0.046	0.061
AR(2):p-value	0.549	0.657	0.453
Hansen:p-value	0.596	0.275	0.224
Instruments	21	45	53

Note: Robust *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.

Table A5. Role of Maximum and Minimum Climate Shocks on the Effect of ODA, FDI and Remittances on Economic Growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	GDP per capita growth											
Log initial GDP per capita	-1.614	-7.142**	-7.994**	-3.096	-0.812	1.531	1.241	2.545	-0.375	-0.726	-1.234	0.924
	(1.28)	(2.46)	(2.41)	(0.89)	(0.42)	(0.64)	(0.35)	(1.39)	(0.28)	(0.56)	(0.69)	(0.15)
Log population growth	3.733	5.686	8.769	-4.633	17.482	20.602	27.008***	18.543**	10.234	7.202	-20.486	23.146***
	(0.44)	(0.39)	(1.23)	(0.28)	(1.45)	(1.42)	(4.87)	(2.00)	(1.02)	(0.73)	(1.40)	(5.06)
Log Fixed Gross Capital Formation	1.564**	0.351	-0.172	1.615	1.102	1.846	2.769***	2.559***	2.719**	4.078***	0.800	-0.981
	(2.01)	(0.39)	(0.14)	(1.53)	(1.01)	(1.56)	(2.71)	(2.97)	(2.19)	(3.71)	(0.79)	(0.91)
Log Human capital	7.395*	22.481**	-6.217	6.653	13.197	6.090	15.880	-0.122	9.905	4.113	1.952	1.640
	(1.91)	(2.33)	(0.91)	(0.66)	(1.38)	(0.44)	(0.98)	(0.01)	(1.20)	(1.21)	(0.39)	(0.38)
Trade of goods and services	-1.085***	-0.611	-1.159**	-2.808	-0.451	-0.836	-1.546*	-1.434***	-0.662	-1.574***	0.294	-1.441**
	(3.04)	(0.83)	(2.23)	(1.49)	(0.90)	(1.61)	(1.90)	(2.71)	(0.34)	(2.67)	(0.14)	(2.47)
Max month precipitation shock	3.561				6.064				-2.129			
	(1.53)				(1.41)				(0.82)			
Max month precipitation shock square	4.207				1.981				6.668***			
	(1.40)				(0.99)				(2.75)			
Log ODA per capita	1.401*	0.227	5.264***	6.062*								
	(1.78)	(0.13)	(2.83)	(1.86)								
Min month precipitation shock		6.179				4.667				6.869		
		(1.47)				(0.69)				(1.24)		
Min month precipitation shock square		-2.460				8.902				-1.079		
		(0.39)				(0.96)				(0.37)		
Max month temperature shock			-2.252*				1.497				0.168	
			(1.79)				(0.56)				(0.08)	
Max month temperature shock square			1.526**				1.577				0.798	
			(2.57)				(1.50)				(1.08)	
Min month temperature shock				6.180				2.295				1.267
				(1.63)				(0.92)				(0.60)
Min month temperature shock square				19.088				12.729				6.756
				(1.46)				(1.24)				(1.37)
(Max month precipitation shock square)x(ODA)	-1.317*											
	(1.72)											
(Min month precipitation shock square)x(ODA)		-0.395										
		(0.42)										
(Max month temperature shock square)x(ODA)			-0.183*									
			(1.67)									
(Min month temperature shock square)x(ODA)				-5.108*								
				(1.85)								
Log FDI per capita					2.240**	3.102*	2.703***	1.259*				
					(2.01)	(1.85)	(3.35)	(1.72)				
(Max month precipitation shock square)x(FDI)					-1.815*							
					(1.83)							
(Min month precipitation shock square)x(FDI)						-3.332*						
						(1.81)						
(Max month temperature shock square)x(FDI)							-0.550*					
							(1.85)					
(Min month temperature shock square)x(FDI)								-5.136*				

								(1.65)				
Log Remittances per capita									0.595^{*}	1.266^{***}	0.666^{*}	1.774^{*}
									(1.71)	(2.66)	(1.65)	(1.76)
(Max month precipitation shock square)x(Remittances)									-1.584^{***}			
									(3.25)			
(Min month precipitation shock square)x(Remittances)										-1.136^{*}		
										(1.94)		
(Max month temperature shock square)x(Remittances)											-0.216^{*}	
											(1.78)	
(Max month temperature shock square)x(Remittances)												-2.753^{**}
												(2.03)
Constant	-3.179	29.013		10.991	-53.182	-76.062	-94.468^{***}	-64.873^{**}	-21.851	-8.317	64.928	
	(0.11)	(0.73)		(0.17)	(1.39)	(1.46)	(3.84)	(2.21)	(0.72)	(0.27)	(1.33)	
Observations	310	310	302	310	310	310	310	310	293	293	293	274
Countries	64	64	64	64	64	64	64	64	63	63	63	63
AR(1):p-value	0.015	0.055	0.038	0.022	0.011	0.030	0.027	0.025	0.031	0.075	0.051	0.067
AR(2):p-value	0.352	0.285	0.255	0.335	0.302	0.816	0.627	0.301	0.743	0.724	0.588	0.870
Hansen:p-value	0.382	0.351	0.514	0.161	0.117	0.138	0.687	0.470	0.636	0.709	0.130	0.765
Instruments	52	51	38	24	56	48	30	30	40	42.	36	35

Note: Robust t statistics in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01. Period dummies are included in the equation. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A6. Role of Natural Disasters on the Effect of ODA, FDI and Remittances on Economic Growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	GDP per capita growth								
Log initial GDP per capita	-12.106***	1.489	0.731	1.309	-1.012	1.440	0.198	0.429	0.350
	(3.86)	(0.70)	(0.82)	(0.70)	(1.02)	(1.25)	(0.29)	(0.35)	(0.18)
Log population growth	3.067	23.006	-6.303	-2.357	3.875	-4.364	10.132	7.066	40.938
	(0.20)	(1.27)	(0.86)	(0.19)	(0.36)	(0.38)	(0.93)	(0.55)	(1.26)
Log Fixed Gross Capital Formation	0.208	0.100	1.190	2.516**	1.143	1.688	2.417***	0.741	-1.928
	(0.21)	(0.05)	(1.15)	(2.56)	(1.10)	(1.47)	(3.15)	(0.83)	(0.93)
Log Human capital	-1.487	3.149	-0.840	-1.620	4.492*	-3.748	5.660*	3.004	29.080
	(0.19)	(0.63)	(0.31)	(0.43)	(1.86)	(0.84)	(1.74)	(0.86)	(1.26)
Trade of goods and services	-0.568	-1.925***	-0.711	-1.502**	-0.566	-0.889	-1.809*	-1.135*	-0.665
	(0.96)	(2.74)	(0.66)	(2.41)	(0.84)	(1.22)	(1.76)	(1.73)	(0.74)
Log ODA per capita	7.423**			1.362			1.074		
	(2.17)			(1.23)			(1.01)		
(Natural Disasters)x(ODA)	-0.474*								
	(1.74)								
Natural Disasters	1.853	1.201	1.027						
	(1.61)	(1.49)	(1.64)						
Log FDI per capita		2.437*			0.410			1.672**	
		(1.84)			(0.60)			(2.20)	
(Natural Disasters)x(FDI)		-0.539*							
		(1.65)							
Log Remittances per capita			0.620*			0.065			0.283
			(1.70)			(0.25)			(0.19)
(Natural Disasters)x(Remittances)			-0.244						
			(1.45)						
Drought				9.503	2.387	3.045			
				(1.64)	(1.37)	(1.55)			
DroughtxODA				-1.955*					
				(1.70)					
DroughtxFDI					-0.925*				
					(1.73)				
DroughtxRemittances						-0.973*			
						(1.69)			
Flood							2.550	1.979	4.512
							(1.58)	(1.59)	(1.60)
FloodxODA							-0.662*		
							(1.78)		
FloodxFDI								-1.020*	
								(1.95)	
FloodxRemittances									-1.269*
									(1.68)
Constant		-80.492	13.959	-0.781	-0.277	9.149	-28.380	-24.805	-136.660
		(1.20)	(0.57)	(0.02)	(0.01)	(0.24)	(0.75)	(0.59)	(1.44)
Observations	276	299	283	299	299	283	299	299	283
Countries	64	64	63	64	64	63	64	64	63
AR(1):p-value	0.059	0.012	0.029	0.023	0.012	0.030	0.011	0.005	0.025
AR(2):p-value	0.149	0.308	0.330	0.329	0.233	0.319	0.357	0.186	0.806
Hansen:p-value	0.261	0.358	0.555	0.251	0.461	0.533	0.407	0.335	0.598
Instruments	40	46	43	32	42	46	50	51	26

Note: Robust t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.

Table A7. Role of Average Climate Shocks on the Effect of ODA, FDI and Remittances on Economic Growth Using Three-year Time Periods

	(1)	(2)	(3)	(4)	(5)	(6)
			GDP per capita growth			
Log initial GDP per capita	-7.232**	-10.300*	-9.243**	-1.007	-1.714	1.317
	(2.25)	(1.69)	(2.44)	(0.38)	(0.65)	(1.14)
Log population growth	-14.943	14.706***	-0.337	8.994	37.761*	2.506
	(1.20)	(6.86)	(0.02)	(0.78)	(1.85)	(0.40)
Log Fixed Gross Capital Formation	2.436***	1.020	3.473*	3.357***	2.120**	2.317**
	(3.83)	(0.72)	(1.91)	(3.53)	(2.08)	(2.44)
Log Human capital	17.293**	-28.825	33.408***	13.758	29.209	-2.069
	(2.35)	(1.19)	(2.94)	(0.75)	(1.58)	(0.56)
Trade of goods and services	-0.052	-1.588	-0.870	-1.331**	-1.815	-2.835
	(0.07)	(0.69)	(0.67)	(2.00)	(1.58)	(1.49)
Average month precipitation shock	20.763		26.834**		2.194	
	(1.61)		(2.14)		(0.27)	
Average month precipitation shock square	18.597		1.883		9.847	
	(1.50)		(0.25)		(1.46)	
Average month temperature shock		-12.739***		-3.926		-12.662***
		(2.89)		(0.57)		(3.33)
Average month temperature shock square		11.699***		4.558		9.533***
		(3.06)		(1.07)		(3.58)
Log ODA per capita	4.166*	3.927**				
	(1.78)	(1.97)				
(Average month precipitation shock square)x(ODA)	-6.847*					
	(1.71)					
(Average month temperature shock square)x(ODA)		-1.166**				
		(2.03)				
Log FDI per capita			5.233**	1.659*		
			(2.03)	(1.82)		
(Average month precipitation shock square)x(FDI)			-6.015**			
			(2.16)			
(Average month temperature shock square)x(FDI)				-0.776*		
				(1.68)		
Log Remittances per capita					2.486**	0.803**
					(2.20)	(2.35)
(Average month precipitation shock square)x(Remittances)					-3.219**	
					(2.25)	
(Average month temperature shock square)x(Remittances)						-0.903**
						(2.12)
Constant	70.313		40.672	-16.905	-108.779*	-4.712
	(1.32)		(0.55)	(0.44)	(1.82)	(0.20)
Observations	496	488	496	496	461	461
Countries	64	64	64	64	63	63
AR(1):p-value	0.003	0.004	0.001	0.002	0.001	0.005
AR(2):p-value	0.613	0.511	0.639	0.492	0.449	0.440
Hansen:p-value	0.606	0.576	0.779	0.157	0.389	0.336
Instruments	27	47	27	51	30	33

Table A8. Role of Average Climate Shocks on the Effect of ODA, FDI and Remittances on Economic Growth According to Development Level

	(1)	(2)	(3)	(4)	(5)	(6)
			GDP per capita growth			
Log initial GDP per capita	-11.240***	-9.083***	-2.109	-3.141**	-3.931*	-2.674
	(3.37)	(3.00)	(1.37)	(2.05)	(1.93)	(1.27)
Log population growth	-13.009	-3.913	-1.355	21.885*	19.710***	14.492
	(0.98)	(0.26)	(0.12)	(1.85)	(3.64)	(1.50)
Log Fixed Gross Capital Formation	2.122	0.066	2.425***	1.640**	2.255**	2.041**
	(1.60)	(0.07)	(2.72)	(2.21)	(2.13)	(2.09)
Log Human capital	23.270***	21.066***	-0.676	23.457***	25.986**	16.074*
	(2.86)	(2.64)	(0.14)	(3.37)	(2.47)	(1.77)
Trade of goods and services	-0.532	-0.976	-0.834	-0.942***	-0.302	0.308
	(0.45)	(0.80)	(0.64)	(2.59)	(0.68)	(0.29)
Average month precipitation shock	8.822		1.322		1.944	
	(0.52)		(0.15)		(0.21)	
Average month precipitation shock square	-1.038		20.291		4.067	
	(0.09)		(1.49)		(0.61)	
Average month temperature shock		-1.985		9.119		-4.029
		(0.36)		(1.11)		(0.76)
Average month temperature shock square		-1.657		-2.238		3.839
		(0.39)		(0.42)		(1.23)
Log ODA per capita	1.016	0.328				
	(0.49)	(0.22)				
(Average month precipitation shock square)x(ODA)	-10.073**					
	(2.33)					
(Precip. shock)x(ODA)x(develop. level)	1.135**					
	(2.15)					
(Average month temperature shock square)x(ODA)		-2.852				
		(1.60)				
(Temp. shock)x(ODA)x(develop. level)		0.398*				
		(1.66)				
Log FDI per capita			2.683*	1.461		
			(1.93)	(1.45)		
(Average month precipitation shock square)x(FDI)			-18.938**			
			(2.16)			
(Precip. shock)x(FDI)x(develop. level)			1.577*			
			(1.86)			
(Average month temperature shock square)x(FDI)				-4.586**		
				(2.07)		
(Temp. shock)x(FDI)x(develop. level)				0.451*		
				(1.84)		
Log Remittances per capita					1.249**	0.446*
					(2.40)	(1.67)
(Average month precipitation shock square)x(Remittances)					-7.584***	
					(2.77)	
(Precip. shock)x(Remit.)x(develop. level)					0.692**	
					(2.10)	
(Average month temperature shock square)x(Remittances)						-3.379***
						(2.63)
(Temp. shock)x(Remit.)x(develop. level)						0.310**
						(2.29)
Constant	111.127**	72.617	20.066	-50.506	-34.543**	-17.792
	(2.19)	(1.39)	(0.58)	(1.28)	(2.24)	(0.60)
Observations	310	310	310	310	293	293
Countries	64	64	64	64	63	63
AR(1):p-value	0.014	0.042	0.001	0.018	0.085	0.060
AR(2):p-value	0.356	0.174	0.715	0.409	0.823	0.522
Hansen:p-value	0.627	0.671	0.277	0.373	0.792	0.618
Instruments	41	36	49	60	55	60

Note: Robust *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.

Table A9. Role of Average Precipitation Shocks on the Effect of ODA, FDI and Remittances on Economic Growth According to the Period

	(1)	(2)	(3)
	GDP per capita growth		
Log initial GDP per capita	-4.072	-0.210	-1.798
	(1.62)	(0.22)	(0.77)
Log population growth	4.075	-3.557	14.653**
	(0.35)	(0.42)	(1.98)
Log Fixed Gross Capital Formation	3.326	2.078**	2.029*
	(1.49)	(2.26)	(1.81)
Log Human capital	13.702**	0.077	15.430
	(2.07)	(0.02)	(1.40)
Trade of goods and services	0.546	0.044	-0.512
	(0.25)	(0.04)	(1.25)
Average month precipitation shock	6.061	6.021	0.027
	(0.30)	(0.61)	(0.00)
Average month precipitation shock square	27.864	12.532	9.313
	(1.21)	(1.60)	(1.10)
Log ODA per capita	3.948*		
	(1.95)		
(Average month precipitation shock square)x(ODA)	-6.029*		
	(1.68)		
(Precip. shock)x(ODA)x(1995-1999 dummy)	-1.152		
	(1.09)		
(Precip. shock)x(ODA)x(2000-2004 dummy)	-1.009		
	(0.30)		
(Precip. shock)x(ODA)x(2005-2009 dummy)	0.617		
	(0.22)		
(Precip. shock)x(ODA)x(2010-2014 dummy)	0.443		
	(0.52)		
Log FDI per capita		2.337*	
		(1.80)	
(Average month precipitation shock square)x(FDI)		-5.261**	
		(2.14)	
(Precip. shock)x(FDI)x(1995-1999 dummy)		1.275*	
		(1.79)	
(Precip. shock)x(FDI)x(2000-2004 dummy)		0.056	
		(0.09)	
(Precip. shock)x(FDI)x(2005-2009 dummy)		0.464	
		(0.73)	
(Precip. shock)x(FDI)x(2010-2014 dummy)		0.904	
		(1.50)	
Log Remittances per capita			1.932**
			(2.16)
(Average month precipitation shock square)x(Remittances)			-2.613*
			(1.71)
(Precip. shock)x(Remit.)x(1995-1999 dummy)			-0.103
			(0.11)
(Precip. shock)x(Remit.)x(2000-2004 dummy)			-0.434
			(0.48)
(Precip. shock)x(Remit.)x(2005-2009 dummy)			-0.153
			(0.20)
(Precip. shock)x(Remit.)x(2010-2014 dummy)			0.193
			(0.37)
Constant	3.644	9.997	-33.803
	(0.09)	(0.36)	(1.48)
Observations	310	310	293
Countries	64	64	63
AR(1):p-value	0.011	0.023	0.078
AR(2):p-value	0.801	0.401	0.748
Hansen:p-value	0.505	0.495	0.711
Instruments	27	55	59

Note: Robust *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.

Table A10. Role of Average Temperature Shocks on the Effect of ODA, FDI and Remittances on Economic Growth According to the Period

	(1)	(2)	(3)
	GDP per capita growth		
Log initial GDP per capita	-4.809**	-11.597***	0.458
	(1.97)	(2.81)	(0.20)
Log population growth	-7.159	12.415***	12.091
	(0.59)	(3.25)	(1.36)
Log Fixed Gross Capital Formation	1.434	-0.838	3.345*
	(0.79)	(0.99)	(1.69)
Log Human capital	6.706	2.619	6.467
	(0.80)	(0.56)	(0.51)
Trade of goods and services	3.386	-0.288	-2.412
	(0.75)	(0.29)	(1.28)
Average month temperature shock	41.469	-0.843	-5.553
	(1.41)	(0.13)	(0.87)
Average month temperature shock square	12.438	4.083	6.880*
	(1.18)	(1.62)	(1.66)
Log ODA per capita	4.861*		
	(1.92)		
(Average month temperature shock square)x(ODA)	-5.732**		
	(2.27)		
(Temp. shock)x(ODA)x(1995-1999 dummy)	-3.408		
	(1.06)		
(Temp. shock)x(ODA)x(2000-2004 dummy)	-3.690		
	(1.54)		
(Temp. shock)x(ODA)x(2005-2009 dummy)	-1.708		
	(0.89)		
(Temp. shock)x(ODA)x(2010-2014 dummy)	-2.869**		
	(2.10)		
Log FDI per capita		14.669	
		(1.49)	
(Average month temperature shock square)x(FDI)		-1.057*	
		(1.89)	
(Temp. shock)x(FDI)x(1995-1999 dummy)		-0.870	
		(0.85)	
(Temp. shock)x(FDI)x(2000-2004 dummy)		-0.620	
		(0.98)	
(Temp. shock)x(FDI)x(2005-2009 dummy)		-0.263	
		(0.49)	
(Temp. shock)x(FDI)x(2010-2014 dummy)		-0.530**	
		(2.20)	
Log Remittances per capita			1.342*
			(1.74)
(Average month temperature shock square)x(Remittances)			-0.982*
			(1.82)
(Temp. shock)x(Remit.)x(1995-1999 dummy)			-1.481
			(1.46)
(Temp. shock)x(Remit.)x(2000-2004 dummy)			-1.059
			(1.36)
(Temp. shock)x(Remit.)x(2005-2009 dummy)			-0.566
			(0.99)
(Temp. shock)x(Remit.)x(2010-2014 dummy)			-0.953**
			(2.17)
Constant	11.843		-31.752
	(0.25)		(0.96)
Observations	310	301	293
Countries	64	64	63
AR(1):p-value	0.041	0.076	0.076
AR(2):p-value	0.848	0.158	0.711
Hansen:p-value	0.809	0.440	0.238
Instruments	23	40	48

Note: Robust *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.

Table A11. Impact of Climate Shocks on the Effect of ODA, FDI and Remittances on Economic Growth According to the Period: Role of Absorptive Capacity

	(1)	(2)	(3)	(4)	(5)	(6)
			GDP per capita growth			
Log initial GDP per capita	-4.285***	-2.409***	-0.412	-0.052	0.743	0.169
	(3.27)	(3.70)	(1.20)	(0.17)	(1.22)	(0.53)
Log population growth	-14.530*	-8.920**	-2.685	-7.904**	3.880	3.021
	(1.86)	(2.48)	(1.23)	(2.51)	(1.08)	(1.07)
Log Fixed Gross Capital Formation	2.119**	0.707**	1.696***	2.613***	1.603***	0.513**
	(2.55)	(1.96)	(6.72)	(4.50)	(3.33)	(2.13)
Trade of goods and services	1.189	-0.131	1.081***	-0.537	2.348***	0.239
	(1.53)	(0.53)	(4.22)	(0.92)	(4.23)	(0.72)
Average month precipitation shock	14.369		-3.903		-7.170**	
	(1.29)		(1.44)		(2.43)	
Average month precipitation shock square	40.192**		13.756***		12.837***	
	(2.42)		(5.33)		(4.03)	
Average month temperature shock		-4.883		-5.267**		-4.464***
		(1.31)		(2.04)		(2.67)
Average month temperature shock square		4.239**		4.839***		2.677**
		(2.20)		(3.28)		(2.36)
Absorptive Capacity dummy	1.242	1.408	0.253	1.041	0.747	0.030
	(1.19)	(1.46)	(0.49)	(1.45)	(1.19)	(0.10)
Log ODA per capita	5.451**	-0.017				
	(2.23)	(0.03)				
(Average month precipitation shock square)x(ODA)	-9.381**					
	(2.26)					
(Precip. shock)x(ODA)x(absorptive Capacity)	-0.686*					
	(1.77)					
(Average month temperature shock square)x(ODA)		-0.254**				
		(2.02)				
(Temp. shock)x(ODA)x(absorptive Capacity)		-0.603*				
		(1.96)				
Log FDI per capita			0.771*	0.131		
			(1.66)	(0.45)		
(Average month precipitation shock square)x(FDI)			-2.468**			
			(2.46)			
(Precip. shock)x(FDI)x(absorptive Capacity)			-0.473*			
			(1.73)			
(Average month temperature shock square)x(FDI)				-0.518***		
				(2.63)		
(Temp. shock)x(FDI)x(absorptive Capacity)				-0.570*		
				(1.81)		
Log Remittances per capita					0.598**	0.658***
					(2.02)	(4.84)
(Average month precipitation shock square)x(Remittances)					-1.417***	
					(2.62)	
(Precip. shock)x(Remit.)x(absorptive Capacity)					-0.804**	
					(2.17)	
(Average month temperature shock square)x(Remittances)						-0.160
						(1.37)
(Temp. shock)x(Remit.)x(absorptive Capacity)						-0.373***
						(3.77)
Constant	49.833*	49.739***	15.350**	32.499***	-9.252	-5.931
	(1.89)	(4.02)	(2.03)	(2.93)	(0.66)	(0.63)
Observations	325	325	325	325	307	307
Countries	67	67	67	67	66	66
AR(1):p-value	0.011	0.014	0.015	0.016	0.054	0.039
AR(2):p-value	0.221	0.247	0.324	0.411	0.743	0.518
Hansen:p-value	0.469	0.855	0.503	0.545	0.375	0.358
Instruments	25	45	60	43	51	57

Note: Robust *t* statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Period dummies are included in the equation.