Climate Risks and FDI

Grace Weishi Gu*, Galina Hale†

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Abstract

Climate-related risks have increased in recent decades, both in terms of the frequency of extreme weather events (physical risk) and implementation of climate-change mitigation policies (transition risk). This paper explores whether multinational firms react to such risks by altering their presence in countries that are more affected. We measure this by examining foreign direct investment (FDI) dynamics in the aggregate as well as at firm level. We propose a theoretical framework for firm production location choice that explicitly incorporates transition and physical risks. The model predicts a reduction in FDI resulting from both physical risks and transition risks but an ambiguous interaction effect of these risks with emission productivity. These predictions are largely consistent with our empirical findings. But, in an extensive empirical analysis at six levels of aggregation we find only a minimal set of statistically significant effects of physical and transition risks on multinational firms' location decisions. Our firm-level results, however, suggest that growing attention to climate risks is likely to increase effects of such risks on FDI going forward.

Keywords: climate change, weather, climate policy, foreign direct investment

JEL codes: F21, F23, F64

*University of California Santa Cruz. grace.gu@ucsc.edu. Corresponding author.

†University of California Santa Cruz, NBER, CEPR. gbhale@ucsc.edu. We thank Ted Liu, Dmitrius Rodriguez, and Axel Morales Sanchez for excellent research assistance. Seminar participants at UC Santa Cruz and Federal Reserve Bank of San Francisco provided valuable feedback. All errors are ours.

1 Introduction

It is well documented in the science literature that the frequency of extreme weather events is increasing due to climate change (Hsiang and Kopp, 2018). Events that once were thought to be extraordinary have become an annual occurrence. Every occurrence of extreme weather events increases perceived risks of climate change, both physical risks, due to destructive effects of such events, and transition risks which arise from increased awareness of these risks and political will to mitigate them.[1] Is this change in the distribution of weather event occurrence, which we can interpret as an increase in physical risks due to climate change, incorporated in behavior of multinational companies? Moreover, do firms react to increased probabilities of climate mitigation policies, or climate transition risks? In this paper we evaluate the response of foreign direct investments (FDI) to extreme weather events and climate-related policies.

As physical manifestations of climate change are becoming more apparent, so is the attention to climate related risks. Perhaps the earliest dates to which climate change discussions can be linked are the establishment of the National Oceanic and Atmospheric Administration (NOAA) in the U.S. in 1970 and the first Intergovernmental Panel on Climate Change (IPCC) in 1988. These were followed by the Kyoto Protocol in 1997 and Al Gore's influential "Inconvenient Truth" documentary in 2006. Very few studies of the private sector response to climate change have an ability to span such long time period. Recent studies of financial market responses consistently find that the Paris Climate Accord of 2015 is a turning point for the markets to incorporate climate risks into their behavior.[2] This, of course, presents difficulties for the empirical analysis, because even today we would not expect the majority of private sector to fully incorporate climate risks in their decisions.

To assess the extent to which firms' location decisions, and therefore FDI, take climate risks into account, we first construct a model in which a multinational enterprise (MNE) chooses how much FDI and how many affiliates to allocate in a target country, fully taking into account climate risks, both physical and transition risks, with rational expectations. This model provides a benchmark for what we should expect to find in the data if climate risks were fully reflected in firms' behavior. We then confront the question with the data, relying on all possible levels of aggregation and available data sources to span long time period, include as many countries as possible, and exploring heterogeneity as much as possible. We find that, while the directions of the effects of climate risks on FDI are mostly consistent with the model and no significant effects directly contradict model predictions, very few of these effects are statistically significant, and are mostly small in terms of magnitude. In contrast with other studies, we do not find a significant increase in response

[1] Choi et al. (2020) demonstrate that rising temperatures increase attention to climate change, while Pankratz (2019) estimates that increasing heat exposure of firms reduces their financial performance, but is not yet fully incorporated in analysis forecasts.

[2] For example, Degryse et al. (2021); Ehlers et al. (2022); Kacperczyk and Peydró (2021); Mueller and Sfrappini (2021); Reghezza et al. (2021) find a change in syndicated loan pricing or quantity to firms exposed to climate risks following COP21.

to climate risks following Paris Climate Accord. We do, however, find that firms that are more exposed or more attentive to climate risks are more likely to react in a predicted way to transition risks, but not to climate risks.

While many models of MNE location decision could incorporate climate risks, we construct a simple partial equilibrium theoretical framework that includes both physical and policy shocks, has predictions about FDI flows on both intensive and extensive margins, and has predictions on how emission productivity (inverse of emission intensity) affects response of FDI to climate risks. Our model is very tractable and has predictions that we can easily map into our empirical analysis. In our two-country model, emissions are modeled as a factor of production, physical risks as expectations of future destructive events, and transition risks as exogenous policies that raise costs of emissions. The model shows that higher physical and transition risks reduce FDI in the affected country on both intensive and extensive margins. In general, greener technology (higher emission productivity) has a positive direct effect on FDI, but can amplify or reduce the impact of climate risk on FDI, depending on initial distribution of the emission productivity, a result that we have not yet seen in the literature.

The data on climate-related physical disasters is available for a longer span of time than any information on emission productivity or climate change mitigation policies. For this reason, we begin with the analysis of the effects of physical risks only, allowing for the effect to be different following Paris Climate Accord, COP21, in 2015. We conduct this analysis in eight different specifications with six different aggregation levels. We find weak evidence of decline in FDI in response to past climate-related disasters, with most effects not statistically significant and not robust across specifications. Only in firm-level regressions do we observe a significant increase in the response of firms to disasters after 2015.

Turning to the full-scale analysis in which we also include an indicator of environmental policies as a proxy for the likelihood of climate mitigation policies, CO2 tax indicator, and emission productivity, we conduct our analysis at four levels of aggregation: target country — year, country pair — year, country—industry—year, and firm — target country — year. In order to reduce influence of spurious effects, we estimate each model with as many fixed effects as possible to allow identification of coefficients of interest. For this reason, we estimate separate regressions for main effects and for the interactions of emission productivity with physical and climate risks (where main effects are generally absorbed by fixed effects). We find that any effects that are statistically significant are consistent with model predictions, but generally the effects are not statistically significant and small in magnitude.[3] The effects of physical risks are especially small by comparison with the effects of transition risks or emission productivity. While the model is ambiguous regarding the effects emission productivity has on FDI response to climate risks, we find that higher emission

[3]In the main effects analysis we find that higher emission productivity is associated with lower FDI in most specifications. However, when we interact emission productivity with physical and transition risks, we find that the main effect of emission productivity, in the absence of these risks, is associated with higher FDI in most specifications and is therefore consistent with model predictions.

productivity tends to amplify the effects of transition risks, and, to some extent, of physical risks.

Based on these results we conclude that there is little evidence in the data of consistent response of multinationals' location decisions, and therefore FDI, to climate risks.[4] If this is a matter of recognizing climate risks, we would expect firms that are more exposed or more attentive to climate risks to react more than others. Thus, at firm-level we interact information of firm exposure to climate risk, constructed by Sautner et al. (2021) based on climate risk mentions in executive calls, with measures of physical and transition risks.[5] In a fully saturated model we find no evidence that firms that are more exposed or attentive to climate risks react more to climate-related disasters, but we do find evidence of a larger response to transition risks by such firms. We also note that MNEs with headquarters in offshore financial centers exhibit different behavior than others. Thus, even though attention to climate risks in FDI decisions appears to be minimal on average, we should expect the response of FDI to climate risks to increase over time as firms' attention to these risks continues to grow.

Our paper fits into the broader literature on the effect of climate change risks on international financial markets and international capital flows. The approach of using weather shocks as a proxy for climate change exposure is not new, as summarized in the survey paper by Dell et al. (2014). Since the survey, the use of weather shocks gained further popularity in the literature due to their exogenous nature, at least in short and medium run.[6] Substantial literature already exists in this context, but to the best of our knowledge, there is no comprehensive analysis of the effect of climate change on FDI.

Two recent papers are closely related to our analysis. In the study of FDI patterns, Barua et al. (2020) show that long-run changes in average temperatures lower FDI flows to developing countries, but increase them for developed economies. In contrast with their analysis, we look at weather disasters rather than changes in temperature trends and conduct our analysis in more disaggregated level. Doytch (2020), using country-level analysis similar to ours but focusing more on dynamics finds that manufacturing FDI is negatively affected immediately after the disaster and positively in the longer run. For service sectors FDI meteorological disasters have no effect, while climatological and hydrological disasters have long-lasting negative effects.[7] In a study not necessarily related to climate risks, Escaleras and Register (2011) find a reduction in FDI following natural disasters. However, Neise et al. (2022) in a sector-level panel analysis of the effects of natural disasters on FDI across countries find either no effect of disasters on FDI, or a delayed positive

[4]This negative results is consistent with the literature, for example, earlier analysis by Hoon Oh (2010) did not find a response to climate-related shocks for MNEs located in Europe, where there is more attention to climate change risks.

[5]This climate risk measures shows a strong upward trend for multinationals in our sample after 2015.

[6]As integrated analysis models show, economic activity affects emissions and therefore climate change, which in turn increases frequency of weather shocks. However, due to a public "bad" nature of these effects, this feedback mechanism is not internalized by economic agents.

[7]We also tend to find more positive effects of meteorological disasters relative to climatological and hydrological ones.

effect.[8] Our comprehensive empirical analysis across variety of sample and aggregation levels shows that effects of climate-related disasters are generally not robust across these dimensions, which may explain inconsistent findings in the literature. More generally, our paper contributes to the growing literature studying the effects of climate-related risks on international capital flows.

Less closely related are studies of the effects of climate risk on supply chains and on financial markets. Of these, most relevant are Pankratz and Schiller (2021) who show that climate-change risks as measured by extreme heat and floods affect global customer-supplier relationships. Importantly, when climate shocks exceed expectations, a substantial portion of the supplier relationships are terminated. To the extent that supply chain relationships might be within as well as across corporations, the effects on FDI location might or might not be similar. The literature on financial markets' reaction to climate change is also growing rapidly. Mallucci (2020); Klomp (2017) look at the effects of climate risks on pricing of sovereign debt and sovereign's access to the global capital market. Cortés and Strahan (2017); Ivanov (2020) document the effect of natural disasters on bank lending, while Roncoroni et al. (2021) analyse the effects of transition risks. A number of recent papers address pricing of climate risks and their effects on lending amount in syndicated bank lending, including Degryse et al. (2021); Ehlers et al. (2022); Javadi and Al Masum (2021); Kacperczyk and Peydró (2021); Mueller and Sfrappini (2021); Reghezza et al. (2021).

We begin our analysis with theoretical framework in section 2, we then describe our data sources section 3, followed by our empirical strategy in section 4. Section 5 discussed empirical results, and section 6 concludes. Given a large number of empirical results, most regression tables are reported in the Appendix.

2 Theoretical Framework

To discipline our priors about the effects of climate risks on FDI, we introduce a two-country partial-equilibrium model that is simplified from Helpman et al. (2004). The model features horizontal FDI, constant returns to scale production, overhead costs, and monopolistic competition in the goods market. It also borrows the element of mergers and acquisitions (M&A) mode of FDI with the purchase price being determined by a bargaining problem from Razin et al. (2007). We do not consider trade or exporting decisions. Our model explains how many affiliates a multinational enterprise (MNE) allocates between the target and source countries, how much FDI flows into the target country, and how the above measures vary with physical and transition climate risks, as well as with emission productivity. Most importantly, the model provides intuition about how climate risks and emission productivity can interact with other each in affecting FDI.

Firms and climate risks

[8] In a related study that provides potential explanation for this positive effect, Wang et al. (2021) show that FDI inflows help countries recover from natural disasters.

There is one MNE and N firms in each country (source or domestic country, and target or foreign country). Each MNE's affiliate location problems in two countries are symmetrical. We start by describing the foreign affiliate location decision by the MNE from the source (or domestic) country. Prospective foreign affiliates indexed by n in target country i are endowed with a known idiosyncratic value of output per unit of emission z_{in} (we refer to it as emission productivity, which is the inverse of emission intensity more commonly used in the literature), with distribution that can be affected by country i climate policies.[9]

We assume that physical disasters do not affect emission productivity distribution. Before the realization of the target country's physical climate shock state is revealed (a disaster or no disaster), the MNE must decide whether to purchase a prospective affiliate n in the target country i, let it produce in the future, and set the price for its unique good if producing. The set price will be applied to all goods that the affiliate produces in the future.

Production q_{in} by affiliate n is linear in emission and is characterized by the technology

$$q_{in} = z_{in} k_{in}$$

The emission productivity z_{in} is known at the time the MNE decides whether to purchase the affiliate n and what good price to charge. The quantity k_{in} is the amount of emission chosen. This can be interpreted as the choice of the amount of an input bundle that has a certain level of emission efficiency.

The MNE takes the pricing schedule and other firms' decisions as given and seeks to maximize each affiliate's expected profit. If the affiliate n is chosen to produce in the target country, it takes on an intra-period zero-interest loan to purchase the inputs and pay the associated emission costs (reflecting emission taxes, carbon trading costs, renewable subsidies, etc.) and repays the loan after production. The loan is measured in terms of emissions k_{in} at unit cost r_i that varies across target countries but not across firms within a country. Both input costs and target country climate policies can affect r_i. We take input costs as being fixed but vary r_i as a part of climate policy changes in the comparative statics analysis.[10]

The affiliate also has to pay an overhead cost f_i during the production. This cost can be thought as the costs of maintaining the affiliate and its production networks in the target country i, as well as an overhead cost of production. Importantly, this cost is subject to disasters due to physical climate-related shocks. When a disaster happens, this cost goes up. This is realistic in the sense that disasters can destroy facilities, raise rents, disrupt utilities and production network, all of which raise the overhead cost. It is similar to the usual fixed costs in the literature in that it does not vary with inputs, yet it differs in that it is repeated and not fixed in time. MNEs incur

[9] For instance, the target country's climate policies can limit or even prohibit the use of certain technologies with low z_{in}.

[10] We choose to let climate policies be reflected by a parameter r_i that bears no uncertainty because policy change tends to be slow, and we assume that the MNE can perfectly foresee any policy change. Our predictions still hold with policy uncertainty and risk neutrality of the MNEs, i.e. if r_i is replaced by $E(r_i)$ in all equations.

the overhead cost only while production happens; hence, it is not a sunk cost. The overhead cost is target-country specific and unknown before the production decision, which represents climate-related physical risks. The MNE considers potential disasters in the target country, whose expected occurrence and cost is reflected in $E(f_i)$. Conditional on producing, the MNE chooses prices to maximize the affiliate's expected profits:

$$\max_{k_{int}} \; E_{t-1}(\Pi_{int}) = \beta E_{t-1}(p_{int}(k_{int})q_{int}(k_{int}) - r_i k_{int} - f_{it}) \geq 0$$

where β is a constant discount factor.[11] With probability $0 < \pi < 1$, $f_{it} = f_{id}$ when there is a disaster during production, and with probability $1 - \pi$, $f_{it} = f_{i0}$ when there is no disaster during production, with $f_{id} > f_{i0} > 0$. Since the affiliate's goods price and input decisions are made ex ante, we can simplify the notation and remove the time subscripts:

$$\max_{k_{in}} \; E(\Pi_{in}) = \beta[p_{in}(k_{in})z_{in}k_{in} - r_h k_{in} - E(f_i)] \geq 0$$

where $E(f_i) = \pi f_{id} + (1 - \pi) f_{i0}$.

Demand and solution

All the goods produced by the affiliate are consumed in the target country (i.e., this is a horizontal FDI model).[12] As in Helpman et al. (2004), the target country's consumer preferences across varieties of products have the standard CES form, with an elasticity of substitution $\sigma > 1$ and share parameters α_{mi}, where m indexes a unique variety produced by each firm m, including MNE's affiliates, domestic firms, and the foreign MNE producing in target country i, for the total of $N + 1$ firms. These preferences generate a demand function $A_i p_{im}^{-\sigma}$, where $A_i = \frac{\alpha_{mi}^{\sigma} C_i}{P_i^{1-\sigma}}$, C_i is the total expenditure of the target country, and $P_i = (\sum_{m=1}^{N+1} \alpha_{mi}^{\sigma} p_{mi}^{1-\sigma})^{\frac{1}{1-\sigma}}$ is target country's price index. The demand level A_i is exogenous from the point of view of the individual supplier.

We solve for the optimal emission input as:

$$k_{in} = \frac{A_i z_{in}^{\sigma-1} (1 - \frac{1}{\sigma})^{\sigma}}{r_i^{\sigma}}$$

with price $p_{in} = \frac{r_i}{z_{in}(1-\frac{1}{\sigma})}$ and quantity $q_{ih} = \frac{A_h z_{ih}^{\sigma} (1-\frac{1}{\sigma})^{\sigma}}{r_h^{\sigma}}$.

[11] Our main predictions do not depend on whether MNE stockholders are risk-averse or risk-neutral, the results are qualitatively similar if a stochastic discount factor is used.

[12] The model can easily be reformulated as a vertical FDI model if the differentiated goods are considered inputs into a domestic single consumption good via a CES aggregator production function. As long as substitution elasticity $\sigma > 1$, the results will be the same. However, one can see that for complementary goods ($0 < \sigma < 1$), such as exist in disaggregated supply chains, some of the results will be reversed.

The expected operating profit for the affiliate is:

$$E(\Pi_{in}) = \beta[\frac{A_i z_{in}^{\sigma-1}(1-\frac{1}{\sigma})^{\sigma-1}}{\sigma r_i^{\sigma-1}} - E(f_i)] \geq 0 \tag{1}$$

Hence, there exists an emission productivity threshold

$$\bar{z} = [\frac{E(f_i)\sigma r_i^{\sigma-1}}{A_i(1-\frac{1}{\sigma})^{\sigma-1}}]^{\frac{1}{\sigma-1}}$$

such that potential affiliates with $z_{in} \geq \bar{z}$ are acquired by the MNE to operate in the target country, otherwise they are not.

2.1 The Number of Foreign Affiliates

In order to measure the number of MNE's affiliates in the target country, we assume that there is a fixed number of potential affiliates (existing local firms) $N_i = \rho N$ in the target country for the MNE to consider for merger or aquizition (M&A), where $0 < \rho < 1$ is a parameter specifying the proportion of local firms open to M&A. We also assume that the potential affiliates' emission productivity z_{in} follow a Pareto distribution as in Helpman et al. (2004). The cumulative distribution function is $F(z) = 1-(\frac{b_i}{z})^{v_i}$, where we assume that $z \geq b_i > 0$ and $v_i > 2$ to ensure the distribution has a finite variance.[13] The scale parameter b_i is the lower bound of the emission productivity distribution and the shape parameter v_i controls its dispersion: a lower v_i gives a higher dispersion of the emission productivity. Therefore, we write the number of MNE's affiliates M_i in the target country as

$$M_i = N_i[1-F(\bar{z})] = N_h(\frac{b_i}{\bar{z}})^{v_i} = N_i b_i^{v_i}[\frac{A_i(1-\frac{1}{\sigma})^{\sigma-1}}{E(f_i)\sigma r_i^{\sigma-1}}]^{\frac{v_i}{\sigma-1}} \tag{2}$$

This result is similar to that of Ramondo (2014): We should expect more affiliates in the target country when the expected overhead cost is lower (lower $E(f_i)$), the emission unit cost is lower (lower r_i), productivity lower bound and productivity mean are higher (higher b_i), productivity dispersion is lower (higher v_i), and the target market is larger (higher A_i).

When a disaster happens after the M&As by the MNE, since the cost of purchasing the foreign affiliates is a sunk cost, there is no gain for the MNE to continue any production by affiliates that now generate negative profits due to the high overhead cost f_{id}. Hence, some foreign affiliates

[13] Boyd (2017) shows that the energy efficiency distributions of U.S. cement manufacturing, auto assembly, and wet corn refining mills resemble Pareto distribution. Bloom et al. (2010) shows that UK manufacturing firms' energy intensity displays a log-normal distribution. Its inverse distribution can provide inference to our emission productivity distribution, which would be heavy-tailed, like Pareto. Our results are robust to using other distributions, such as Fréchet distribution used in Eaton and Kortum (2002) for productivity. More specifically, our first-order qualitative results will still hold if using Fréchet distribution and second-order results can also hold given plausible distribution parameter values.

default on their intra-period loans and the number of foreign affiliates becomes:[14]

$$M_{id} = N_i b_i^{v_i} [\frac{A_i(1-\frac{1}{\sigma})^{\sigma-1}}{f_{id}\sigma r_i^{\sigma-1}}]^{\frac{v_i}{\sigma-1}}$$

where $f_{id} > E(f_i)$ is the actual overhead cost during a disaster.

With the above model setup, we use changes to $E(f_i)$ to reflect physical risk and use changes to r_i and emission productivity distribution to reflect climate policy changes. We derive the following propositions to guide interpretation of our empirical results.

Proposition 1. Physical risk *When a target country's physical climate risk increases such that the affiliate's expected overhead cost $E(f_i)$ increases, or when a disaster actually happens, it reduces the number of affiliates in the target country.*

Proof: Since $\sigma > 1$, we can see from equation (2) that $\frac{\partial M_i}{\partial E(f_i)} < 0$. And during a disaster since the realized overhead cost $f_{id} > E(f_i)$, M_i will decrease from the level prior to the disaster and the absolute change $M_i - M_{id} \equiv \Delta M_i = N_i b_i^{v_i} \frac{f_{id}^{\frac{v_i}{\sigma-1}} - E(f_i)^{\frac{v_i}{\sigma-1}}}{f_{id}^{\frac{v_i}{\sigma-1}} E(f_i)^{\frac{v_i}{\sigma-1}}} (\frac{B}{r_i^{\sigma-1}})^{\frac{v_i}{\sigma-1}} > 0$, where $B = \frac{A_i(1-\frac{1}{\sigma})^{\sigma-1}}{\sigma}$. □

For the following propositions that are related to transition risk, climate policies can include emission taxes, carbon trading schemes, renewable/R&D subsidies, emission limits, etc. They can have different effects on the target country and thus affect FDI inflows. In the model, such policies are reflected by the change to the abstract emission unit cost r_i.

Proposition 2. Transition risk *When climate policies increase emission unit cost r_i, the number of MNE's affiliates in the target country decreases; and the policies reduce the effect of physical risk from Proposition 1.*

Proof: Since $\sigma > 1$, we can see from equation (2) that $\frac{\partial M_i}{\partial r_i} < 0$. In addition, $\frac{\partial^2 M_i}{\partial E(f_i)\partial r_i} = N_i b_i^{v_i} \frac{v_i^2}{\sigma-1} [E(f_i)]^{-\frac{v_i}{\sigma-1}-1} r_i^{-v_i-1} B^{\frac{v_i}{\sigma-1}} > 0$. To show how the policies affect the impact of an actual disaster, we see that $\frac{\partial \Delta M_i}{\partial r_i} < 0$ and thus the policies reduces ΔM_i upon a disaster. □

This result of diminishing impact of climate policies on disaster effect is not surprising, given the negative impact of both $E(f_i)$ and r_i. The intuition is that a higher emission unit cost can make MNE more selective about its affiliates, thus have a smaller mass of more productive affiliates to start with. When physical risk increases or a disaster strikes, fewer of these productive affiliates will exit. Other models can generate the same prediction. What's special about this model is that it generates the following proposition.

Proposition 3. Emission Productivity. *When technology becomes greener which increases the emission productivity distribution's lower bound b_i (i.e., shifting distribution right and increasing*

[14]This implies that the intra-period loans are repaid by foreign affiliates after production, and are not committed by the MNE. Alternatively, we could have the MNE commit to the repayment and thus the loan becomes a sunk cost to the MNE and the threshold for affiliate exits becomes $\bar{z}_d = [\frac{f_{id} r_i^{\sigma-1}}{A_i(1-\frac{1}{\sigma})^{\sigma-1}}]^{\frac{1}{\sigma-1}}$ (i.e., affiliates exit if $p_{in}q_{in} \leq f_{id}$). As long as $f_{id} > \sigma E(f_i)$, Propositions 1-6, and our overall model predictions still hold.

the emission productivity mean), the number of MNE's affiliates in the target country increases; and in this case higher emission productivity amplifies the effect of climate risks from Propositions 1 and 2.

Proof: Since $\sigma > 1$, we can see from equation (2) that $\frac{\partial M}{\partial b_i} > 0$. In addition, $\frac{\partial^2 M}{\partial E(f_i)\partial b_i} = N_i v_i b_i^{v_i-1} \frac{v_i}{\sigma-1} E(f_i)^{-\frac{v_i}{\sigma-1}-1} (\frac{B}{r_i^{\sigma-1}})^{\frac{v_i}{\sigma-1}} < 0$. To show how emission productivity affects the impact of an actual disaster, we see that $\frac{\partial \Delta M_i}{\partial b_i} > 0$ and thus it increases ΔM_i upon a disaster. Similarly, $\frac{\partial^2 M}{\partial r_i \partial b_i} < 0$ and thus higher emission productivity with a higher b_i can severe the impact of transition risk on FDI. □

The intuition of Proposition 3 is that when more emission-productive technologies can raise the entire distribution's mean, and as the productivity distribution shifts right, a larger mass of affiliates will qualify to be acquired by the MNE to start with. Hence, when physical risk increases or a disaster strikes, or when policies raise emission costs, a larger mass of affiliates will be affected negatively and exit. While we do not take a stand on what cause the emission productivity to change over time, Proposition 3 states that any possible emission productivity mean change can alter the impact of climate risks on FDI.[15]

Suppose that the source country affiliate allocation problem of the same MNE is symmetrical with the above problem. As long as the source country's physical and transition climate risks stay unchanged (or increase not as much as the foreign country's), an increase in the foreign country's climate risk, as stated in the above propositions, can also alter the *share* of total affiliates in the foreign country in the same direction.

2.2 FDI Value

Our model can also predict how the amount of FDI reacts to climate risks. Note that FDI here is in the form of M&A, therefore MNE's total purchase cost of foreign affiliates is the gross FDI inflow to the target country. Let's assume that the foreign MNE has an overhead cost advantage over local firms as in Razin et al. (2007), such that $E(f_i) < E(f)$ where $E(f)$ is the expected overhead costs paid by target country's local entrepreneurs if they were to operate the same affiliate. This can be true in reality because the MNE may be endowed with superior intangible capital, or know-how, coming from its specialization or expertise in the industry.

This cost advantage implies that the foreign MNE can afford to acquire an affiliate in the target country with a price larger than the affiliate's expected profit to its original local owner. Assuming the original owners hold all the bargaining power, each potential affiliate whose $z_{in} > \bar{z}$ is purchased by the MNE at its expected profit to the MNE, which is the maximized $E(\Pi_{in})$ in equation (1).[16]

[15]Climate policies and disasters may in principle affect technology innovation and thus the emission productivity, but in the empirical exercise we do observe reduction in average emissions (increase in emission productivity) following an introduction of CO2 tax or tightening of environmental protection policies. Local projection results supporting this findings are available upon request.

[16]Since by assumption only ρ share of target-country local firms are potential affiliates open to M&A, not all

Hence, the amount of FDI flow from the source country MNE to target country is:

$$FDI_i = \int_{\bar{z}}^{\infty} \beta[\frac{A_i z_{in}^{\sigma-1}(1-\frac{1}{\sigma})^{\sigma-1}}{\sigma r_i^{\sigma-1}} - E(f_i)]f(z_{in})dz_{in}$$

where $f(z) = \frac{v_i b_i^{v_i}}{z^{v+1}}$ is the emission productivity density function. Notice that FDI_i is the gross FDI inflow received by the target country as there is only one MNE from the source country investing in the target country. Assuming $\sigma - v_i < 1$, we can simplify the FDI amount to:[17]

$$FDI_i = \beta \frac{b_i^{v_i}(\sigma-1)}{1-(\sigma-v_i)} \frac{1}{E(f_i)^{\frac{1-(\sigma-v_i)}{\sigma-1}}} [\frac{A_i(1-\frac{1}{\sigma})^{\sigma-1}}{\sigma r_i^{\sigma-1}}]^{\frac{v_i}{\sigma-1}} \tag{3}$$

To formalize our predictions of FDI inflows to the target country, we derive the following propositions.

Proposition 4. Physical risk. *When a target country's physical climate risk increases such that the affiliate's expected overhead cost $E(f_i)$ increases, it reduces the FDI inflows to the target country.*

Proof: Since $\sigma > 1$ and $\sigma - v_i < 1$, we can see from equation (3) that $\frac{\partial FDI_i}{\partial E(f_i)} < 0$. □

Proposition 5. Transition risk. *When climate policies increase emission unit cost r_i, the FDI inflows to the target country decrease.*

Proof: Since $v_i > 0$, we can see from equation (3) that $\frac{\partial FDI_i}{\partial r_i} < 0$. □

Proposition 6. Emission Productivity. *When technology becomes greener which increases the emission productivity distribution's lower bound b_i (i.e., increasing the emission productivity mean), the FDI inflows to the target country increase; and in this case higher emission productivity amplifies the effect of climate risks from Propositions 4 and 5.*

Proof: Since $v_i > 0$, $\sigma > 1$ and $\sigma - v_i < 1$, we can see from equation (3) that $\frac{\partial FDI_i}{\partial b_i} > 0$. Also, we have $\frac{\partial^2 FDI_i}{\partial E(f_i)\partial b_i} < 0$ and $\frac{\partial^2 FDI_i}{\partial r_i \partial b_i} < 0$. □

Suppose that the problem of the other MNE from the foreign country is symmetrical with the above problem of the MNE from the domestic country. As long as the domestic country's physical and transition climate risks stay unchanged (or increase not as much as the foreign country's), an increase in the foreign country's climate risk, as stated in the above propositions, can also alter the *net* FDI inflow to the target country in the same direction.

target-country local firms with positive profits will be purchased by the foreign MNE.

[17] Russ (2007) sets $v_i = \sigma + 0.1$, our assumption of $\sigma - v_i < 1$ is not unrealistic.

2.3 Discussion

So far we have assumed that $\bar{z} > b_i$ always holds. In a comparative static analysis for this case, comparing the FDI change in a target country (or a particular industry in the target country) with higher emission productivity (the distribution to the right in Figure 1) with the FDI change in a country (or industry) with lower emission productivity (the distribution to the left in Figure 1), we find that more emission-productive countries or industries will have more exits and FDI reduction due to rising climate risks. At first this result appears surprising, but the intuition is straightforward: The mass of potential affiliates that are qualified for M&A and being purchased by the MNE is larger to start with in the more emission-productive country or industry, than in the less emission-productive one. When rising climate risks raise $\bar{z}$, the mass of affiliates and FDI being reduced is also larger. We call this the case of "Better Loses," and it is the case covered in Proposition 3.

When we relax the assumption of $\bar{z} > b_i$, the comparative static result will change. Here we cannot exhaust all the possible cases due to the qualitative nature of the analysis, but we will highlight a couple of scenarios useful for discussion. Suppose that $\bar{z} > b_i$ only for the target country or industry with low emission productivity distribution and $\bar{z} < b_h$ for the country or industry with high emission productivity distribution (Figure 2). In this case, the more emission-productive countries or industries experience fewer exits or less FDI reduction due to their rising climate risks than less emission-productive ones. We call this the case of "Better Wins."

In a different case, $\bar{z}$ may be so low relative to b_i (this could be due to a low r_i or a high A_i, or highly emission-productive countries or industries), that $\bar{z} < b_i$ for both types of countries or industries (Figure 3). In this case, all ρN local firms that are open to M&A are acquired by the MNE. Here, a target country or industry emission productivity does not matter for the impact of climate risks on its received FDI, until its $\bar{z}$ is eventually raised higher than b_i. We call this the case of "No Effect."

Which case does the data suggest? Using our data on emission productivity (see the next section for the details on data sources and calculations), we plot the histogram of country average emission productivity across industries and years for each country in the group of advanced countries and those in emerging economies (Figure 4).[18]. On average, advanced countries have a higher emission productivity than emerging economies. Although Figure 4 is not exactly the same as the z's Pareto distribution in the model, it indicates that on average the distribution of "firm" emission productivity for advanced economies is likely to the right of that for emerging economies. Thus, for advanced economies b_{AE} is likely higher on average, but not too much higher than emerging economies' b_{EME}. Given the gap of between b_{AE} and b_{EME} and their distance to zero are small, the chance of $\bar{z}$ falling below b_{AE} would be small, hence "Better Loses" case is most likely (i.e., Proposition 3). Of course, there is no clear-cut prediction because emission productivity dispersion

[18]This is a distribution of average z across countries, not the distribution of z in given a country or industry across firms, as in the model.

can also play a role here.

Overall, the model predicts a direct negative impact of rising target country physical and transition risks on the number of foreign affiliates and their share in the total affiliates for an MNE, and on the FDI inflows to the target country. Transition risk may reduce the impact of physical risk on FDI. Moreover, higher emission productivity can have a positive effect on FDI directly, and can amplify or reduce the impact of climate risk on FDI depending on the relative position of $\bar{z}$ and b_i, with ampilification being a more likely scenario empirically.

In our empirical analysis, we proxy for physical risk with data on past hydrological, meterological, and climatological disasters, and proxy for transition risk with information on environmental policies and on CO2 tax data. We examine the climate risk and emission productivity effects on FDI inflows to target countries at country, country-pair, and country-industry levels of aggregation, and then investigate the impact on the number of foreign affiliates at the firm level. In the firm-level analysis, we also include firms' exposure to or attention to climate risks and interact it with the climate risks. The latter may be interpreted as affecting $E(f_i)$, expectations about the the overhead cost, although in the model we assume $E(f_i)$ reflects the true expected cost.

3 Data

We combine multiple data sources to measure climate-related risks, both physical, by looking at extreme weather events, and transition, by looking at environmental protection policies and CO2 taxes as well as emissions at country-industry level. In addition, we use firm-level climate risk exposure data constructed by Sautner et al. (2020) who scrape executive calls data for the mentions of climate risk. This firm-level measure reflects firm exposure, but also firm's attention to climate-related risks. We combine these data with information on FDI flows, at target country, source country-target country pair, and target country-industry levels. We also construct firm-level data set, where for each multinational enterprise we count the number of affiliates in each foreign country. All these data sets are described in detail below.

3.1 Climate data

We seek to measure exposure of countries, industries, and firms to both physical and transition risks that are due to climate change. To do so, we obtain information from multiple sources.

Extreme weather events

Our first data source is The Emergency Events Database (EM-DAT) housed at the Centre for Research on the Epidemiology of Disasters (CRED), University of Louvain. It provides data of disaster events worldwide from 1900 and present. To be included in the data, at least one of the

following criteria must be fulfilled: 10 or more human deaths; 100 or more people injured or left homeless; declaration by the country of a state of emergency and/or an appeal for international assistance.[19]

This data set provides monthly count of events by disaster subgroups: geophysical, meteorological, hydrological, climatological, and biological, of which we retain climate-related disaster events: climatological, which includes wildfire and drought; meteorological, which includes extreme temperatures and storms; hydrological, which includes flood. The dataset only includes monthly number of deaths, number of people affected, and economic losses in USD. We aggregate these data to country-year level, and for country-years where no disasters are reported we assume that all indicators are zero — no events. We express economic losses in real USD, by dividing the amount by the U.S. CPI.

Figures 5 and 6 show the total number of the events in the world that is reported in our data, by year. Figure 5 breaks down the total into the event types as described above, while Figure 6 breaks it down by advanced, emerging, and low-income economies. We can see a rapid increase in the number of events, especially due to an increase in emerging markets, until early 2000s, after which the number is stabilized. It is possible that the number of countries covered in the data and the degree of coverage increase over time, leading to an overall increase in total number of events. For this reason, in our regression analysis we include year fixed effects that capture any common trends. Figure 7 shows the distribution of the total number of disaster events across countries.

Hsiang (2016) and Lemoine (2021) demonstrate that weather data, when used appropriately, identifies the effects of climate change. While these studies are focusing on average weather characteristics, such as temperature, precipitation, and humidity, we believe the occurrence of extreme weather events show the impact of climate change in a more transparent and catastrophic way and, therefore, is more likely to raise investors' and firms' attention and affect their behavior. We think of it as a proxy for physical risk. We observe that there is substantial variation of the frequency of climate-related events across regions. Figure 8 shows country-year average of event occurrence across broad geographical regions, broken down by advanced and emerging economies.

Among different components of the three types of climate-related disasters we consider, we find that the most impactful events are drought, which drives the climatological event result, and flood, which drives the hydrological event result. We do not conduct such detailed breakdown in the bulk of our analysis, but we demonstrate this breakdown in the target country-level regression for full sample reported in Table 2.

We supplement these data with the The Notre Dame-Global Adaptation Index (ND-GAIN) climate vulnerability index. This index, while constructed to reflect climate change exposure, sensitivity and adaptive capacity, as well as economic, governance and social components, is empirically

[19]This data set has been used in a related study by Feng and Li (2021) and is also the main source for the World Meteorological Organization Atlas of Mortality and Economic Losses from Weather, Climate, and Weather Extremes (1970-2019).

highly correlated with incidence of climatological disasters in our data. For this reason, we only include it as a separate proxy for the physical risk and not together with disaster measures.

Climate policy data

We obtain environmental policy stringency (EPS) index data at country level from OECD (1990-2015). This composite index is computed by scoring and aggregating environmental policy instruments, primarily related to climate and air pollution, including emission taxes, trading schemes, renewable and R&D subsidies, and emission limits. While many variables contribute to this index, we think of it as a proxy for transition risk — countries with stricter environmental regulations are more likely to be more aggressive on climate change mitigation. One component of the score is a measure for CO2 tax, which we consider separately, as it is closer related to climate change policy in particular. Higher values of these variables are interpreted as higher transition risk. Figure 9 shows the distribution of EPS averaged over years across countries. Advanced countries tend to have higher EPS, while emerging markets have lower EPS.

Country-industry emissions data

Some industries may be more sensitive to transition risk than the others, as they have different emission levels and climate policies are heavily emission targeted. We obtain data on emissions by country-industry and year from World Input-Output Database version 2016 (WIOD 16) environmental accounts (2000-2016) from Timmer et al. (2015). These accounts report energy use by fuel type. We construct our emissions measure as emission-relevant total energy use (in Terajoule) minus energy use from nuclear and renewable resources (in Terajoule).

In our country-industry analysis, we merge this dataset with the climate risk datasets mentioned above and the target-country-industry FDI inflow data, and interact it with climate risk variables. We interpret this measure as a proxy for vulnerability to transition risk — industries with higher emission levels are at a higher risk of stranded assets and additional capital adjustment costs. In our analysis we use a measure of "emission productivity," to be consistent with the model. We measure emission productivity as a ratio of emissions in country-industry to its value added, which is obtained from the main WIOD 16 table. We further construct weighted averages of emission productivity by country-year, which we then merge with FDI data at country, country-pair, and firm level.

Firm climate risk exposure data

Sautner et al. (2021) report climate change exposure index for publicly traded firms, with ISIN numbers (2002-2019). In our firm-level analysis, we merge this information to the firms in our

data set, at the headquarter level. If we replace rational expectations with exogenous attention to climate risks in the model, it will predict that firms with higher attention to climate risk are more reactive to both physical and transition risks in the target countries where their affiliates are located.

Sautner et al. (2021) construct measures of positive and negative climate change sentiments as well as a measure of climate risk. In our preliminary analysis, only climate risk measure has an effect, and only when it is converted into a binary indicator of climate risk being above the median in the full sample of firms and year. We intentionally do not construct year-specific medians of this measure, to capture growing attention to climate risks over time. Figure 11 shows that average measure of climate risk increased over the available sample time, with a notable increase following Paris Climate Accord.

3.2 FDI data

We gather information on FDI from a variety of sources. The longest time series at annual frequency are available from World Bank's World Development Indicators (WDI) at country level. For the country-industry level data we turn to OECD database. Finally, we obtain firm level data from ORBIS.

Target country level

Country level data (both FDI and other macro variables) are from WDI and start in 1970 for most of the 94 countries in the sample. The last year for which we observe the data is 2019. According to the World Bank, FDI in our data are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. It shows net inflows (new investment inflows less disinvestment) in the target economy from foreign investors, and is divided by GDP. Figure 10 shows the log of average annual percentage change in net FDI inflow to GDp ratio in 2010-2019 (not including offshore financial centers).

Country-pair level

We obtain country-pair panel data on FDI flows from the IMF's Coordinated Direct Investment Survey (CDIS) data set. CDIS records bilateral FDI flows at the gross-net level (thus flows can be positive or negative, but they are not netted out within a country pair), by residency principle. The data are available for 2010-2019 and cover most advanced and emerging economies. Because of the bilateral nature of the data, there is a large number of zeros, which leads us to using Poisson

Pseudo Maximum Likelihood (PPML) approach proposed by Silva and Tenreyro (2015), adapted to the panel data.

Country-industry level

Different industries have different exposures to climate change risks. Therefore, we would expect that the sensitivity of FDI inflows to climate risks revealed by the weather disasters and the climate policies vary by industry. Country-industry data on FDI inflows are obtained from OECD International Direct Investment Statistics Yearbooks for 2005-2019. The industry classification corresponds to ISIC4 codes, and the aggregation level with most available public data is generally corresponding to a 2-digit level (49 industries).

Firm (MNE) level

Firm-level data are obtained from ORBIS. We use the data for 2007 through 2019. To properly classify all affiliates of multinationals, we rely on vintage ownership data collected for each year. We restrict our analysis to firms with total assets in excess of 1 billion USD for a given year. This gives us an unbalanced firm-year panel with 5915 firms from 66 countries with affiliates across 206 countries with the total of over a million of firm-target country-year observations.

For each firm, we aggregate information on affiliates by affiliate country and year and construct two measures: an extensive margin, which is an indicator of whether a firm has an affiliate in a given country in a given year; and an intensive margin, which is the number of affiliates in a given country in a given year as a share of total number of affiliates that the firm has in that year.[20] For each firm we retain information on the country of its headquarters and its industry.

Obviously, most observations drop out in the regression analysis due to missing climate variables or due to the inclusion of fixed effects (for example, if only one firm has affiliates in a given country in a given year, this observation will be dropped due to firm-year fixed effects). We also exclude OFCs as target countries, but do keep firms with headquarters in OFCs. Our regression analysis, therefore, includes up to 138,824 observations, with 2140 firms located in 31 countries (2 OFCs) and affiliates in 32 countries (10 EMEs, 22 AEs).

4 Empirical Specifications

We conduct our empirical analysis at different levels of aggregation, which allow us to include different sets of controls and fixed effects. We analyze both intensive and extensive margins, with

[20] Total assets are not reported for all affiliates, thus, we decided to rely on the count of affiliates for data completeness.

most regressions estimated by OLS (linear probability model in the case of the extensive margins). For some with many zeros we also use Poisson Pseudo Maximum Likelihood (PPML) approach proposed by Silva and Tenreyro (2015), adapted to the panel data. We keep as many specification features as possible the same across all aggregation level.

Because we observe FDI flows at the annual level, we lag all climate variables by one year. This is mainly because natural disasters, policy changes, etc. may occur late in the year and because FDI decisions likely incur substantial lags. For the climate policies, we include both environmental policy stringency (EPS) and CO2 tax together as controls, since they are not correlated with each other in the data. We include macroeconomic control variables — trade/GDP, PPI inflation, and real GDP growth — also lagged by one year for the same reason and to avoid any reverse causality.[21] In all cases, we include as many fixed effects as possible given the aggregation level of explanatory variables. We cluster standard errors as appropriate in all regressions.

We conduct our analysis for the full panel as well as for the subsets of countries. In a recent study, Cevik and ao Tovar Jalles (2020) demonstrate that the impact of climate risks on sovereign credit ratings is larger for developing countries than for advanced economies. They conjecture that this is due to lower-income countries having less fiscal space for technological greening and abatement measures. We believe these differences can play an important role in the sensitivity of foreign investors to climate risks of FDI target countries, which is consistent with findings by Barua et al. (2020). Through pre-testing we find that it is useful to define three sets of countries: advanced, emerging, and low-income, which we classify according to the IMF definition. We do not separately report the effects for low-income countries (LICs) in the bulk of our analysis because in most data sets these countries are missing. However, we can see from the basic regression specification in Table 2 that the effects of climate disasters on LICs is different from the effects on other countries, though without statistical significance.

Controls, reported in the full regressions in the Appendix, generally have expected effects and vary in terms of their statistical significance, which is not surprising given that different specifications include different sets of fixed effects.

4.1 Target country-level regressions

All country-level the regressions include year t, country i, and country-group (advanced, emerging, or low income economies) fixed effects and standard errors are clustered at regional level (Africa, Asia, Australasia, Europe, North America, and South America).

The intensive margin $FDIY$ is measured by the net FDI flow as a share of GDP. Because at that aggregation level we do not have many zeros, we do not measure extensive margin. The intensive

[21] We have also considered other macroeconomic controls, such as credit ratings, real exchange rate changes, and GDP per capita. The first two variables greatly reduce the sample size and the last one is highly correlated with the existing macroeconomic variables.

margin regression equation for target country-level analysis is as follows:

$$FDIY_{igt} = \alpha_i + \alpha_t + \alpha_{gt} + CD'_{it-1}\boldsymbol{\beta}_1 + \beta_2 EPS_{it-1} + \beta_3 \,\mathrm{I}(Tax_{it-1}) + \beta_4 z_{it-1} + M'_{it-1}\boldsymbol{\gamma} + \varepsilon_{it},$$

where α_i, α_t, and α_{gt} are country, year, and country-group times year fixed effects, CD is a matrix of the number of climate disasters: climatological, meteorological, and hydrologica, with the corresponding vector of coefficients $\boldsymbol{\beta}_1$, EPS it the Environmental Protection Score, I(Tax) is a 0/1 indicator of the presence of a tax on CO2, z is emission productivity, and M is a matrix of macroeconomic control variables. Standard errors ε are robust and clustered at the region level. In addition, we estimate a similar specification for regressions where all disaster and policy variables are interacted with emission productivity.

Because emission productivity and climate policies data are limiting the sample, we also estimate this regression with only climate disasters and controls on the right-hand side, including interactions with post-COP21 (post-2015) indicator $Post$.

$$FDIY_{igt} = \alpha_i + \alpha_t + \alpha_{gt} + CD'_{it-1}\boldsymbol{\beta}_1 + Post * CD'_{it-1}\boldsymbol{\beta}_2 + M'_{it-1}\boldsymbol{\gamma} + \varepsilon_{it}.$$

Alternatively, we replace in the above regression all climate disaster types with the climate vulnerability index V:

$$FDIY_{igt} = \alpha_i + \alpha_t + \alpha_{gt} + \beta_1 V_{it-1} + \beta_2 Post * V_{it-1} + M'_{it-1}\boldsymbol{\gamma} + \varepsilon_{it}.$$

For the disaster-only regressions, we also conduct target country-level analysis in the cross-section, by computing country average FDI flow across years, separately before and after 2015 $\overline{FDI_{igT}}$. For this analysis level we compute sums of the number of disaster events and average values of macroeconomic controls $\overline{M_{iT}}$, also before and after 2015. These regressions are estimated with country group and post-COP21 ($Post$) fixed effects.

$$\overline{FDIY_{igT}} = \alpha_g + (\sum_{t<=2015} CD'_{it})\boldsymbol{\beta}_1 + (\sum_{t>2015} CD'_{it})\boldsymbol{\beta}_2 + \beta_3 Post + \overline{M_{iT}}'\boldsymbol{\gamma} + \varepsilon_{iT},$$

where T takes on two values — before COP21 and after. Here standard errors ε are also clustered at the region level.

4.2 Bilateral level regressions

Bilateral regressions are also estimated as a panel, in the main specification, as well as cross-section averages, for disaster-only analysis. For the intensive margin and similar to the firm-level analysis, FDI are measures as a change in the FDI position going to target country i from source country j

scaled by total FDI position from country j in the previous year,

$$\Delta fdi_{ijt} = \frac{FDI_{ijt} - FDI_{ijt-1}}{\sum_i FDI_{ijt-1}}.$$

For the extensive margins, we use an indicator $\mathrm{I}(\Delta fdi_{ijt} > 0)$ as a 0/1 measure of inflows and $\mathrm{I}(\Delta fdi_{ijt} > 0)$ as a 0/1 measure of outflows. We estimate intensive margin by OLS and PPML and we estimate extensive margin by linear probability model.[22]

In the panel specification, we include country-pair and year fixed effects when estimated by OLS and PPML. Note that country-pair fixed effects absorb all standard gravity variables. Standard errors are clustered on country-pair (OLS) and target-country region (PPML), respectively. We denote source country as j and target country as i (that is, FDI flows are measured $j \longrightarrow i$. We include all variables of interest as well as macro controls for both source and target countries. For both OLS and PPML specifications we thus have

$$\begin{aligned}\Delta fdi_{ijt} = \alpha_{ij} + \alpha_t + CD'_{it-1}\boldsymbol{\beta}_{t1} + CD'_{jt-1}\boldsymbol{\beta}_{s1} + \beta_{t2}EPS_{it-1} + \beta_{s2}EPS_{jt-1} + \beta_{t3}\,\mathrm{I}(Tax_{it-1}) \\ +\beta_{s3}\,\mathrm{I}(Tax_{jt-1}) + \beta_{s4}z_{it-1} + \beta_{t4}z_{jt-1} + M'_{it-1}\boldsymbol{\gamma_s} + M'_{jt-1}\boldsymbol{\gamma_t} + \varepsilon_{ijt}.\end{aligned}$$

Specification for extensive margins is the same with the indicators $\mathrm{I}(\Delta fdi_{ijt} > 0)$ and $\mathrm{I}(\Delta fdi_{ijt} > 0)$ replacing Δfdi_{ijt}. We estimate similar set of regressions for the specifications with interactions with emission productivity in target country.

For disaster-only regressions, we repeat the approach described above for the country level, now including disaster and vulnerability measures for both source and target countries. Again we use both OLS and PPML estimators. With OLS, we include country-pair and source-year fixed effects; with PPML, we include country-pair and only year fixed effects but add source climate and macroeconomic controls.

Finally, we construct a bilateral cross-country panels for before and after 2015, in a similar way to the target country panel. In all regressions we include country-pair fixed effects and cluster standard errors on target-country region.

4.3 Country-industry level regressions

We next turn to regression analysis of FDI at industry level. Country-industry level data are only available for target countries i. The measure of FDI we use for intensive margin is similar to the target-country panel regressions, except we scale FDI by country-industry value added. As before, we construct 0/1 indicators of inflows and outflows for extensive margins as FDI inflows being positive or negative, respectively. All regressions are estimated by OLS with country-industry and industry-year fixed effects. Standard errors are clustered at country-industry level.

[22] Probit regressions are not identified for models with a large number of fixed effects, while logit regressions do not always converge.

Disaster, policy, and macro variables are only available at country level, while emission productivity varies by country and industry. Thus, the regression equation becomes

$$FDIVA_{ikt} = \alpha_{ik} + \alpha_{kt} + CD'_{it-1}\boldsymbol{\beta}_1 + \beta_2 EPS_{it-1} + \beta_3 \,\mathrm{I}(Tax_{it-1}) + \beta_4 z_{ikt-1} + M'_{it-1}\boldsymbol{\gamma} + \varepsilon_{ikt},$$

where k is the industry indicator.

For disaster-only analysis, we do not include the interaction with *Post* because the data from WIOD are only available through 2016.

For the regressions with interactions with emission productivity, we are able to estimate a fully saturated model with country-industry, country-year, and industry-year fixed effects. Main effects of all country-year level climate variables are absorbed by country-year fixed effects. The only variables that varies at country-industry-year level is emission productivity and its interactions with disaster and policy measures:

$$\begin{aligned} FDIVA_{ikt} = \alpha_{ik} + \alpha_{kt} + \alpha_{it} + (z_{ikt-1}CD_{it-1})'\boldsymbol{\beta}_1 + \beta_2 z_{ikt-1} EPS_{it-1} \\ + \beta_3 z_{ikt-1}\,\mathrm{I}(Tax_{it-1}) + \beta_4 z_{ikt-1} + \varepsilon_{ikt}, \end{aligned}$$

4.4 Firm-level regressions

Finally, we turn to the firm level analysis, which allows us to control for the climate risks of both the source country and the target country as well as for characteristics of individual MNEs. In this analysis, the dependent variable is either a change in the share of the total number of a given MNE's affiliates located in a given target country i in a given year (conditional on affiliates being present in both prior and current year), for the intensive margin; a 0/1 indicator of whether a given MNE has new affiliates in a given target country in a given year (whereas there were no affiliates in this country in the previous), for the extensive margin of inflows; or a 0/1 indicator of whether a given MNE closed all its affiliates in a given target country between previous and current year.

In these regressions, when we want to study effects of disasters and policies at both source and target country levels, we only include firm (MNE), target country, year, and affiliate industry fixed effects. In disaster-only regressions, because we are not looking at source country effects, and in regressions with emission productivity interactions, we replace firm and year fixed effects with firm times year fixed effects. Emission productivity is measured at a source-country and target-country level. We can now include a firm-level measure of climate change risk CCR_{ft}, which varies by firm and year. Standard errors are clustered two-way, at firm and target country levels.

The regression for the main effects of disaster and policy variables is as follows

$$\begin{aligned} \Delta Naff_{fjikt} = \alpha_f + \alpha_i + \alpha_k + \alpha_t + CD'_{it-1}\boldsymbol{\beta}_{t1} + CD'_{jt-1}\boldsymbol{\beta}_{s1} + \beta_{t2} EPS_{it-1} + \beta_{s2} EPS_{jt-1} \\ + \beta_{t3}\,\mathrm{I}(Tax_{it-1}) + \beta_{s3}\,\mathrm{I}(Tax_{jt-1}) + \beta_{s4} z_{it-1} + \beta_{t4} z_{jt-1} + \beta_5 CCR_{ft-1} + M'_{it-1}\boldsymbol{\gamma_s} + + \varepsilon_{fit}, \end{aligned}$$

where $Naff_{fjitk}$ is the number of affiliates MNE f headquartered in country j has in country i industry k in year t. As before, we use the same specification for the regression with interactions with emission productivity in target country, except we include firm-year fixed effects which absorb all main effects of source-country variables as well as the main effect if the firm-level climate change exposure.

To study whether firms' climate risk exposure CCR leads to a differencial effects of climate disasters and policies, we also estimate the following regression that includes firm-target country, firm-year, target country-year and target industry fixed effects. For this analysis compute relative policy measures as target country EPS minus source country EPS, and an indicator for target country CO2 tax and an indicator for both source and target countries' CO2 tax. All main effects are absorbed by fixed effects, with only interactions estimated off the firm-target country-time variance. For the disaster data, only interactions with target-country disasters are included.

$$\begin{aligned}\Delta Naff_{fjikt} = \alpha_{fi} + \alpha_{ft} + \alpha_{it} + \alpha_k + (CCR_{ft-1} * CD'_{it-1}\boldsymbol{\beta}_1 + \beta_2 CCR_{ft-1}(EPS_{it-1} - EPS_{jt-1}) \\ + \beta_3 CCR_{ft-1}\,\mathrm{I}(Tax_{it-1}) + \beta_4 CCR_{ft-1}\,\mathrm{I}(Tax_{it-1} * Tax_{jt-1}) + \varepsilon_{ijt}.\end{aligned}$$

Similar regressions are estimated for the extensive margins of inflows and outflows. In addition to advanced and emerging economies subsamples, we estimate all regressions for the subsample of MNEs with headquarters located in offshore financial centers (OFCs).

5 Results

Because of the large number of specifications, we summarize our empirical results first in terms of significance and sign and then in terms of magnitudes. We focus on both intensive and extensive margins and we conduct our analysis for the full sample as well as for subsamples of advanced and emerging economies. We summarize main effects of physical and transition risks as well as the effects of their interactions with emission productivity, to confront our model predictions. Full regressions are reported in the Appendix.

It is important to emphasize that we do not view our empirical analysis as testing model predictions. The model provides structure that helps us organize the interpretation of the results. However, the model makes an important assumption that MNEs fully internalize climate-related risks in their affiliate location decisions. Given that our emissions data and therefore majority of our regressions only go as far as 2016, we do not expect most firms to be attentive to such risks. Therefore, we view our model predictions as an "ideal world" benchmark for the firms' expected reaction to climate-related shocks.

5.1 Significance and signs

We begin by summarizing our results relative to model predictions. The results are reported in Table 1 for main effects as well as for emission interactions. We first list the sign of model predictions and then report the count of significant positive and significant negative coefficients, with the third number in each cell listing the number of specifications available.

We can see that in most cases we do not find significant effects of climate disasters, regardless of their types. However, whenever the effects are significant, most of them are consistent with model predictions: when climate-related disasters occur or policy tightens, FDI inflows fall the following year, both along intensive and along extensive margins. Importantly, we do not observe predominantly significant results that contradict model predictions (i.e., no red cells in the table). While in an occasional specification the main effect of climate disasters on FDI flows in the following year is positive, none of these results are robust.

We do not see a consistent significant effect of EPS score, indicating that either EPS is a poor proxy for the future transition risk or that firms are not incorporating such risks in their decision making. We do find that the introduction of CO2 tax reduces FDI flows to emerging economies in the following year, as predicted by the model, only in terms of reduced inflows on both intensive and extensive margins rather than increased outflow.[23]

Finally, we do not see a significant effect of higher emission productivity, except as a main effect in the regressions where we include interactions of disaster and policy variables with emission productivity. Our model predicts that higher emission productivity will increase FDI flows. We observe this effect for advance economies in the absence of physical or transition risks. However, this positive effect of emission productivity is offset for countries that have higher transition risk, as proxied by higher EPS, consistent with model Proposition 3.

5.2 Magnitudes

Most of our climate-risk variables are either 0/1 indicators, or distributed between 0 and 1, or have mean between 0 and 1. Appendix Table A.3 reports summary statistics for these variables in our target-country data set. Thus, we can compare the regression coefficients directly, without standardizing them. One exception is EPS that varies between 1 and 4.1 with the mean 1.56.

We summarize magnitudes of the effects in two ways: first, we combine all the coefficients from different regression specifications in a heatmap, where the coefficients are compared to each other, regardless of their significant level, within each aggregation level but across intensive and extensive margins and across all regressors. We present these for three sets of specifications: first, only looking at the effects of climate-related disasters in target countries, which allows us to include interaction with the post-COP21 dummy (Figure 12); second for the main effects of all variables included

[23] We also estimated the coefficients of the interaction between the physical risk variables and the transition risk variables, they turn out largely insignificant.

together in the regressions (Figure 13); third for the interactions with emission productivity, where we only report the main effect of emission productivity, but omit any other main effects that are not captured by the fixed effects (Figure 14). Coefficients in bold in the heatmaps are the ones that are statistically significant at 10% level at the least.

We also construct plots of the changes in FDI as predicted by the regressions that include interactions of emission productivity with climate policies and disasters. Since the specification with most significant coefficients is bilateral PPML intensive-margin regression, we base the plots on these estimates for illustrative purposes. The plots are reported in Figures 15-17.

Disasters and vulnerability

Figure 12 summarizes the results of specifications in which we only include target country physical risk measures (climate disasters or, in a separate regression, climate vulnerability) and interact them, when possible with an indicators *Post* that takes on a value of 1 post-COP21 (from year 2016 on). Red-colored cells are those with most negative effect (reduction in FDI inflows or reduction in FDI outflows), while green- or blue- colored cells are those with most positive effects, regardless of statistical significance.

Eight different aggregation levels are included: (1) target country cross-section averages before and after 2015; (2) country-pair cross-section averages before and after 2015 estimated by OLS; (3) country-pair cross-section averages before and after 2015 estimated by PPML; (4) target country panel; (5) country-pair panel estimated by OLS; (6) country-pair panel estimated by PPML; (7) target country-industry panel; (8) firm-level panel. The heatmap lists dependent variables as well as fixed effects and sample years included in each specification. Because country-industry data are not available after 2016, this specification does not include interactions with *Post*.

We do observe a number of specifications in which the effects of climate disasters on FDI are negative, as model predicts, and in some cases these effects are stronger after COP21. However, this pattern is not robust across specifications and does not carry through to the regression where climate disasters are replace with vulnerability measures. In fact, the effects of vulnerability measures appear to be reversed following COP21.

It is also important to note that the effects are generally small. Consider target country panel regressions (top right segment of Figure 12), where the effects are the largest. The 2019 median FDI inflow to GDP share among advanced countries in our sample is 2.51 percent, while for emerging economies it is 2.18 percent. A climatological or a hydrological disaster in an advanced economy would reduce this share by 0.3 percentage points to 2.2 percent, while in an emerging economy one of such events will reduce the share by 0.09 percentage points to 2.1 percent.

One paper in the literature which allows us to make a direct comparison of the magnitudes of the effects in our analysis is Escaleras and Register (2011). This study is using a collapsed cross-section of FDI inflows across countries, which corresponds to our cross-section target country regression.

The authors find that one additional natural disaster, which may not be climate-related, reduces FDI inflows by 0.02-0.06 percent of GDP. In our regressions we see an additional climatological disaster associated with an increase in FDI inflows to target country by 0.03 percent of GDP on average, while a hydrological disaster is associated with a decline in FDI inflows by 0.007 percent of GDP. Thus, the magnitudes of the effects we find are in the same ballpark as in the literature.

Main effects and interactions with emission productivity

Figure 13 reports the results of the specifications with only main effects of climate-risk measures included, while Figure 14 reports interactions with emission productivity as well as main effect of emission productivity, with other main effects omitted or absorbed by fixed effects. We conduct this analysis at four aggregation levels: (1) target country panel; (2) country-pair panel estimated by PPML (for intensive margins) and OLS (for extensive margins); (3) target country-industry panel; (4) firm-level panel.

We see that emission productivity has the largest magnitude impact on FDI, with FDI to advanced economies falling with emission productivity along intensive margin and FDI to emerging economies increasing with emission productivity (consistent with model Proposition 3) along intensive, but not extensive margin.

Between physical and transition risk, we observe that policy variables tend to have a larger impact than climate disasters in terms of magnitude, in most cases in the direction predicted by the model. We also note that most source-country variables, including firm-level climate risk exposure in the firm-level regressions, do not have much impact on FDI.

Between advanced and emerging economies, transition risk variables appear to have more negative impact on advanced than emerging economies' FDI intensive margin. Since emission productivity is generally lower in emerging economies (as shown in Figure 4), the effects of EPS and CO2 tax on FDI are broadly consistent with model Proposition 3 (the case of "Better Loses").

Turning to emission productivity interaction effects, we find that climate policies in source countries tend to reduce FDI into emission-productive target countries, which is a counterintuitive funding. Meanwhile, CO2 tax in target countries tend to increase FDI into emission-productive target countries (except for the bilateral-PPML intensive margin result). This finding is consistent with the model case of "Better Wins" where countries with low emission productivity are more negatively affected by climate risks. The interaction result of EPS with emission productivity is mixed.

To better see combined effects of policies, emission productivity and disasters, including all main effects and interactions, we construct illustrative charts that are based on the results of bilateral panel data estimation using PPML, the specification with the largest number of significant coefficients. The results are presented in Figures 15-17 for full sample, advanced, and emerging economies. The effects of source countries, control variables, and fixed effects are all set to zero.

We can see from Figure 15 that for the full sample only climatological disasters have a negative effect on FDI (red plane lies below the blue one), while other two types of disasters have positive effects (red plane is on top of the blue one). Regardless of the sign, these effects are small compared to the effects of emission productivity or climate policies.

We find that for high levels of emission productivity, the effect of EPS is positive while the effect of CO2 tax is negative — that is, for low-polluting countries, increase in environmental protection is associated with higher FDI, while CO2 tax is associated with lower FDI. However, for low emission productivity countries, there is no effect of EPS or CO2 tax on FDI. This is broadly consistent with model prediction (Proposition 3) which shows that for high levels of emission productivity, CO2 tax policies are likely to have an amplified effect on FDI.

For advanced economies (Figure 16), the effects of climate disasters are mostly positive (red plane above the blue plane), especially for countries with high emission productivity (red plane shifting up more from blue plane for higher levels of emission productivity). While partially at odds with our model, these results are consistent with Doytch (2020) who finds an initial increase in FDI following climate-related disasters. Moreover, the effects of EPS and CO2 tax are positive for countries with low emission productivity and negative for countries with high emission productivity, which is consistent with model Proposition 3 as well.

For emerging economies (Figure 17), there is a small positive effect of climate disasters on FDI, while the effects of EPS are similar to the full sample. For both EPS and CO2 tax, we observe a positive effect for high emission productivity countries, and a slightly negative effect for low emission productivity, which is the opposite of Proposition 3 prediction but is consistent with the model case of "Better Wins".

Source-target relative policies

In our bilateral and firm-level analysis we can also replace source and country policy variables, with relative ones.[24] We find that stricter environmental policies in the target country relative to the source country actually reduce the share of affiliates the firm chooses to locate in that target country, which is in contrast with our country-level results and points to the likely presence of composition effects when analyzing aggregate data. This result is consistent with our model's transition risk channel. It is also in line with findings in the literature that MNEs in industrial countries, like the U.S., "exports" their emissions (López and Arce, 2019). Moreover, on average, if a target country has a CO2 tax, MNEs increase the share of affiliates in that country, however this result is driven by the difference between AEs and EMEs rather than by differences within these groups of target countries. Here we also see a difference for MNEs located in OFCs — they are less likely to have affiliates in target countries with CO2 tax. If both source and target countries have a tax on CO2 emissions, FDI presence is more likely for EME targets, but less likely for AE

[24]The results are available upon request.

targets.

5.3 The role of firm-level climate exposure

Our interpretation of the results so far is that, while we find some evidence in support of model predictions and therefore of firms reactions to climate risks, the effects are generally small and not very robust. This implies the decisionmakers in MNEs do not fully take into account the effects of climate risks. To test this implication, we consider interactions of physical and transition risk measures in target countries with firm-level measure of climate risk (CCR) and expect firms that are more exposed to climate risks to react more to them. The results are reported in Table 3, where we include firm-target country, firm-year, target country-year, and target industry fixed effects, so that all main effects and controls are absorbed.

We find that the effects of natural disasters and relative EPS do not vary significantly with CCR, except with a couple of exceptions that generally go in the direction of exacerbating main effects. This means that firms that discuss climate risks more do not in general react differently to climate-related natural disasters and to changes in environmental policies than other firms. One notable exception is closing affiliates in emerging target countries — firms that are more exposed or attentive to climate risks are more likely to close their affiliates in emerging economies following climatological disasters or tightening of environmental protection in these countries.[25] This is consistent with our hypothesis that increasing attention to climate change risks increases reaction of MNEs to changes in these risks.

For the cases when target country has a CO2 tax while headquarter country does not, we observe firms that are more exposed to climate risks increasing outflow of FDI from advanced economies and decreasing inflow to emerging economies. When both countries have a tax on CO2, firms that are more sensitive to climate risks appear to be a reallocating their affiliates on both intensive and extensive margins from advanced to emerging economies. For the full sample, firms that are more sensitive to climate risks, reduce FDI inflows along both intensive and extensive margins when both countries have CO2 tax, unless MNEs are headquartered in OFCs, in which case there is an increase in inflows along the intensive margin.

While not all these results are clear-cut, they generally show that firms that recognize their climate exposure are less likely to locate affiliates in countries with higher transition risks, which supports our interpretation of overall results.

[25]The effect of meteorological disasters is the opposite, which also amplifying the effects, because meteorological disasters tend to have a positive effect in most specifications.

6 Conclusion

We can now return to the question we posed in the beginning of the paper: Do multinational firms incorporate physical and transition climate risks into their location decisions? By comparing the predictions of our theoretical framework with our empirical results, we can see that the answer is "No quite" or "Not yet." Our comprehensive empirical analysis finds only weak evidence of firms' responses to climate related risks in the direction predicted by the model. It is, however, encouraging that we do not find any robust significant effects that contradict model predictions.

One of our contributions to the literature is a model that reveals that firms' reactions to climate risks may not be straightforward in an environment where technologies adapt to such risks. Although in our data we find little evidence of such adaptation to date, going forward this result may become important for the analysis. We also find evidence that attention of multinationals to climate-related risks started to rise following Paris Climate Accord and that firms that are more attentive to climate risks react more to our proxies of climate mitigation policies.

Taken together, our results imply that in the future one should expect an increased attention of the firms to climate risks that may lead to substantial reallocation of global production as climate-related shocks intensify. In fact, lack of consistent or sizeable response of FDI to climate shocks in the data suggests potential for large and abrupt changes going forward, especially if stricter climate mitigation policies are adopted around the world.

References

Barua, Suborna, Sisira Colombage, and Ernesto Valenzuela, "Climate Change Impact on Foreign Direct Investment Inflows: A Dynamic Assessment at the Global, Regional and Economic Level," SSRN Working Paper 3674777 2020.

Bloom, Nicholas, Christos Genakos, Ralf Martin, and Raffaella Sadun, "Modern Management: Good for the Environment or Just Hot Air?*," *The Economic Journal*, 2010, *120* (544), 551–572.

Boyd, G.A., "Comparing the statistical distributions of energy efficiency in manufacturing: meta-analysis of 24 Case studies to develop industry-specific energy performance indicators (EPI)," *Energy Efficiency*, 2017, *10*, 217–238.

Cevik, Serhan and Jo ao Tovar Jalles, "Feeling the Heat: Climate Shocks and Credit Ratings," International Monetary Fund Working Paper WP/20/286 2020.

Chang, Oetzel-Jennifer Hoon Oh, "Multinationals' response to major disasters: how does subsidiary investment vary in response to the type of disaster and the quality of country governance?," 2010.

Choi, Darwin, Zhenyu Gao, and Wenxi Jiang, "Attention to Global Warming," *The Review of Financial Studies*, 02 2020, *33* (3), 1112–1145.

Cortés, Kristle Romero and Philip E. Strahan, "Tracing out capital flows: How financially integrated banks respond to natural disasters," *Journal of Financial Economics*, 2017, *125* (1), 182–199.

Degryse, Hans, Roman Goncharenko, Carola Theunisz, and Tamas Vadasz, "When Green Meets Green," Centre for Economic Policy Research Discussion Paper DP16536 2021.

Dell, Melissa, Benjamin F. Jones, and Benjamin A. Olken, "What Do We Learn from the Weather? The New Climate-Economy Literature," *Journal of Economic Literature*, September 2014, *52* (3), 740–98.

Doytch, Nadia, "Upgrading destruction? International Journal of Climate Change Strategies and Management," 2020.

Eaton, Jonathan and Samuel Kortum, "Technology, Geography, and Trade," *Econometrica*, 2002, *70* (5), 1741–1779.

Ehlers, Torsten, Frank Packer, and Kathrin de Greiff, "The pricing of carbon risk in syndicated loans: Which risks are priced and why?," *Journal of Banking and Finance*, 2022, *136*, 106180.

Escaleras, Monica and Charles A. Register, "Natural Disasters and Foreign Direct Investment," *Land Economics*, 2011, *87* (2), 346–363.

Feng, Alan and Haishi Li, "We Are All in the Same Boat: Cross-Border Spillovers of Climate Risk Through International Trade and Supply Chain," *IMF Working Paper*, 2021, *2021* (013).

Helpman, Elhanan, Marc J. Melitz, and Stephen R. Yeaple, "Export Versus FDI with Heterogeneous Firms," *American Economic Review*, March 2004, *94* (1), 300–316.

Hsiang, Solomon, "Climate Econometrics," *Annual Review of Resource Economics*, 2016, *8* (1), 43–75.

_ and Robert E. Kopp, "An Economist's Guide to Climate Change Science," *Journal of Economic Perspectives*, November 2018, *32* (4), 3–32.

Ivan, Machiavelli Marco Santos Joao A.C. Ivanov, "Bank Lending Networks and the Propagation of Natural Disasters," 2020.

Javadi, Siamak and Abdullah Al Masum, "Using Weather Data and Climate Model Output in Economic Analyses of Climate Change," *Journal of Corporate Finance*, 2021, *69*, 102019.

Kacperczyk, Marcin and José Luis Peydró, "Carbon Emissions and the Bank-Lending Channel," Center for Economic Policy Research Discussion Paper DP16778 2021.

Klomp, Jeroen, "Flooded with debt," *Journal of International Money and Finance*, 2017, *73*, 93–103.

Lemoine, Derek, "Estimating the Consequences of Climate Change from Variation in Weather," Centre for Economic Policy Research Discussion Paper DP16194 2021.

Mallucci, Enrico, "Natural Disasters, Climate Change, and Sovereign Risk," *FRB International Finance Discussion Paper*, 07 2020, (1291).

Mueller, Isabella and Eleonora Sfrappini, "Climate change-related regulatory risks and Bank lending," 2021.

Neise, Thomas, Franziska Sohns, Moritz Breul, and Javier Revilla Diez, "The effect of natural disasters on FDI attraction: a sector-based analysis over time and space," *Natural Hazards*, 2022, *110*, 999–1023.

Pankratz, Nora M. C., "Climate Change, Firm Performance, and Investor Surprises," SSRN Working Paper 3443146 2019.

_ and Christoph Schiller, "Climate Change and Adaptation in Global Supply-Chain Networks," European Corporate Governance Institute – Finance Working Paper 775/2021 June 2021.

Ramondo, Natalia, "A quantitative approach to multinational production," *Journal of International Economics*, 2014, *93* (1), 108–122.

Razin, Assaf, Efraim Sadka, Mihir A. Desai, and Deborah Swenson, "Productivity and Taxes as Drivers of Foreign Direct Investment [with Comments and Discussion]," *Brookings Trade Forum*, 2007, pp. 105–148.

Reghezza, Alessio, Yener Altunbas, David Marques-Ibanez, Costanza Rodriguez d'Acri, and Martina Spaggiari, "Do Banks Fuel Climate Change?," ECB Working Paper 2021/2550 2021.

Roncoroni, Alan, Stefano Battiston, Luis O.L. Escobar-Farfán, and Serafin Martinez-Jaramillo, "Climate risk and financial stability in the network of banks and investment funds," *Journal of Financial Stability*, 2021, *54*, 100870.

Russ, Katheryn, "The endogeneity of the exchange rate as a determinant of FDI: A model of entry and multinational firms," *Journal of International Economics*, 2007, *71* (2), 344–372.

Sautner, Zacharias, Laurence van Lent, Grigory Vilkov, and Ruishen Zhang, "Firm-level Climate Change Exposure," 2020.

_ , _ , _ , and _ , "Data for: Firm-level Climate Change Exposure," Jun 2021.

Silva, J.M.C. Santos and Silvana Tenreyro, "PPML: Stata module to perform Poisson pseudo-maximum likelihood estimation," Statistical Software Components, Boston College Department of Economics October 2015.

Timmer, Marcel P., Erik Dietzenbacher, Bart Los, Robert Stehrer, and Gaaitzen J. de Vries, "An Illustrated User Guide to the World Input–Output Database: the Case of Global Automotive Production," *Review of International Economics*, 2015, *23* (3), 575–605.

Wang, Pengji, Huiping Zhang, and Jacob Wood, "Chapter 7 - Foreign Direct Investment, Natural Disasters, and Economic Growth of Host Countries," in Taha Chaiechi, ed., *Economic Effects of Natural Disasters*, Academic Press, 2021, pp. 97–117.

Ángeles Zafrilla-Jorge López Luis-Antonio, Cadarso María and Guadalupe Arce, "The carbon footprint of the U.S. multinationals' foreign affiliates," *Nature Communications*, 04 2019, *10* (1).

Figure 1: Comparative Statics: Emission Productivity Distribution: Better Loses

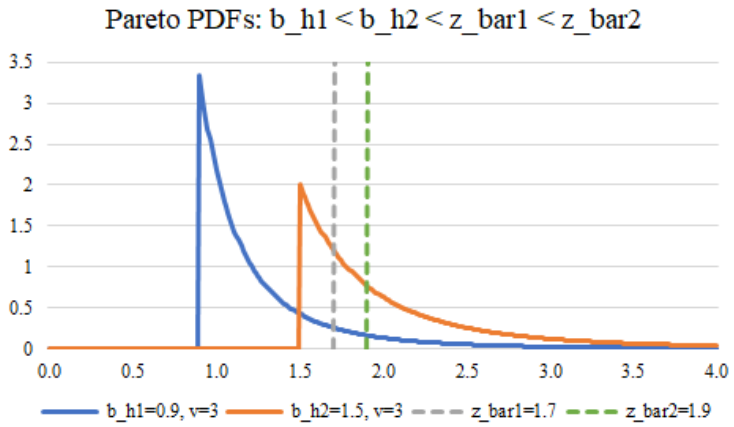


Figure 2: Comparative Statics: Emission Productivity Distribution: Better Wins

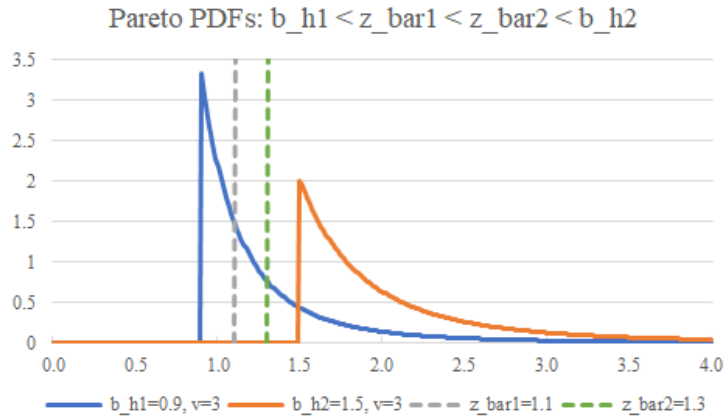


Figure 3: Comparative Statics: Emission Productivity Distribution: No Effect

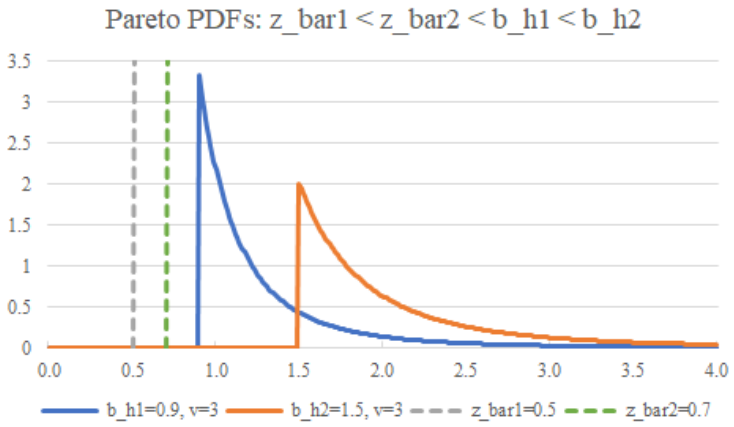


Figure 4: Histogram of Country Average Emission Productivity by Group

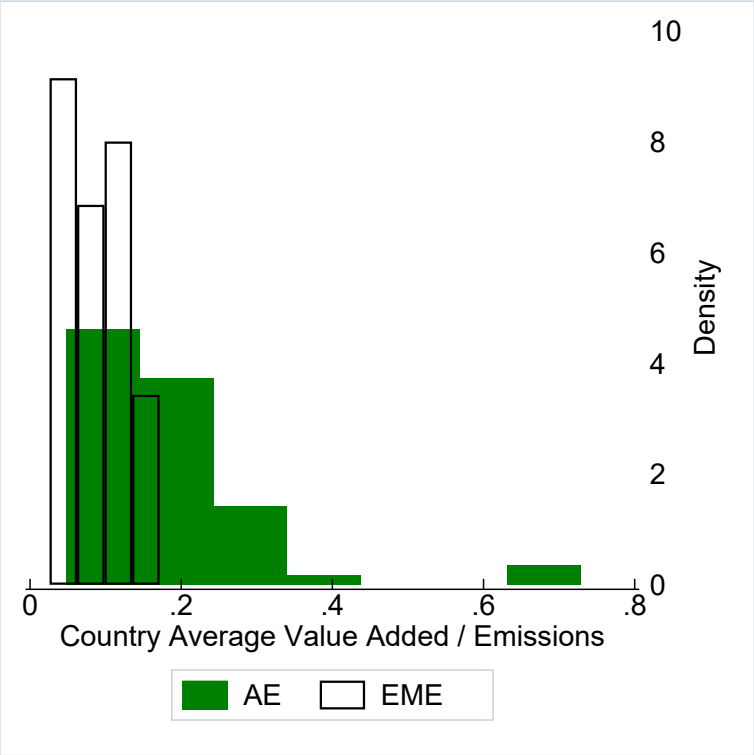


Figure 5: Climate-related disaster events by type

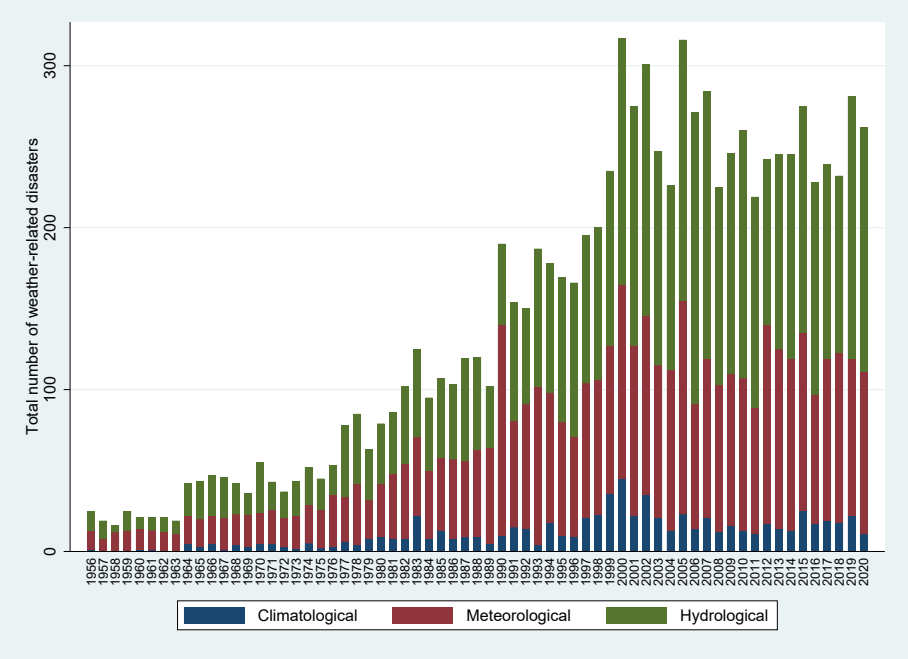


Figure 6: Climate-related disaster events by country group

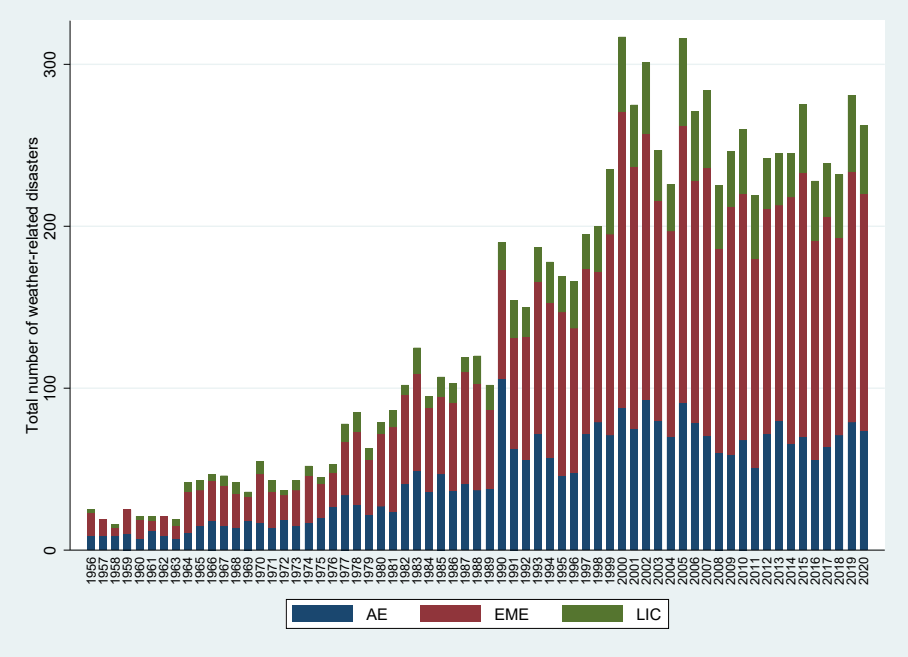


Figure 7: Climate-related disaster events

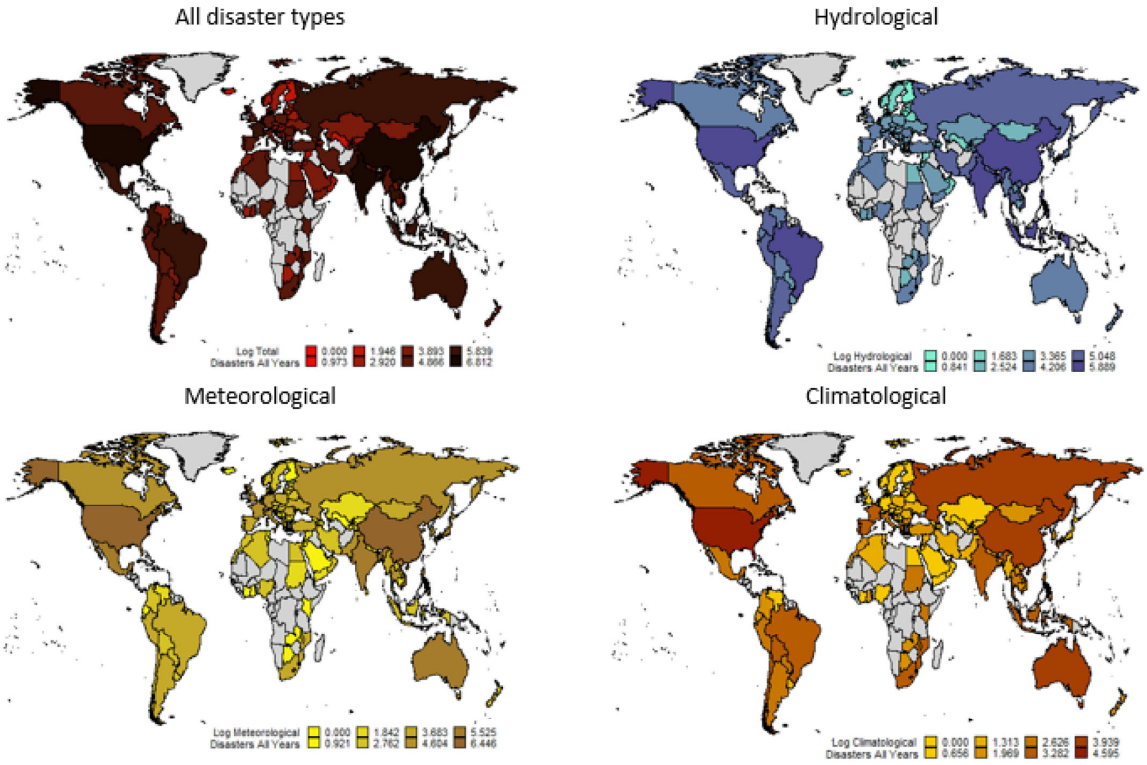


Figure 8: Frequency of climate-related disaster events by region

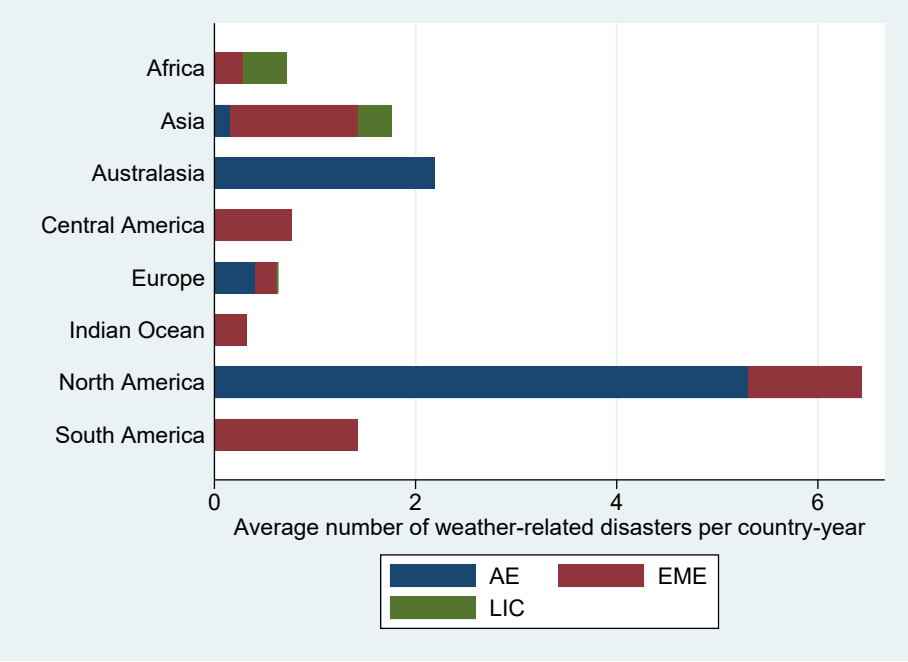


Figure 9: Environmental policy stringency

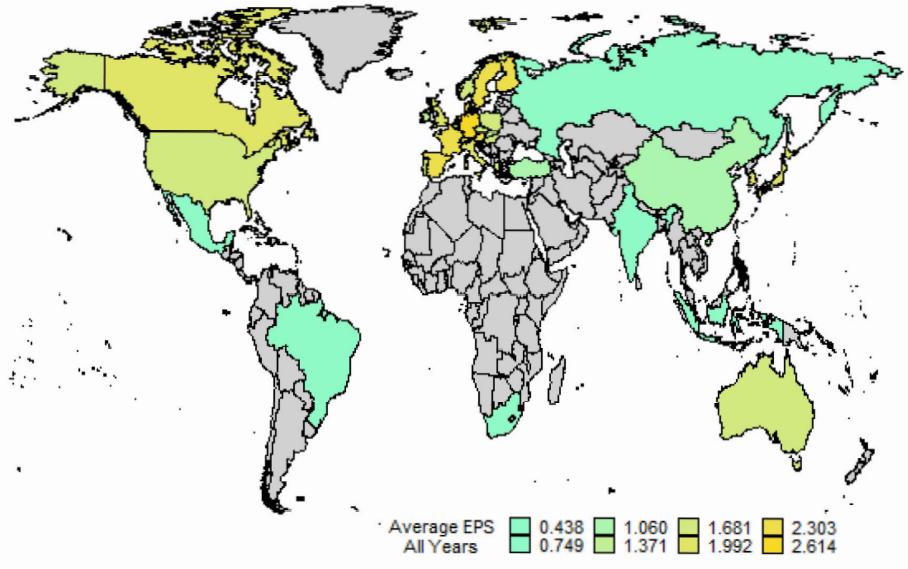


Figure 10: Average annual change in net FDI inflows

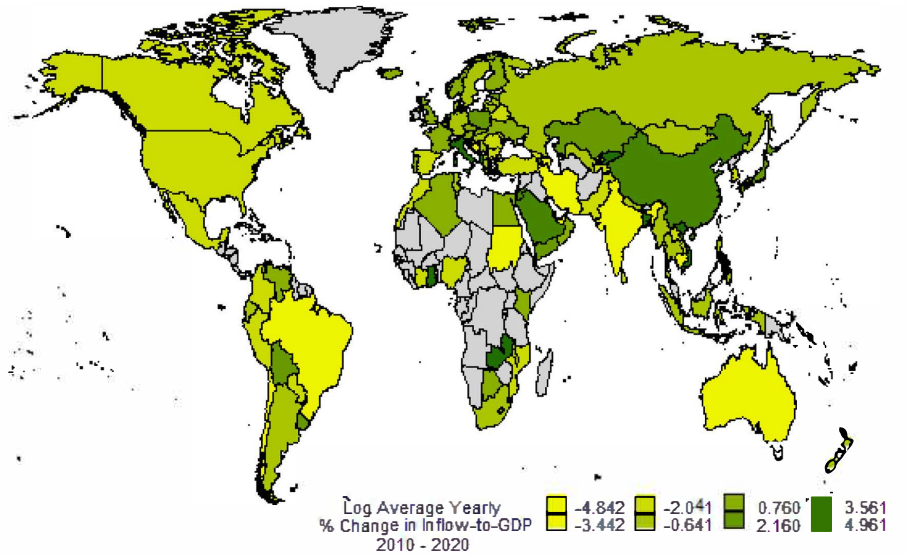


Figure 11: Climate change risk index

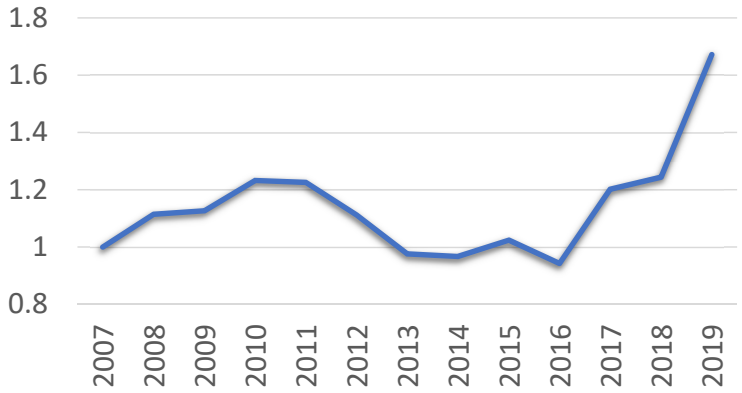


Figure 12: Interactions with Post-COP21

Aggregation level:	**X-section TC**			**X-section Bilateral**			**X-section bilateral PPML**			**Target country**		
	Full	AE	EME	Full	AE	EME	Full	AE	EME	Full	AE	EME
Sample years	pre/post 2015 aggregate			pre/post 2015 aggregate			pre/post 2015 aggregate			1970(96)-2019		
FEs	Country group			TC, SC			TC, SC			TC, Year, CG*Year		
LHS	TC inflow/GDP			D.FDI / Total FDI from SC			D.FDI / Total FDI from SC			TC inflow/GDP		
Effect on FDI (intensive margin)												
reg1												
Climatological	**0.029**	**0.043**	-0.016	0.011	0.104	**-0.003**	**0.046**	**-0.073**	**-0.050**	**-0.309**	-0.334	-0.094
Meteorological										0.013	0.007	0.009
Hydrological	-0.007	-0.030	0.000	-0.002	-0.033	0.000	**0.023**	**0.034**	**0.044**	**-0.112**	**-0.311**	-0.085
Post*C	0.249	0.195	-0.148	0.014	0.103	-0.001	**-0.064**	-0.018	-0.027	**0.979**	1.444	-0.121
Post*M										**-0.108**	-0.337	-0.064
Post*H	0.015	0.060	0.023	-0.001	-0.042	0.000	**0.036**	**-0.057**	**0.046**	**0.167**	0.858	**0.172**
reg2												
Vulnerability	**-3.674**	17.55	-3.509	4.42	16.23	**0.89**	9.29	-42.35	-10.49	-23.8	4.8	-34.5
Post*Vulnerability	**12.38**	-16.10	**5.713**	0.54	2.07	**0.09**	**5.98**	**13.04**	6.29	6.0	-15.1	**15.7**

Aggregation level:	**Bilateral OLS**			**Bilateral-PPML**			**Target Country-industry**			**Firm**		
	Full	AE	EME	Full	AE	EME	Full	AE	EME	Full	AE	EME
Sample years	2010-2019			2010-2019			2006-2014(19)			2008-2019		
FEs	TC*SC, SC*Year			TC*SC, Year			TC*TI, TI*Year			Firm*Year, TC, TI		
LHS	D.FDI / Total FDI from SC			D.FDI / Total FDI from SC			TC Inflow/VA			D.Aff in TC/Total aff		
Effect on FDI (intensive margin)												
reg1												
Target:												
Climatological	-0.003	-0.007	-0.007	0.037	-0.297	-0.006	0.019	0.096	-0.077	-0.0035	**-0.0056**	**0.0022**
Meteorological	0.013	**0.021**	0.004	**-0.062**	-0.110	-0.008	-0.015	-0.001	-0.047	0.0004	**0.0014**	**-0.0010**
Hydrological	-0.009	-0.031	-0.001	**0.167**	**0.182**	**0.193**	0.000	-0.011	-0.074	-0.0002	0.0012	-0.0001
Post*C	0.002	0.020	0.009	**0.330**	0.279	**1.037**				-0.0006	0.0024	**-0.0026**
Post*M	0.000	0.014	0.002	-0.041	0.040	-0.050				**0.0005**	-0.0019	**-0.0004**
Post*H	0.001	-0.055	-0.002	0.001	**-0.190**	-0.028				**-0.0009**	**-0.0014**	0.0004
reg2												
Vulnerability	1.817	11.09	-1.783	0.63	1.18	**0.20**	5.19	5.71	-27.31	-0.1460	-0.0397	0.1760
Post*Vulnerability	0.364	1.17	0.065	0.44						**0.0275**	-0.0275	0.0086
Effect on FDI (extensive: inflow)												
reg1	I(D.FDI / Total FDI from SC>0)						I(TC Inflow/VA>0)			I(new affiliates in TC)		
Climatological	0.022	0.046	0.007				0.010	0.005	0.024	-0.0077	**-0.0114**	**0.0103**
Meteorological	**-0.007**	-0.014	-0.003				-0.009	-0.008	-0.005	0.0003	0.0014	-0.0025
Hydrological	-0.001	-0.001	-0.005				0.007	0.012	0.000	**-0.0013**	-0.0008	-0.0004
Post*C	-0.023	-0.053	-0.007				**-0.033**	-0.021	**-0.125**	0.0010	0.0056	**-0.0129**
Post*M	0.003	0.014	0.000				0.007	0.007	0.013	-0.0001	-0.0013	**-0.0020**
Post*H	0.001	-0.007	0.003				-0.013	-0.025	0.010	**-0.0018**	**-0.0022**	0.0005
reg2												
Vulnerability	2.775	5.100	4.175				-1.12	-1.76	-12.02	-0.6550	-0.1300	-0.3720
Post*Vulnerability	0.205	-0.062	**-0.479**				0.03	-0.04	**1.14**	**0.0770**	-0.0370	0.0120
Effect on FDI (extensive: outflow)												
reg1	I(D.FDI / Total FDI from SC<0)						I(TC Inflow/VA<0)			I(no more affiliates in TC)		
Climatological	0.021	0.007	0.012				-0.015	-0.003	-0.033	-0.0001	**-0.0012**	0.0013
Meteorological	-0.002	-0.008	0.004				0.001	-0.003	0.003	0.0001	0.0000	**-0.0007**
Hydrological	0.008	0.008	0.005				0.001	-0.008	0.002	0.0000	-0.0002	**0.0005**
Post*C	-0.019	-0.025	0.022				0.022	-0.006	**0.139**	0.0001	0.0013	0.0002
Post*M	0.009	**0.014**	0.004				-0.005	-0.001	-0.013	0.0001	**-0.0030**	**-0.0005**
Post*H	**-0.013**	-0.026	-0.009				0.004	0.019	-0.004	**-0.0005**	0.0000	0.0000
reg2												
Vulnerability	**3.474**	3.022	1.465				2.49	2.34	10.98	-0.1560	-0.1270	0.0344
Post*Vulnerability	0.149	-0.137	0.028				**-0.77**	-0.77	-0.98	**0.0229**	0.0021	-0.0110

Figure 13: Main results summary

Aggregation level:	**Target Country**			**Bilateral-PPML**			**Target Country-industry**			**Firm**		
	Full	AE	EME	Full	AE	EME	Full	AE	EME	Full	AE	EME
Sample years	2001-2016			2010-2016			2006-2014		2009-13	2008-2016		
FEs	TC, Year, CG*Year			TC*SC, Year			TC*TI, TI*Year			Firm, Year, TC, TI		
LHS	TC inflow/GDP			D.FDI / Total FDI from SC			TC Inflow/VA			D.Aff in TC/Total aff		
Effect on FDI (intensive margin)												
Source:												
Climatological				**-0.26**	**-0.30**	**-0.24**				-0.003	**-0.004**	-0.002
Meteorological				0.00	0.03	-0.03				0.000	0.000	-0.001
Hydrological				0.03	0.00	**0.10**				0.000	-0.001	0.000
EPS				-0.20	-0.33	0.17				0.002	0.001	0.004
CO2 Tax				-0.31	0.22	-0.89				0.009	0.021	**-0.007**
Emission productivity				**-7.72**	**-9.72**	-1.57				0.069	0.071	0.058
Climate risk										-0.002	-0.002	0.000
Target:												
Climatological	0.00	-0.04	0.16	**-0.23**	-0.13	0.12	0.004	0.119	-1.879	**-0.011**	**-0.016**	0.001
Meteorological	0.09	0.08	0.05	**0.09**	**-0.04**	0.05	-0.009	-0.002	0.977	0.001	0.001	**-0.002**
Hydrological	-0.16	**-0.32**	-0.14	0.08	**-0.12**	**0.14**	-0.006	-0.039	-0.268	-0.001	-0.002	0.000
EPS	0.16	0.12	1.09	**0.31**	0.00	**1.86**	-0.026	-0.142	17.340	-0.006	-0.006	-0.006
CO2 Tax	0.03	-0.93	2.01	**-1.18**	**-1.09**	**-1.86**				0.009	0.021	**-0.007**
Emission productivity	-15.46	-31.99	23.55	-6.59	-0.69	6.27	-0.340	-2.440	45.670	**-0.239**	-0.120	-0.054
Effect on FDI (extensive: inflow)				Bilateral-Linear								
Sample years				2010-2016			2006-2015		2009-15	2008-2016		
LHS				I(D.FDI / Total FDI from SC>0)			I(TC Inflow/VA>0)			I(new affiliates in TC)		
Source:												
Climatological				**-0.01**	**-0.01**	0.00				-0.005	-0.004	-0.006
Meteorological				0.00	0.00	0.00				0.002	0.002	0.002
Hydrological				**0.00**	**0.01**	0.00				-0.003	-0.003	-0.002
EPS				**-0.02**	**-0.03**	-0.01				**-0.028**	**-0.028**	**-0.027**
CO2 Tax				0.03	0.03	0.02				**0.011**	0.005	**0.028**
Emission productivity				-0.14	-0.20	-0.04				0.315	0.284	**0.400**
Climate risk										0.000	0.001	-0.001
Target:												
Climatological				0.00	0.01	-0.01	0.029	0.055	-0.020	-0.002	-0.005	0.006
Meteorological				0.00	0.00	0.00	-0.022	-0.034	0.032	**-0.001**	0.000	**-0.002**
Hydrological				0.00	0.00	0.00	0.009	0.006	-0.034	-0.001	0.000	-0.001
EPS				0.00	0.00	0.00	0.012	-0.030	0.433	0.003	**0.006**	**0.011**
CO2 Tax				-0.01	0.00	0.01				**0.011**	0.005	**0.028**
Emission productivity				0.01	-0.11	-0.13	**-6.12**	**-5.83**	-28.22	0.148	0.163	**-0.037**
Effect on FDI (extensive: outflow)												
LHS				I(D.FDI / Total FDI from SC<0)			I(TC Inflow/VA<0)			I(no more affiliates in TC)		
Source:												
Climatological				**0.01**	0.01	0.01				0.004	0.004	0.002
Meteorological				**0.00**	**-0.01**	0.00				0.000	0.000	0.000
Hydrological				0.00	0.00	0.00				**0.004**	**0.004**	**0.005**
EPS				0.00	0.00	0.00				-0.006	-0.006	-0.008
CO2 Tax				0.03	0.04	0.01				0.002	**0.010**	0.000
Emission productivity				0.14	0.22	-0.04				-0.008	-0.007	-0.007
Climate risk										0.006	**0.009**	-0.001
Target:												
Climatological				0.00	0.01	0.00	-0.026	-0.039	0.012	**0.002**	0.001	**0.007**
Meteorological				0.00	0.00	0.00	0.006	0.010	-0.023	**0.000**	-0.001	**-0.001**
Hydrological				0.00	0.01	0.00	-0.001	0.002	0.021	0.000	0.000	**0.001**
EPS				0.00	0.01	-0.02	0.038	0.072	-0.270	0.001	0.001	**0.005**
CO2 Tax				**0.03**	0.01	-0.01				0.002	**0.010**	0.000
Emission productivity				-0.24	-0.34	**0.43**	3.117	2.49	30.95	**-0.031**	0.015	-0.076

Figure 14: Interactions with Emission productivity summary

Aggregation level:	**Target Country**			**Bilateral-PPML**			**Target Country-industry**			**Firm**		
	Full	AE	EME	Full	AE	EME	Full	AE	EME	Full	AE	EME
Sample years	2001-2016			2010-2016			2006-2014		2009-13	2008-2016		
FEs	TC, Year, CG*Year			TC*SC, Year			TC*TI, TI*Year, TC*Year			Firm*Year, TC, TI		
LHS	TC inflow/GDP			D.FDI / Total FDI from SC			TC Inflow/VA			D.Aff in TC/Total aff		
Effect on FDI (intensive margin)												
Source:												
Climatological				1.34	**1.84**	**0.55**				**-0.014**	-0.016	**-0.014**
Meteorological				**-1.39**	**-1.65**	**-1.15**				**0.002**	0.003	**0.002**
Hydrological				**0.45**	**0.42**	0.47				-0.002	-0.006	-0.002
EPS				-0.99	**-2.37**	0.47				0.000	0.001	0.000
CO2 Tax				**-7.91**	**-8.39**	-5.57				**-0.043**	**-0.060**	**-0.043**
Emission productivity				**-44.43**	-40.58	-6.05				**0.061**	**0.087**	**0.061**
Climate risk										**-0.019**	**-0.025**	**-0.019**
Target:												
Climatological	-3.47	0.65	-5.69	-0.52	**6.76**	6.03	**2.22**	6.24	-22.16	-0.015	0.088	-0.015
Meteorological	-3.29	**-7.88**	-0.96	0.54	1.06	**6.04**	-0.17	-0.72	-5.96	**0.017**	**0.026**	**0.017**
Hydrological	0.50	-0.32	4.83	**0.76**	**2.95**	**3.00**	-0.91	-2.08	-3.59	-0.003	0.002	-0.003
EPS	**-12.07**	**-14.16**	-7.43	2.60	**-3.61**	**26.96**	-2.20	-2.41	-122.80	-0.025	0.008	-0.025
CO2 Tax	-4.02	**40.87**	-1.49	-5.33	**-68.52**	49.24				0.030	0.021	**0.030**
Emission productivity	**21.22**	**26.31**	6.74	-5.69	**13.58**	**-37.35**	2.05	0.63	293.80	-0.128	-0.242	-0.128
Effect on FDI (extensive: inflow)				Bilateral-Linear Probability								
Sample years				2010-2016			2006-2015		2009-15	2008-2016		
FEs				TC*SC, SC*Year			TC*TI, TI*Year, TC*Year			Firm*Year, TC, TI		
LHS				I(D.FDI / Total FDI from SC>0)			I(TC Inflow/VA>0)			I(new affiliates in TC)		
Source:												
Climatological				-0.02	0.01	-0.03				-0.009	0.002	0.019
Meteorological				0.00	0.00	-0.02				0.002	0.000	-0.001
Hydrological				0.05	0.05	0.04				-0.009	-0.008	-0.007
EPS				0.10	0.14	**0.23**				-0.006	-0.002	0.008
CO2 Tax				-0.01	-0.08	-0.13				-0.055	-0.019	0.030
Emission productivity				-1.31	-0.93	-0.66				0.066	0.029	**0.310**
Climate risk										-0.008	-0.017	0.026
Target:												
Climatological				0.16	0.02	-0.02	**2.64**	**3.20**	-17.45	**-0.102**	0.013	-0.034
Meteorological				-0.06	-0.08	0.04	0.10	0.08	8.62	**0.030**	0.028	**0.064**
Hydrological				0.00	-0.06	-0.01	-0.49	-0.64	-2.00	0.003	0.049	0.008
EPS				0.08	0.02	0.21	**-3.81**	-2.38	-83.48	-0.058	-0.046	-0.323
CO2 Tax				0.06	0.32	-2.97				0.020	0.346	1.040
Emission productivity				-0.29	-0.18	-0.73	-1.00	-4.85	126.20	0.181	0.095	0.237
Effect on FDI (extensive: outflow)												
LHS				I(D.FDI / Total FDI from SC<0)			I(TC Inflow/VA<0)			I(no more affiliates in TC)		
Source:												
Climatological				-0.05	-0.13	0.15				-0.005	-0.003	-0.014
Meteorological				-0.03	-0.01	-0.04				**0.003**	**0.003**	0.003
Hydrological				0.04	0.01	0.07				0.000	0.000	-0.002
EPS				**0.32**	**0.42**	0.27				0.002	0.004	-0.029
CO2 Tax				-0.09	-0.27	-0.09				-0.026	0.017	**-0.075**
Emission productivity				-0.59	-0.63	-1.88				**0.101**	**0.114**	0.088
Climate risk										**0.033**	**0.037**	**-0.042**
Target:												
Climatological				0.09	0.14	0.18	-0.51	-1.08	17.82	**-0.021**	0.003	-0.008
Meteorological				-0.01	0.01	-0.10	**-0.42**	**-0.40**	-8.72	-0.005	-0.007	**-0.027**
Hydrological				0.04	0.01	0.05	0.54	0.81	2.31	**-0.008**	0.002	-0.004
EPS				0.12	0.16	0.39	0.00	**-1.32**	81.13	-0.011	-0.011	-0.093
CO2 Tax				-0.12	1.01	3.01				0.049	0.086	**1.960**
Emission productivity				**-1.39**	-1.88	-0.56	**6.42**	**9.61**	-119.7	-0.009	-0.018	0.131

Figure 15: Effects on FDI: PPML. Full sample

Blue plane shows the effects in absence of climate disasters. Red plane adds a given climate disaster set to 1. Specification is from regression reported in Table A.22.

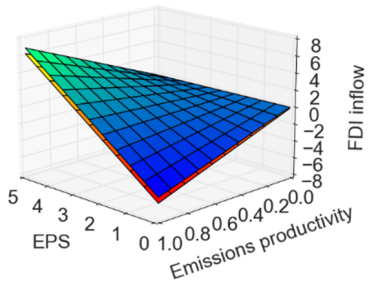
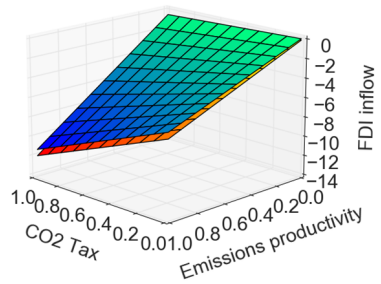
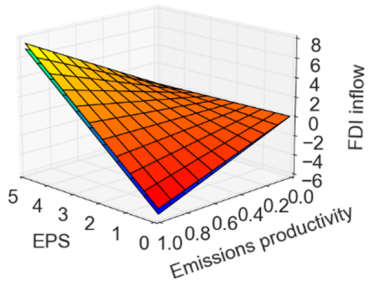
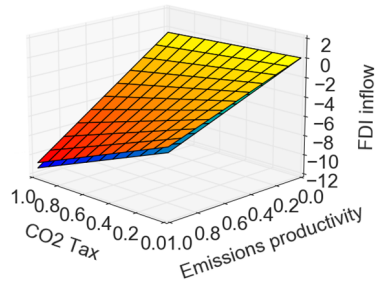
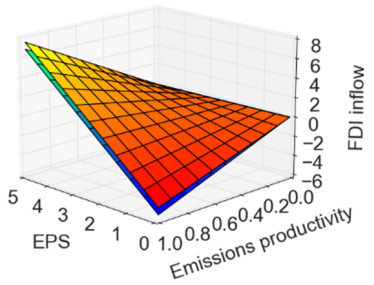
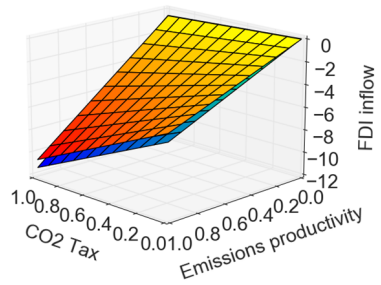
	EPS	CO2 Tax
Climatological		
Meteorological		
Hydrological		

Figure 16: Effects on FDI: PPML. Advanced Economies

Blue plane shows the effects in absence of climate disasters. Red plane adds a given climate disaster set to 1. Specification is from regression reported in Table A.22.

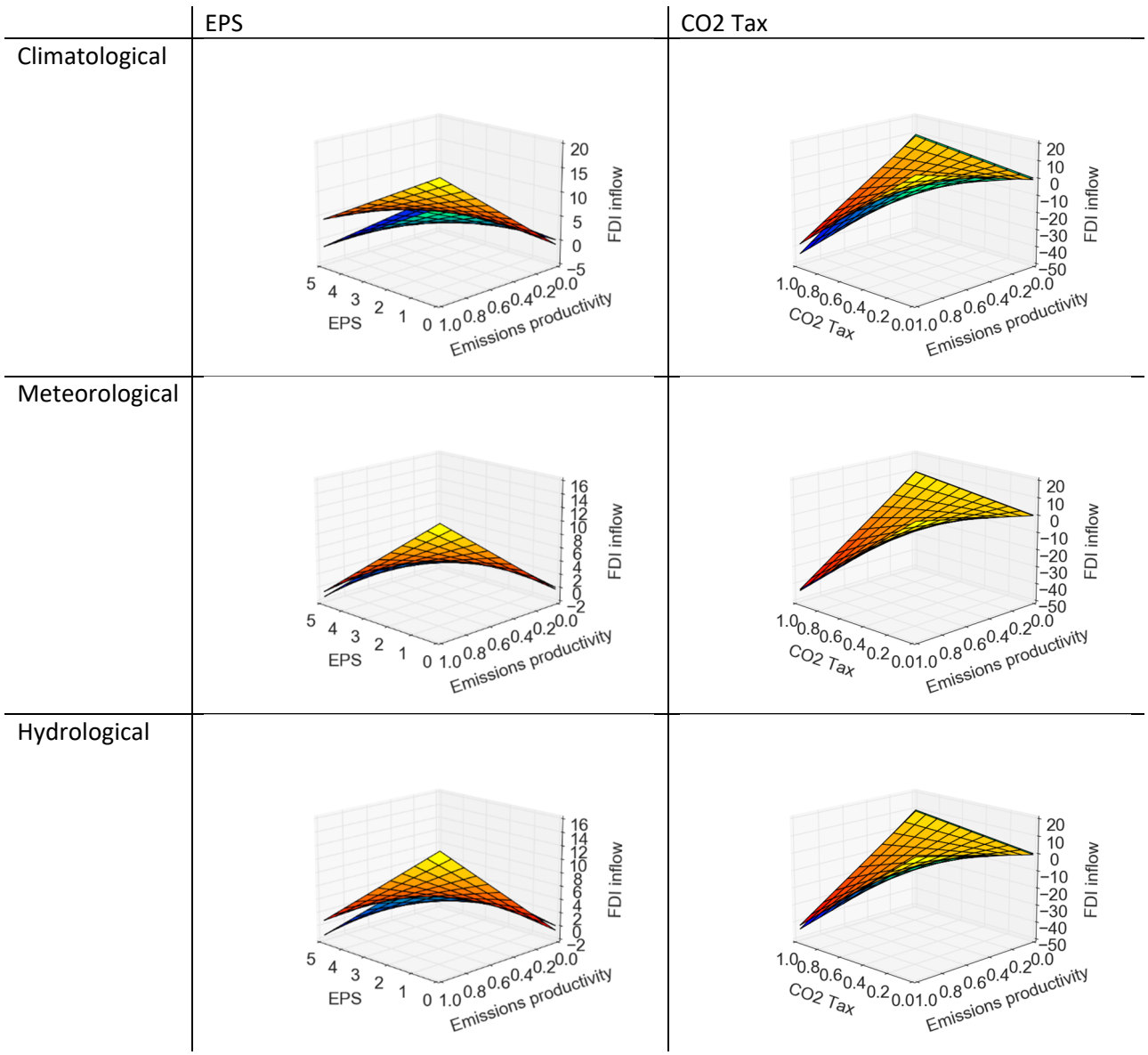


Figure 17: Effects on FDI: PPML. Emerging Economies

Blue plane shows the effects in absence of climate disasters. Red plane adds a given climate disaster set to 1. Specification is from regression reported in Table A.22.

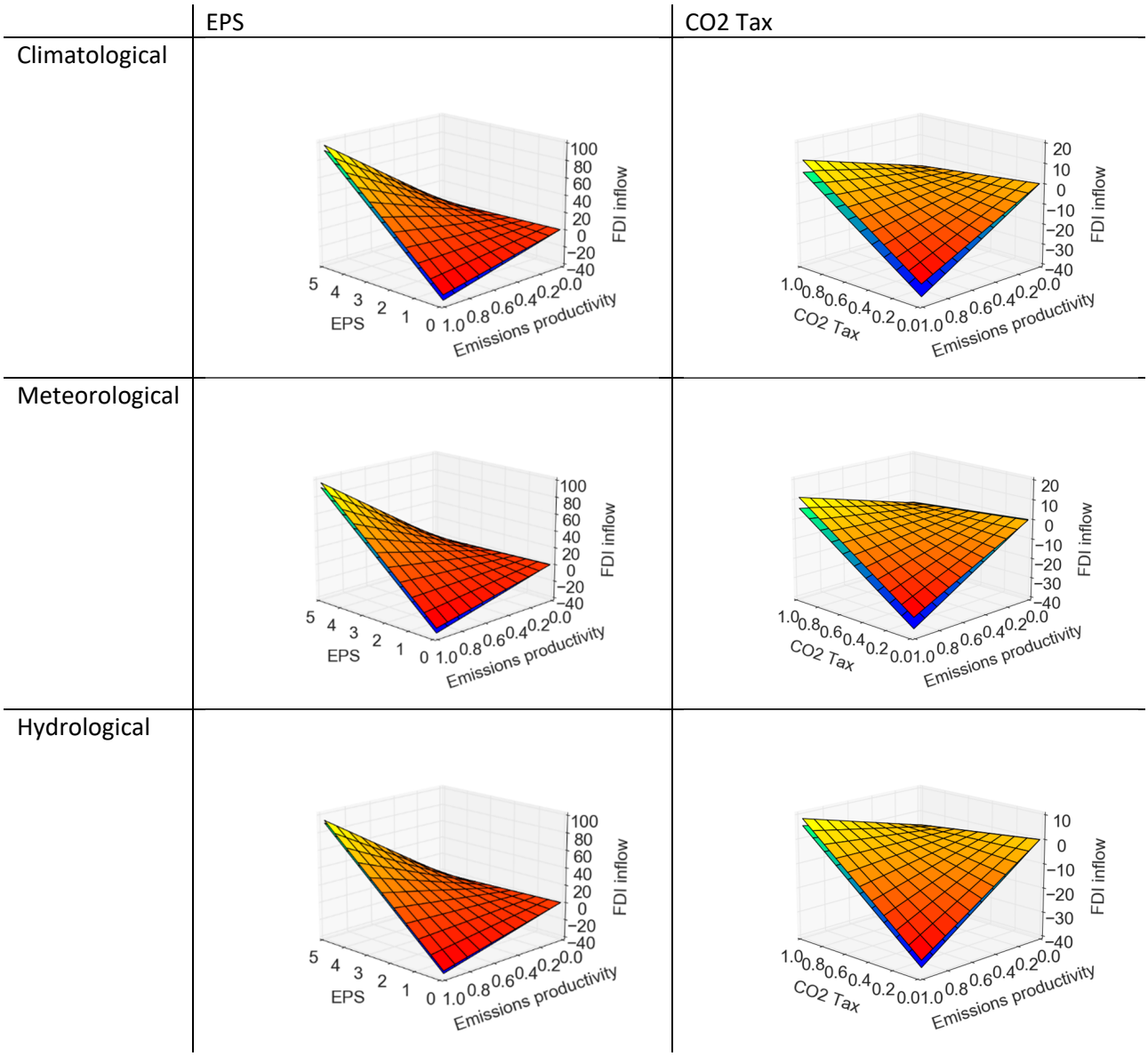


Table 1: Summary of the results: count of significant coefficients

	Main effects				Interactions with emission productivity			
	Model	All	AEs	EMEs	Model	All	AEs	EMEs
Effect on FDI (intensive margin)								
Target:								
Climatological	< 0	2 / 3 /12	1 / 3 /12	1 / 2 /12	< 0 or > 0	1 / 0 / 4	1 / 0 / 4	0 / 0 / 4
Meteorological	< 0	1 / 2 / 9	2 / 1 / 9	0 / 2 / 9	< 0 or > 0	1 / 0 / 4	1 / 1 / 4	2 / 0 / 4
Hydrological	< 0	2 / 1 /12	1 / 2 /12	2 / 0 / 12	< 0 or > 0	1 / 0 / 4	1 / 0 / 4	1 / 0 / 4
EPS	< 0	1 / 0 / 4	0 / 0 / 4	1 / 0 / 4	< 0 or > 0	0 / 1 / 4	0 / 2 / 4	1 / 0 / 4
CO2 Tax	< 0	0 / 1 / 3	0 / 1 / 3	0 / 2 / 3	< 0 or > 0	0 / 1 / 3	1 / 1 / 3	1 / 0 / 3
Emission Productivity	> 0	0 / 1 / 4	0 / 0 / 4	0 / 0 / 4	> 0	1 / 0 / 4	2 / 0 / 4	0 / 1 / 4
Effect on FDI (extensive: inflow)								
Target:								
Climatological	< 0	0 / 2 / 7	0 / 2 / 7	1 / 0 / 7	< 0 or > 0	1 / 1 / 3	1 / 0 / 3	0 / 0 / 3
Meteorological	< 0	1 / 2 / 7	0 / 1 / 7	0 / 1 / 7	< 0 or > 0	1 / 0 / 3	0 / 1 / 3	1 / 0 / 3
Hydrological	< 0	0 / 1 / 7	0 / 2 / 7	1 / 0 / 7	< 0 or > 0	0 / 0 / 3	0 / 0 / 3	0 / 0 / 3
EPS	< 0	1 / 0 / 4	0 / 0 / 4	1 / 0 / 4	< 0 or > 0	1 / 0 / 3	0 / 0 / 3	0 / 0 / 3
CO2 Tax	< 0	0 / 1 / 3	0 / 1 / 3	0 / 2 / 4	< 0 or > 0	0 / 0 / 2	0 / 0 / 2	0 / 0 / 2
Emission Productivity	> 0	0 / 1 / 4	0 / 0 / 4	0 / 0 / 4	> 0	0 / 0 / 3	0 / 0 / 3	0 / 0 / 3
Effect on FDI (extensive: outflow)								
Target:								
Climatological	> 0	1 / 0 / 7	0 / 1 / 7	1 / 0 / 7	< 0 or > 0	0 / 1 / 3	0 / 0 / 3	0 / 0 / 3
Meteorological	> 0	1 / 0 / 7	0 / 0 / 7	0 / 2 / 7	< 0 or > 0	0 / 1 / 3	0 / 1 / 3	0 / 1 / 3
Hydrological	> 0	0 / 0 / 7	0 / 0 / 7	2 / 0 / 7	< 0 or > 0	0 / 1 / 3	0 / 0 / 3	0 / 0 / 3
EPS	> 0	0 / 0 / 4	0 / 0 / 4	1 / 0 / 4	< 0 or > 0	0 / 0 / 3	0 / 1 / 3	0 / 0 / 3
CO2 Tax	> 0	1 / 0 / 3	1 / 0 / 3	0 / 0 / 4	< 0 or > 0	0 / 0 / 2	0 / 0 / 2	1 / 0 / 2
Emission Productivity	< 0	0 / 1 / 4	0 / 0 / 4	1 / 0 / 4	> 0	1 / 1 / 3	1 / 0 / 3	0 / 0 / 3

Notes: First two numbers in each cell are the number of positive and negative significant coefficients across specifications, the last number is the number of specifications considered. Cells are in green if at least half of specifications are consistent with model predictions; in red if at least half of specifications contradict model predictions; in blue if half of specifications have a clear effect for the cases where model predicts an ambiguous effect. Magnitudes of the effects are in Figures 13 and 14.

Table 2: Country-level regressions: Extreme weather disasters

Dependent variable is net FDI inflows as a share of GDP in year t. "Any disaster" only includes climate-related disasters. *Hydro*, *Meteo*, and *Climat* are numbers of hydrological, meteorological, and climatological disasters from EM Data. The sample has total 97 countries, 28 advanced economies, 52 emerging economies, and 17 low income countries, for 1970-2019. All RHS variables are lagged one year. All regressions include country, year, and country-group (AE/EME/LIC) fixed effects are estimated by OLS. Clustered (at region) standard errors are in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	(1) Full sample	(2) AEs	(3) EMEs	(4) LICs	(5) Full sample	(6) Full sample
Any disaster	-0.0557**	-0.101	-0.0389	0.00444		
	(0.0155)	(0.0432)	(0.0286)	(0.0257)		
Climat					-0.202**	
					(0.0580)	
Meteo					0.0110	
					(0.0215)	
Hydro					-0.0919**	
					(0.0316)	
Drought						-0.399**
						(0.120)
Fire						-0.0941
						(0.125)
Temp						0.262
						(0.301)
Storm						-0.0172
						(0.0438)
Flood						-0.0967**
						(0.0368)
Trade/GDP	0.0330**	0.0374*	0.0273**	0.0394	0.0329***	0.0328***
	(0.00831)	(0.0121)	(0.00633)	(0.0219)	(0.00816)	(0.00787)
PPI Inflation	-0.000271	0.106***	-0.000238	-0.00283	-0.000268	-0.000266
	(0.000136)	(0.0150)	(0.000135)	(0.00160)	(0.000135)	(0.000140)
Real GDP Growth	0.0537**	0.0383	0.0611***	0.0207	0.0533**	0.0530**
	(0.0139)	(0.0685)	(0.00905)	(0.0171)	(0.0139)	(0.0139)
N	3774	1142	2031	601	3774	3774
R^2	0.361	0.308	0.365	0.551	0.361	0.362

Table 3: Firm-level regressions: Climate exposure, policies, and disasters

Notes: An observation is a firm-target country-year cell. Dependent variables are either Intensive margin, measured as a change in the share of total firm's affiliates located in a given target country in a given year, or Extensive margin, measured as an indicator of whether a firm has an affiliate in a new given target country (inflow) or whether a firm has closed all affiliates in a given target country (outflow). *CCR* is a measure of firm exposure to climate risks as discussed in executive calls provided in Sautner et al. (2021) and discussed in Sautner et al. (2020). *Hydro*, *Meteo*, and *Climat* are numbers of hydrological, meteorological, and climatological disasters from EM Data, at country-year level, for target countries. *RelEPS* is the difference between target country's and source country's Environmental Policy Stringency Index; *CO2Tax* is 0/1 indicator of a presence of carbon tax (in both source and target countries, or in only target country) derived from a measure of carbon taxation; both are from OECD. All RHS variables are lagged one year. All regressions include firm-target country, firm-year, target country-year, and affiliate industry fixed effects. Robust standard errors are clustered two-way by firm and target country. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Full sample			Target in AE			Target in EME			Headquarter in OFC		
		Extensive			Extensive			Extensive			Extensive	
	Intensive	Inflow	Outflow	Intensive	Inflow	Outflow	Intensive	Inflow	Outflow	Intensive	Inflow	Outflow
$CCR * Climat$	-0.00034	-0.000016	0.00063	0.00376	-0.00148	0.00051	-0.00096	-0.00678	0.00347*	0.00051	0.00317	-0.00366
	(0.00084)	(0.00125)	(0.00120)	(0.00574)	(0.00222)	(0.00285)	(0.00664)	(0.00832)	(0.00193)	(0.00211)	(0.00313)	(0.00691)
$CCR * Meteo$	0.000321	0.0004	-0.000004	-0.00147	-0.00050	-0.00125	-0.000350	0.00562**	-0.00096**	-0.000428	-0.00183*	0.000818
	(0.00024)	(0.00034)	(0.00017)	(0.00190)	(0.00069)	(0.00106)	(0.00184)	(0.00243)	(0.00043)	(0.00050)	(0.00085)	(0.00129)
$CCR * Hydro$	-0.00008	-0.00065	0.000031	0.00171	0.000751	0.00172	0.000640	-0.00560	-0.000143	0.000358	0.000267	0.000613
	(0.00022)	(0.00070)	(0.000107)	(0.00220)	(0.000829)	(0.00168)	(0.00171)	(0.00379)	(0.000387)	(0.00129)	(0.000639)	(0.00248)
$CCR * RelEPS$	-0.00038	-0.00294	0.00071	0.00668	-0.000182	-0.00789	-0.00346	-0.0250	0.00292**	0.000208	0.00808*	-0.00331
	(0.00087)	(0.00300)	(0.000650)	(0.00478)	(0.00242)	(0.00610)	(0.00554)	(0.0170)	(0.00107)	(0.00269)	(0.00382)	(0.00514)
$CCR * CO_2Tax_i$	0.00450	0.00651*	0.000963	0.00307	0.00180	0.0136**	-0.0244	-0.0659**	-0.00035	-0.00222	-0.00505	-0.00897
	(0.00290)	(0.00317)	(0.00234)	(0.00989)	(0.00822)	(0.00586)	(0.0156)	(0.0281)	(0.00498)	(0.00492)	(0.00753)	(0.00838)
$CCR * CO_2Tax_{both}$	-0.00571**	-0.00816***	-0.00470	-0.0122*	0.0674***	0.0556*	0.0515	0.0724*	0.0220*	0.0304**	0.0229	0.0770**
	(0.00216)	(0.00208)	(0.00455)	(0.00657)	(0.0192)	(0.0288)	(0.0512)	(0.0416)	(0.0112)	(0.0135)	(0.0187)	(0.0326)
Observations	80941	52959	26438	2823	123517	82191	38993	4757	108545	71917	34097	3906
R^2	0.490	0.500	0.583	0.541	0.725	0.755	0.746	0.822	0.765	0.792	0.775	0.752

A Appendix

Tables below provide summary statistics of our weather events data for advanced and emerging economics separately. 1 is for advanced countries, 2 is for emerging economies, and 3 is for low-income countries.

Table A.1: Summary Statistics of Climate Disaster Events

	disaster_m	climatological_m	meteorological_m	hydrological_m
1				
mean	1.51	0.16	0.90	0.46
sd	3.61	0.61	2.48	1.05
2				
mean	1.53	0.10	0.51	0.92
sd	3.34	0.36	1.55	2.03
3				
mean	1.10	0.07	0.36	0.67
sd	1.84	0.27	1.06	1.09
Total				
mean	1.44	0.11	0.59	0.74
sd	3.20	0.43	1.81	1.66

The table below provides summary statistics of all of our key variables.

Table A.2: Summary Statistics of Climate Disaster Events: Five Categories

	drought_m	temperature_m	flood_m	storm_m	wildfire_m
1					
mean	0.03	0.12	0.41	0.78	0.13
sd	0.18	0.37	1.02	2.37	0.53
2					
mean	0.06	0.10	0.78	0.41	0.04
sd	0.25	0.35	1.74	1.45	0.24
3					
mean	0.06	0.04	0.60	0.32	0.01
sd	0.25	0.21	1.00	0.98	0.09
Total					
mean	0.05	0.09	0.64	0.50	0.06
sd	0.23	0.34	1.45	1.70	0.33

Table A.3: Summary Statistics: Annual Country-level Data

Variable	Obs	Mean	Std. dev.	Min	Max
FDI Inflow/GDP (%)	4,519	3.26	9.76	-58.32	280.13
Climatological	6,649	0.11	0.43	0.00	9.00
Meteorological	6,649	0.56	1.74	0.00	27.00
Hydrological	6,649	0.69	1.60	0.00	26.00
EPS	805	1.56	0.96	0.21	4.13
CO2 Tax	833	0.05	0.22	0.00	1.00
Emission Productivity	697	0.15	0.12	0.01	0.93
Vulnerability	2,585	0.41	0.08	0.25	0.62
CCR (firm-level)	581,293	0.19	0.39	0.00	1.00
Trade/GDP (%)	4,989	72.33	47.30	0.17	442.62
PPI Inflation (%)	5,182	31.71	333.02	-98.70	15,444.40
Real GDP Growth (%)	5,204	3.84	5.70	-56.31	88.96

The tables below provide detailed regression results that are used to construct the result heatmap and summaries in the main text.

Table A.4: Country-level: Cross section. Intensive margin

	All countries	AE	EME
Climatological	0.0288**	0.0426*	-0.0162
	(0.0102)	(0.0172)	(0.0422)
Meteorological	-0.00695	-0.0298	-0.000449
	(0.00373)	(0.0136)	(0.00254)
Climatological* Post COP21	0.249	0.195	-0.148
	(0.153)	(0.143)	(0.128)
Hydrological* Post COP21	0.0153	0.0597	0.0226
	(0.0323)	(0.105)	(0.0233)
Post COP21	-0.892	-3.028*	-0.657
	(1.434)	(1.002)	(1.143)
Trade/GDP	0.0396***	0.0290*	0.0416*
	(0.00760)	(0.0103)	(0.0150)
PPI Inflation	0.00513	-0.160**	0.00688
	(0.0101)	(0.0443)	(0.0104)
Real GDP Growth	-0.0356	-0.0684	-0.105
	(0.115)	(0.162)	(0.126)
N	192	56	102
r2	0.215	0.213	0.201
Vulnerability	-3.674*	17.55	-3.509
	(1.766)	(10.68)	(5.646)
Vulnerability * Post COP21	12.38***	-16.10	5.713*
	(2.473)	(7.020)	(2.375)
Post COP21	-5.528**	3.005	-2.748
	(1.739)	(1.301)	(1.919)
Trade/GDP	0.0388***	0.0242**	0.0412*
	(0.00606)	(0.00463)	(0.0178)
PPI Inflation	0.00554	-0.150**	0.00702
	(0.00963)	(0.0345)	(0.0106)
Real GDP Growth	-0.0663	-0.208	-0.0803
	(0.106)	(0.219)	(0.132)
N	192	56	102
r2	0.216	0.171	0.199

Standard errors in parentheses

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

Table A.5: Bilateral: Cross section. Intensive margin

	All countries	AE	EME
Climatological	0.0106	0.104	-0.00327**
	(0.0163)	(0.107)	(0.00101)
Hydrological	-0.00185	-0.0327	0.000113
	(0.00264)	(0.0276)	(0.0000958)
Climatological* Post COP21	0.0142	0.103	-0.00148
	(0.0134)	(0.0921)	(0.00451)
Hydrological* Post COP21	-0.000562	-0.0422	0.000339
	(0.00101)	(0.0313)	(0.000260)
Post COP21	-0.0325	-0.176	-0.00139**
	(0.0373)	(0.171)	(0.000417)
Trade/GDP	0.0000650	0.0105	-0.000288
	(0.000714)	(0.0140)	(0.000178)
PPI Inflation	-0.00273	-0.117	0.000226
	(0.00388)	(0.129)	(0.000218)
Real GDP Growth	0.000632	0.0170	0.000650
	(0.00580)	(0.00758)	(0.000544)
N	28580	9992	14502
r2	0.00782	0.0248	0.0244
Vulnerability	4.418	16.23	0.891**
	(4.449)	(20.14)	(0.217)
Vulnerability * Post COP21	0.544	2.072	0.0898**
	(0.566)	(2.787)	(0.0281)
Post COP21	-0.219	-0.744	-0.0326**
	(0.232)	(0.958)	(0.0108)
Trade/GDP	0.000294	0.00977	-0.000382*
	(0.00108)	(0.0169)	(0.000138)
PPI Inflation	-0.000644	-0.103	0.000261
	(0.00170)	(0.161)	(0.000225)
Real GDP Growth	0.00571	0.00873	0.000774***
	(0.00537)	(0.0144)	(0.000160)
N	28580	9992	14502
r2	0.00784	0.0242	0.0243

Standard errors in parentheses

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

Table A.6: Bilateral: Cross section. Intensive margin: PPML

	All countries	AE	EME
Climatological	0.0464**	-0.0733*	-0.0496**
	(0.0230)	(0.0443)	(0.0240)
Hydrological	0.0230***	0.0339***	0.0439***
	(0.00708)	(0.00525)	(0.00852)
Climatological * Post COP21	-0.0640***	-0.0178	-0.0267
	(0.0119)	(0.0475)	(0.234)
Hydrological* Post COP21	0.0359***	-0.0572***	0.0457***
	(0.00874)	(0.0215)	(0.00797)
Post COP21	0.0883***	-0.0712*	-0.196**
	(0.0337)	(0.0432)	(0.0898)
Trade/GDP	-0.0236**	-0.0485***	-0.00420
	(0.0120)	(0.00819)	(0.0103)
PPI Inflation	0.0453***	0.317***	0.0236*
	(0.0119)	(0.106)	(0.0130)
Real GDP Growth	0.258***	0.481***	0.0457
	(0.0201)	(0.0190)	(0.0658)
N	28580	9952	14502
r2	0.356	0.355	0.398
Vulnerability	9.285	-42.35	-10.49
	(32.46)	(32.58)	(46.73)
Vulnerability * Post COP21	5.979***	13.04***	6.294
	(0.814)	(3.504)	(5.281)
Post COP21	-2.146***	-4.737***	-2.511
	(0.292)	(0.878)	(2.168)
Trade/GDP	-0.0129	-0.0281	-0.00752
	(0.0124)	(0.0219)	(0.0137)
PPI Inflation	0.0350*	0.329***	-0.00704
	(0.0208)	(0.125)	(0.0366)
Real GDP Growth	0.265***	0.448***	0.0395
	(0.0466)	(0.0911)	(0.0453)
N	28580	9952	14502
r2	0.360	0.358	0.403

Standard errors in parentheses

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

Table A.7: Country-level: Main Effects. Intensive margin

	All countries	AE	EME
Climatological	-0.000117	-0.0386	0.161
	(0.113)	(0.212)	(0.488)
Meteorological	0.0941	0.0840	0.0517
	(0.140)	(0.0586)	(0.207)
Hydrological	-0.155	-0.315*	-0.137
	(0.115)	(0.106)	(0.198)
EPS	0.163	0.124	1.092
	(0.239)	(0.472)	(1.108)
CO2 Tax	0.0326	-0.933	2.006
	(0.205)	(0.582)	(1.816)
Emissions	-15.46	-31.99	23.55
	(14.44)	(14.64)	(14.01)
Trade/GDP	-0.0289*	-0.0325	-0.0292
	(0.0112)	(0.0196)	(0.0250)
PPI Inflation	-0.0438	-0.150	0.00348
	(0.0493)	(0.0761)	(0.0252)
Real GDP Growth	-0.000554	-0.00657	0.0151
	(0.0898)	(0.0665)	(0.135)
N	443	305	138
r2	0.514	0.567	0.329

Standard errors in parentheses

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

Table A.8: Country-level: Interactions with emission productivity. Intensive margin

	All countries	AE	EME
Climatological	0.332	-0.311	0.737
	(0.339)	(0.546)	(1.061)
Meteorological	0.446	1.362	0.0514
	(0.504)	(0.711)	(0.198)
Hydrological	-0.275	-0.337	-0.452
	(0.229)	(0.378)	(0.322)
EPS	1.708*	2.238***	2.111
	(0.661)	(0.346)	(3.619)
CO2 Tax	0.483	-7.866**	2.460
	(2.564)	(1.695)	(4.174)
Climatological$*EP^T$	-3.474	0.653	-5.686
	(3.480)	(2.365)	(10.12)
Meteorological$*EP^T$	-3.287	-7.879*	-0.958
	(2.793)	(3.325)	(5.192)
Hydrological$*EP^T$	0.498	-0.319	4.827
	(0.876)	(1.601)	(2.715)
EPS$*EP^T$	-12.07**	-14.16***	-7.429
	(3.245)	(1.521)	(23.70)
CO2 Tax$*EP^T$	-4.015	40.87***	-1.487
	(22.98)	(4.911)	(26.73)
Emissions (EP^T)	21.22**	26.31**	6.738
	(6.312)	(5.593)	(25.28)
Trade/GDP	-0.0348	-0.0675	-0.0116
	(0.0247)	(0.0315)	(0.0246)
PPI Inflation	-0.0267	-0.0822	-0.0127
	(0.0351)	(0.0689)	(0.0349)
Real GDP Growth	-0.00210	0.0344	0.00724
	(0.0969)	(0.0475)	(0.179)
N	443	305	138
r2	0.522	0.577	0.338

Standard errors in parentheses

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

Table A.9: Country-level: Disasters only. Intensive margin

	All countries	AE	EME
Climatological	-0.309***	-0.334	-0.0940
	(0.0750)	(0.244)	(0.128)
Meteorological	0.0133	0.00657	0.00932
	(0.0224)	(0.0312)	(0.0330)
Hydrological	-0.112**	-0.311*	-0.0848
	(0.0325)	(0.103)	(0.0582)
Climatological* Post COP21	0.979**	1.444	-0.121
	(0.372)	(1.092)	(0.520)
Meteorological* Post COP21	-0.108***	-0.337	-0.0637
	(0.0230)	(0.263)	(0.0556)
Hydrological* Post COP21	0.167***	0.858	0.172*
	(0.0228)	(0.425)	(0.0771)
Trade/GDP	0.0337**	0.0427*	0.0278**
	(0.00838)	(0.0135)	(0.00642)
PPI Inflation	-0.000271	0.108***	-0.000237
	(0.000138)	(0.0174)	(0.000139)
Real GDP Growth	0.0531**	0.0273	0.0608***
	(0.0138)	(0.0722)	(0.00911)
N	3774	1142	2031
r2	0.363	0.313	0.366
Vulnerability	-23.83	4.780	-34.50
	(17.87)	(12.87)	(27.65)
Vulnerability * Post COP21	6.029	-15.11	15.66*
	(7.615)	(18.17)	(5.721)
Trade/GDP	0.0350**	-0.0363*	0.0554*
	(0.0126)	(0.0144)	(0.0224)
PPI Inflation	-0.00233	-0.0190	-0.000813
	(0.00168)	(0.0265)	(0.00296)
Real GDP Growth	0.0450	-0.0333	0.0676
	(0.0488)	(0.0508)	(0.0375)
N	2252	663	1193
r2	0.369	0.370	0.347

Standard errors in parentheses

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

Table A.10: Target-Country-Target-Country-Industry-level: Main Effects. Intensive margin

	All countries	AE	EME
Climatological	0.00406	0.119	-1.879
	(0.0166)	(0.102)	(1.859)
Meteorological	-0.00871	-0.00195	0.977
	(0.00749)	(0.00183)	(1.012)
Hydrological	-0.00645	-0.0385	-0.268
	(0.0142)	(0.0294)	(0.281)
EPS	-0.0264	-0.142	17.34
	(0.0343)	(0.106)	(18.00)
Emissions	-0.340	-2.440	45.67
	(1.319)	(1.946)	(35.69)
Trade/GDP	-0.00342	-0.00761	0
	(0.00444)	(0.00633)	(.)
PPI Inflation	-0.0395	-0.0215	0
	(0.0372)	(0.0191)	(.)
Real GDP Growth	0.0143	0.0274	0
	(0.0125)	(0.0174)	(.)
N	1872	1215	450
r2	0.814	0.755	0.838

Standard errors in parentheses

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

Table A.11: Target-Country-Industry-level: Main Effects. Extensive margin: inflows

	All countries	AE	EME
Climatological	0.0290	0.0550	-0.0195
	(0.0298)	(0.0440)	(0.112)
Meteorological	-0.0218	-0.0338	0.0318
	(0.0134)	(0.0191)	(0.0280)
Hydrological	0.00881	0.00615	-0.0340
	(0.0106)	(0.0182)	(0.0453)
EPS	0.0117	-0.0300	0.433
	(0.0427)	(0.124)	(0.386)
Emissions	-6.120*	-5.830***	-28.22
	(2.842)	(1.697)	(31.83)
Trade/GDP	-0.00282	-0.00360	0.0107
	(0.00463)	(0.00766)	(0.0172)
PPI Inflation	-0.00743	0.000427	0
	(0.0127)	(0.0152)	(.)
Real GDP Growth	0.0148***	0.0316	0
	(0.00444)	(0.0248)	(.)
N	2499	1717	606
r2	0.649	0.671	0.747

Standard errors in parentheses

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

Table A.12: Target-Country-Industry-level: Main Effects. Extensive margin: outflows

	All countries	AE	EME
Climatological	-0.0255	-0.0385	0.0120
	(0.0179)	(0.0228)	(0.111)
Meteorological	0.00612	0.00983	-0.0225
	(0.00844)	(0.0117)	(0.0269)
Hydrological	-0.000698	0.00164	0.0213
	(0.0101)	(0.0142)	(0.0463)
EPS	0.0381	0.0719	-0.270
	(0.0485)	(0.114)	(0.365)
Emissions	3.117	2.490	30.95
	(4.292)	(4.158)	(31.98)
Trade/GDP	0.00248	0.00372	-0.00805
	(0.00420)	(0.00709)	(0.0174)
PPI Inflation	0.0138	0.00813	0
	(0.0105)	(0.0169)	(.)
Real GDP Growth	-0.0104**	-0.0235	0
	(0.00381)	(0.0215)	(.)
N	2499	1717	606
r2	0.522	0.568	0.729

Standard errors in parentheses

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

Table A.13: Target-Country-Industry-level: Interactions with emission productivity. Intensive margin

	All countries	AE	EME
Climatological$*EP^T$	2.218***	6.240	-22.16
	(0.574)	(5.724)	(44.59)
Meteorological$*EP^T$	-0.168	-0.724	-5.959
	(0.0933)	(0.752)	(7.928)
Hydrological$*EP^T$	-0.910	-2.084	-3.594
	(0.536)	(2.093)	(4.850)
EPS$*EP^T$	-2.195	-2.407	-122.8
	(1.814)	(2.927)	(48.31)
Emissions (EP^T)	2.045	0.633	293.8
	(3.834)	(4.836)	(120.4)
N	1871	1214	450
r2	0.818	0.760	0.845

Standard errors in parentheses

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

Table A.14: Target-Country-Industry-level: Interactions with emission productivity. Extensive margin: inflows

	All countries	AE	EME
Climatological$*EP^T$	2.637**	3.196**	-17.45
	(1.158)	(1.137)	(10.44)
Meteorological$*EP^T$	0.104	0.0839	8.619
	(0.385)	(0.428)	(3.829)
Hydrological$*EP^T$	-0.494	-0.637	-1.995
	(0.589)	(0.643)	(3.411)
EPS$*EP^T$	-3.805**	-2.378	-83.48
	(1.511)	(1.306)	(44.74)
Emissions (EP^T)	-0.998	-4.849	126.2
	(3.948)	(4.130)	(83.22)
N	2497	1715	606
r2	0.665	0.691	0.753

Standard errors in parentheses

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

Table A.15: Target-Country-Industry-level: Interactions with emission productivity. Extensive margin: outflows

	All countries	AE	EME
Climatological$*EP^T$	-0.512	-1.078	17.82
	(0.894)	(0.755)	(10.44)
Meteorological$*EP^T$	-0.419**	-0.397**	-8.721
	(0.172)	(0.172)	(3.824)
Hydrological$*EP^T$	0.538	0.808	2.311
	(0.644)	(0.676)	(3.417)
EPS$*EP^T$	0.00247	-1.320**	81.13
	(1.140)	(0.570)	(44.56)
Emissions (EP^T)	6.420**	9.612***	-119.7
	(2.290)	(0.437)	(83.29)
N	2497	1715	606
r2	0.536	0.588	0.736

Standard errors in parentheses

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

Table A.16: Target-Country-Industry-level: Disasters only. Intensive margin

	All countries	AE	EME
Climatological	0.0192	0.0964	-0.0766
	(0.0340)	(0.0862)	(0.139)
Meteorological	-0.0145	-0.000865	-0.0465
	(0.0187)	(0.0233)	(0.0461)
Hydrological	-0.000371	-0.0108	-0.0735
	(0.0154)	(0.0184)	(0.0836)
Trade/GDP	-0.0127	-0.0147	0.0422
	(0.0108)	(0.0124)	(0.0426)
PPI Infaltion	-0.00923	-0.00921	0.0759
	(0.0125)	(0.0124)	(0.0813)
Real GDP Growth	0.0166	0.0168	0
	(0.0153)	(0.0162)	(.)
N	3517	2815	540
r2	0.645	0.644	0.840
Vulnerability	5.186	5.713	-27.31
	(4.128)	(3.501)	(62.94)
Trade/GDP	-0.0129	-0.0141	0.00802
	(0.0111)	(0.0125)	(0.00662)
PPI Inflation	-0.00852	-0.00740	-0.0589
	(0.0117)	(0.0109)	(0.0488)
Real GDP Growth	0.0157	0.0153	0.0523
	(0.0152)	(0.0148)	(0.0500)
N	3517	2815	540
r2	0.645	0.644	0.838

Standard errors in parentheses

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

Table A.17: Target-Country-Industry-level: Disasters only. Extensive margin: inflows

	All countries	AE	EME
Climatological	0.00990	0.00534	0.0236
	(0.0184)	(0.0214)	(0.0467)
Meteorological	-0.00915	-0.00836	-0.00493
	(0.00612)	(0.00790)	(0.0121)
Hydrological	0.00668	0.0123	-0.0000121
	(0.00653)	(0.0110)	(0.0122)
Climatological* Post COP21	-0.0327*	-0.0214	-0.125*
	(0.0173)	(0.0208)	(0.0597)
Meteorological* Post COP21	0.00700	0.00661	0.0129
	(0.00441)	(0.00664)	(0.0150)
Hydrological* Post COP21	-0.0128	-0.0245	0.00981
	(0.0103)	(0.0155)	(0.0153)
Trade/GDP	-0.00173*	-0.00159	-0.00162
	(0.000891)	(0.000948)	(0.00249)
PPI Inflation	-0.00160	0.00153	-0.00944
	(0.00354)	(0.00418)	(0.00807)
Real GDP Growth	0.00410	0.00202	0.0128*
	(0.00280)	(0.00290)	(0.00552)
N	11581	9629	1800
r2	0.498	0.492	0.564
Vulnerability	-1.120	-1.755	-12.02
	(3.265)	(4.137)	(9.604)
Vulnerability * Post COP21	0.0252	-0.0361	1.137*
	(0.345)	(0.460)	(0.477)
Trade/GDP	-0.00170*	-0.00169*	-0.00123
	(0.000904)	(0.000989)	(0.00236)
PPI Inflation	-0.00147	0.00170	-0.000634
	(0.00344)	(0.00424)	(0.00591)
Real GDP Growth	0.00374	0.00152	0.0147*
	(0.00264)	(0.00283)	(0.00591)
N	11581	9629	1800
r2	0.498	0.491	0.563

Standard errors in parentheses

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

Table A.18: Target-Country-Industry-level: Disasters only. Extensive margin: outflows

	All countries	AE	EME
Climatological	-0.0147	-0.00347	-0.0328
	(0.0147)	(0.0139)	(0.0449)
Meteorological	0.000731	-0.00313	0.00336
	(0.00601)	(0.00724)	(0.0118)
Hydrological	0.000982	-0.00770	0.00201
	(0.00720)	(0.00981)	(0.0124)
Climatological* Post COP21	0.0216	-0.00596	0.139**
	(0.0169)	(0.0146)	(0.0517)
Meteorological* Post COP21	-0.00512	-0.00127	-0.0131
	(0.00422)	(0.00565)	(0.0132)
Hydrological* Post COP21	0.00427	0.0188	-0.00423
	(0.0123)	(0.0135)	(0.0135)
Trade/GDP	0.00141	0.00166	-0.000767
	(0.000982)	(0.00106)	(0.00256)
PPI Inflation	0.00653*	0.00636	0.00798
	(0.00331)	(0.00475)	(0.00744)
Real GDP Growth	-0.00516**	-0.00448	-0.0120*
	(0.00243)	(0.00295)	(0.00596)
N	11581	9629	1800
r2	0.321	0.329	0.513
Vulnerability	2.488	2.339	10.98
	(3.322)	(3.841)	(8.876)
Vulnerability * Post COP21	-0.773**	-0.769	-0.979
	(0.360)	(0.495)	(0.548)
Trade/GDP	0.00136	0.00138	-0.000821
	(0.000888)	(0.000943)	(0.00266)
PPI Inflation	0.00684**	0.00591	-0.000323
	(0.00337)	(0.00454)	(0.00680)
Real GDP Growth	-0.00556**	-0.00447	-0.0142
	(0.00221)	(0.00269)	(0.00710)
N	11581	9629	1800
r2	0.322	0.329	0.512

Standard errors in parentheses

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

Table A.19: Bilateral: Main Effects. Intensive margin: PPML

	All countries	AE	EME
Source:			
Climatological	-0.258***	-0.300***	-0.241**
	(0.0449)	(0.0355)	(0.108)
Meteorological	-0.00195	0.0284	-0.0292
	(0.0374)	(0.0421)	(0.0289)
Hydrological	0.0290	0.00370	0.0990***
	(0.0311)	(0.0286)	(0.0278)
EPS	-0.195	-0.333	0.170
	(0.167)	(0.230)	(0.393)
CO2 Tax	-0.312	0.216	-0.885
	(0.265)	(0.151)	(0.747)
Emissions	-7.715***	-9.723***	-1.565
	(2.082)	(3.410)	(2.525)
Trade/GDP	-0.0479***	-0.0641***	0.0229
	(0.0106)	(0.00773)	(0.0157)
PPI Inflation	0.0116	-0.00553	0.0744***
	(0.0167)	(0.00830)	(0.0275)
Real GDP Growth	0.0419	0.0822**	-0.0113
	(0.0377)	(0.0323)	(0.0180)
Target:			
Climatological	-0.228*	-0.125	0.120
	(0.133)	(0.117)	(0.196)
Meteorological	0.0868*	-0.0443**	0.0515
	(0.0518)	(0.0192)	(0.0637)
Hydrological	0.0833	-0.119***	0.141***
	(0.0779)	(0.0255)	(0.0529)
EPS	0.306**	-0.00315	1.858***
	(0.151)	(0.275)	(0.520)
CO2 Tax	-1.179***	-1.087*	-1.858*
	(0.435)	(0.657)	(1.097)
Emissions	-6.589	-0.686	6.265
	(5.610)	(3.195)	(15.28)
Trade/GDP	0.0514***	0.0337***	0.203***
	(0.0106)	(0.00474)	(0.0637)
PPI Inflation	0.0547**	0.205***	0.0685***
	(0.0268)	(0.0381)	(0.0261)
Real GDP Growth	0.118***	0.203***	0.0428***
	(0.0358)	(0.0347)	(0.0143)
N	4228	2823	1405

Standard errors in parentheses

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

Table A.20: Bilateral: Main Effects. Extensive margin: inflows

	All countries	AE	EME
Source:			
Climatological	-0.00942*	-0.0128**	-0.00292
	(0.00486)	(0.00594)	(0.00796)
Meteorological	-0.000509	0.000752	-0.00291
	(0.00199)	(0.00218)	(0.00285)
Hydrological	0.00461*	0.00563*	0.00260
	(0.00270)	(0.00312)	(0.00436)
EPS	-0.0219**	-0.0298**	-0.00579
	(0.0101)	(0.0142)	(0.00965)
CO2 Tax	0.0288	0.0329	0.0226
	(0.0220)	(0.0338)	(0.0193)
Emissions	-0.144	-0.201	-0.0370
	(0.181)	(0.258)	(0.204)
Trade/GDP	-0.0000613	0.000241	-0.000723
	(0.000532)	(0.000913)	(0.000967)
PPI Inflation	-0.00115	-0.00271	0.00259
	(0.00121)	(0.00159)	(0.00215)
Real GDP Growth	0.000255	0.000603	-0.000490
	(0.00205)	(0.00250)	(0.00354)
Target:			
Climatological	0.00170	0.00699	-0.00882
	(0.00506)	(0.0101)	(0.00560)
Meteorological	-0.000832	-0.00144	0.00188
	(0.00174)	(0.00360)	(0.00128)
Hydrological	-0.00142	-0.00177	-0.00217
	(0.00159)	(0.00405)	(0.00184)
EPS	0.00318	-0.00296	0.00406
	(0.0104)	(0.0137)	(0.0213)
CO2 Tax	-0.00535	-0.00394	0.00747
	(0.0109)	(0.0339)	(0.0317)
Emissions	0.0106	-0.108	-0.125
	(0.259)	(0.282)	(0.353)
Trade/GDP	-0.000243	-0.000750	-0.000768
	(0.000887)	(0.00124)	(0.00215)
PPI Inflation	-0.000570	-0.00270	-0.000113
	(0.00164)	(0.00344)	(0.00126)
Real GDP Growth	0.00497*	0.00865*	0.00204
	(0.00245)	(0.00497)	(0.00127)
N	4455	3010	1445
r2	0.328	0.337	0.311

Standard errors in parentheses

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

Table A.21: Bilateral: Main Effects. Extensive margin: outflows

	All countries	AE	EME
Source:			
Climatological	-0.00812*	-0.00917	-0.00629
	(0.00476)	(0.00708)	(0.00594)
Meteorological	0.00494**	0.00668**	0.00156
	(0.00226)	(0.00311)	(0.00215)
Hydrological	-0.00289	-0.00486	0.00138
	(0.00338)	(0.00466)	(0.00398)
EPS	-0.00151	-0.00367	0.00342
	(0.0123)	(0.0172)	(0.0128)
CO2 Tax	-0.0280	-0.0362	-0.0118
	(0.0224)	(0.0346)	(0.0114)
Emissions	-0.140	-0.222	0.0409
	(0.153)	(0.233)	(0.131)
Trade/GDP	0.0000689	-0.000268	0.000820
	(0.000345)	(0.000353)	(0.000883)
PPI Inflation	0.000218	-0.000366	0.00160
	(0.00120)	(0.00125)	(0.00214)
Real GDP Growth	-0.000395	0.000500	-0.00266
	(0.00134)	(0.00191)	(0.00222)
Target:			
Climatological	-0.00480	-0.0108	0.00136
	(0.00513)	(0.0109)	(0.00225)
Meteorological	-0.00130	-0.000693	-0.00286
	(0.00200)	(0.00352)	(0.00200)
Hydrological	-0.00183	-0.00630	-0.000695
	(0.00190)	(0.00435)	(0.00122)
EPS	-0.00150	-0.0147	0.0200
	(0.00878)	(0.0135)	(0.0210)
CO2 Tax	-0.0258**	-0.00788	0.00818
	(0.0106)	(0.0298)	(0.0149)
Emissions	0.242	0.344	-0.431*
	(0.285)	(0.388)	(0.225)
Trade/GDP	0.00158*	0.00179	-0.00119
	(0.000829)	(0.00110)	(0.000807)
PPI Inflation	-0.0000996	-0.00157	-0.000692
	(0.00108)	(0.00288)	(0.00101)
Real GDP Growth	0.00117	0.00330	-0.000144
	(0.00153)	(0.00247)	(0.00146)
N	4461	3022	1439
r2	0.347	0.338	0.402

Standard errors in parentheses

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

Table A.22: Bilateral: Interactions with emission productivity. Intensive margin: PPML

	All countries	AE	EME
Source:			
Climatological$*EP^T$	1.337	1.838***	0.553**
	(0.862)	(0.285)	(0.216)
Meteorological$*EP^T$	-1.387***	-1.654***	-1.145***
	(0.309)	(0.381)	(0.435)
Hydrological$*EP^T$	0.448***	0.424*	0.468
	(0.172)	(0.232)	(0.805)
EPS$*EP^T$	-0.993	-2.374***	0.474
	(1.672)	(0.565)	(4.678)
CO2 Tax$*EP^T$	-7.912***	-8.391***	-5.570
	(2.912)	(2.911)	(6.705)
Emissions$*EP^T$	-44.43***	-40.58	-6.054
	(13.81)	(29.16)	(47.08)
Climatological	-0.440***	-0.565***	-0.271***
	(0.159)	(0.0501)	(0.0977)
Meteorological	0.192***	0.279***	0.0706*
	(0.0304)	(0.0407)	(0.0364)
Hydrological	-0.0392**	-0.0508	0.00918
	(0.0189)	(0.0665)	(0.0708)
EPS	-0.0960	0.0207	0.0453
	(0.195)	(0.295)	(0.785)
CO2 Tax	0.826**	1.348**	-0.181
	(0.419)	(0.626)	(1.141)
Emissions	-0.112	-1.767	-0.356
	(4.792)	(8.399)	(8.105)
TRADE/GDP	-0.0484***	-0.0640***	0.0277**
PPI Inflation	0.0138	-0.0107	0.0655***
Real GDP Growth	0.0486	0.0973***	-0.00213
Target:			
Climatological$*EP^T$	-0.523	6.764***	6.032
	(2.766)	(2.111)	(3.821)
Meteorological$*EP^T$	0.543	1.061	6.040***
	(0.496)	(0.836)	(1.101)
Hydrological$*EP^T$	0.761***	2.947**	2.997***
	(0.253)	(1.285)	(0.868)
EPS$*EP^T$	2.601	-3.614***	26.96***
	(1.773)	(1.237)	(6.925)
CO2 Tax$*EP^T$	-5.333	-68.52***	49.24
	(10.20)	(7.004)	(48.19)
Climatological	-0.138	-0.963***	0.0272
	(0.239)	(0.240)	(0.319)
Meteorological	0.0140	-0.273**	-0.401***
	(0.0174)	(0.130)	(0.0658)
Hydrological	-0.0380	-0.682**	-0.0868
	(0.0832)	(0.273)	(0.0801)
EPS	-0.0369	0.573	-0.803
	(0.189)	(0.463)	(0.584)
CO2 Tax	-0.532	9.629***	-5.749
	(1.266)	(1.217)	(5.034)
Emissions (EP^T)	-5.690	13.58***	-37.35***
	(11.23)	(2.362)	(5.331)
TRADE/GDP	0.0468***	0.0162***	0.135***
PPI Inflation	0.0534**	0.238***	0.0542***
Real GDP Growth	0.118***	0.227***	0.0557***
N	4228	2823	1405

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.23: Bilateral: Interactions with emission productivity. Extensive margin: inflows

	All countries	AE	EME
Source:			
Climatological$*EP^T$	-0.0222	0.0107	-0.0298
	(0.0368)	(0.0736)	(0.0546)
Meteorological$*EP^T$	0.00404	-0.00191	-0.0246
	(0.0149)	(0.0194)	(0.0377)
Hydrological$*EP^T$	0.0456	0.0522	0.0422
	(0.0333)	(0.0447)	(0.0530)
EPS$*EP^T$	0.0980	0.141	0.228**
	(0.0866)	(0.170)	(0.0869)
CO2 Tax$*EP^T$	-0.0132	-0.0803	-0.126
	(0.178)	(0.285)	(0.133)
Emissions$*EP^T$	-1.313	-0.933	-0.658
	(0.830)	(0.922)	(1.924)
Target:			
Climatological$*EP^T$	0.160	0.0239	-0.0230
	(0.110)	(0.182)	(0.142)
Meteorological$*EP^T$	-0.0569	-0.0792	0.0415
	(0.0346)	(0.0530)	(0.0808)
Hydrological$*EP^T$	0.00354	-0.0616	-0.00780
	(0.0275)	(0.0641)	(0.0435)
EPS$*EP^T$	0.0813	0.0248	0.207
	(0.0984)	(0.172)	(0.494)
CO2 Tax$*EP^T$	0.0623	0.318	-2.967
	(0.367)	(0.788)	(2.160)
Climatological	-0.0158*	0.00145	-0.00841
	(0.00859)	(0.0274)	(0.00880)
Meteorological	0.00553	0.0118	-0.000752
	(0.00340)	(0.00771)	(0.00583)
Hydrological	-0.000940	0.00924	-0.00106
	(0.00452)	(0.0125)	(0.00537)
EPS	-0.0110	-0.00610	-0.0158
	(0.0159)	(0.0303)	(0.0333)
CO2 Tax	-0.00577	-0.0615	0.326
	(0.0485)	(0.121)	(0.249)
Emissions (EP^T)	-0.294	-0.181	-0.734
	(0.431)	(0.878)	(0.731)
Trade/GDP	-0.000234	-0.000644	-0.00109
	(0.000974)	(0.00131)	(0.00242)
PPI Inflation	-0.000472	-0.00236	-0.0000334
	(0.00162)	(0.00365)	(0.00150)
Real GDP Growth	0.00477**	0.00826	0.00169
	(0.00227)	(0.00542)	(0.00214)
N	4455	3010	1445
r2	0.355	0.376	0.415

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.24: Bilateral: Interactions with emission productivity. Extensive margin: outflows

	All countries	AE	EME
Source:			
Climatological$*EP^T$	0.0492	0.128	-0.147
	(0.0641)	(0.101)	(0.0959)
Meteorological$*EP^T$	0.0253	0.00631	0.0429
	(0.0161)	(0.0263)	(0.0255)
Hydrological$*EP^T$	-0.0381	-0.0116	-0.0728
	(0.0467)	(0.0663)	(0.0414)
EPS$*EP^T$	-0.316**	-0.416*	-0.271
	(0.153)	(0.220)	(0.193)
CO2 Tax$*EP^T$	0.0897	0.274	0.0883
	(0.187)	(0.268)	(0.180)
Emissions$*EP^T$	0.587	0.626	1.880
	(1.586)	(1.894)	(1.898)
Target:			
Climatological$*EP^T$	-0.0938	-0.135	-0.177
	(0.0893)	(0.175)	(0.123)
Meteorological$*EP^T$	0.00711	-0.00911	0.0950
	(0.0301)	(0.0699)	(0.0668)
Hydrological$*EP^T$	-0.0444	-0.00975	-0.0473
	(0.0266)	(0.0836)	(0.0529)
EPS$*EP^T$	-0.116	-0.159	-0.389
	(0.0946)	(0.186)	(0.283)
CO2 Tax$*EP^T$	0.124	-1.007	-3.008
	(0.442)	(1.010)	(2.505)
Climatological	0.00330	0.00801	0.0106
	(0.00691)	(0.0228)	(0.00737)
Meteorological	-0.00222	0.0000145	-0.00921
	(0.00371)	(0.0112)	(0.00502)
Hydrological	0.00305	-0.00530	0.00304
	(0.00380)	(0.0150)	(0.00445)
EPS	0.0145	0.0109	0.0497
	(0.0146)	(0.0348)	(0.0348)
CO2 Tax	-0.0409	0.177	0.322
	(0.0617)	(0.178)	(0.270)
Emissions (EP^T)	1.390**	1.879	0.563
	(0.550)	(1.209)	(0.395)
Trade/GDP	0.00176**	0.00186	-0.00138
	(0.000785)	(0.00108)	(0.00144)
PPI Inflation	-0.0000324	-0.00150	-0.000943
	(0.00101)	(0.00332)	(0.00122)
Real GDP Growth	0.00115	0.00371*	-0.0000630
	(0.00162)	(0.00200)	(0.00213)
N	4461	3022	1439
r2	0.374	0.373	0.483

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.25: Bilateral: Disasters only. Intensive margin

	All countries	AE	EME
Climatological	-0.00300	-0.00721	-0.00739
	(0.00893)	(0.0195)	(0.00607)
Meteorological	0.0134	0.0211*	0.00405
	(0.00944)	(0.0113)	(0.00354)
Hydrological	-0.00878	-0.0305	-0.000515
	(0.00688)	(0.0202)	(0.00120)
Climatological* Post COP21	0.00211	0.0196	0.00908
	(0.00984)	(0.0306)	(0.00727)
Meteorological* Post COP21	-0.000240	0.0138	0.00180
	(0.00657)	(0.0291)	(0.00481)
Hydrological* Post COP21	0.000936	-0.0547	-0.00195
	(0.00295)	(0.0744)	(0.00276)
Trade/GDP	0.0000318	-0.000329	-0.0000211
	(0.000121)	(0.000879)	(0.000347)
PPI Inflation	0.0000186	0.00304	-0.000236
	(0.000206)	(0.00401)	(0.000390)
Real GDP Growth	-0.000972	0.00717	-0.00294
	(0.00143)	(0.00503)	(0.00274)
N	142692	49960	72718
r2	0.0941	0.129	0.0609
Vulnerability	1.817	11.09	-1.783
	(2.149)	(10.49)	(1.793)
Vulnerability * Post COP21	0.364	1.170	0.0647
	(0.395)	(1.266)	(0.0832)
Trade/GDP	0.000136	0.000349	0.0000455
	(0.000132)	(0.00150)	(0.000310)
PPI Inflation	0.000117	-0.00135	-0.000289
	(0.000157)	(0.00433)	(0.000400)
Real GDP Growth	-0.000373	0.00696	-0.00338
	(0.00139)	(0.00524)	(0.00305)
N	142692	49960	72718
r2	0.0941	0.129	0.0609

Standard errors in parentheses

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

Table A.26: Bilateral: Disasters only. Intensive margin: PPML

	All countries	AE	EME
Source:			
Climatological	-0.00387	-0.612***	0.177
	(0.200)	(0.0842)	(0.488)
Meteorological	-0.281**	-0.524***	0.153
	(0.142)	(0.0667)	(0.127)
Hydrological	0.149	0.159	0.215***
	(0.0931)	(0.135)	(0.0748)
Climatological* Post COP21	-0.291	-0.000960	-0.148
	(0.327)	(0.105)	(0.551)
Meteorological* Post COP21	0.278***	0.379***	0.116
	(0.0718)	(0.0561)	(0.112)
Hydrological* Post COP21	-0.150***	-0.212**	-0.0823
	(0.0439)	(0.0889)	(0.117)
Trade/GDP	0.0104***	-0.00226	0.0185***
PPI Inflation	-0.0182***	-0.0239***	-0.00606
Real GDP Growth	-0.0211	-0.0249**	0.0315***
Target:			
Climatological	0.0372	-0.297	-0.00596
	(0.230)	(0.211)	(0.201)
Meteorological	-0.0624***	-0.110	-0.00801
	(0.0235)	(0.174)	(0.0916)
Hydrological	0.167***	0.182**	0.193***
	(0.0548)	(0.0917)	(0.0539)
Climatological* Post COP21	0.330**	0.279	1.037**
	(0.144)	(0.367)	(0.424)
Meteorological* Post COP21	-0.0412	0.0396	-0.0504
	(0.0332)	(0.145)	(0.115)
Hydrological* Post COP21	0.00124	-0.190**	-0.0275
	(0.0165)	(0.0957)	(0.0732)
Post COP21	-0.862***	0.294	-1.692***
	(0.0657)	(0.348)	(0.331)
Trade/GDP	0.00275	-0.00299	0.00269
PPI Inflation	0.0297***	0.0908***	0.0110
Real GDP Growth	0.00160	0.111	-0.0170
Observations	54252	20554	26888
Source:			
Vulnerability	13.20	10.73	32.19*
	(16.09)	(19.25)	(18.16)
Vulnerability * Post COP21	-6.456***	-10.12***	-0.823
	(2.143)	(2.318)	(2.277)
Trade/GDP	0.0142***	0.00290	0.0204***
Real GDP Growth	-0.00900	-0.0114	0.0301*
PPI Inflation	-0.0225***	-0.0333***	-0.00599
Target:			
Vulnerability	42.48	106.6***	-89.14***
	(29.26)	(34.93)	(26.54)
Vulnerability * Post COP21	5.695***	9.705**	2.255
	(1.528)	(3.810)	(2.723)
Post COP21	0.0439	1.395	-1.199
	(0.858)	(1.985)	(1.484)
Trade/GDP	-0.000877	-0.0133	-0.00111
Real GDP Growth	0.00929	0.0570	-0.0197
PPI Inflation	0.0262***	0.00806	0.00847
Observations	53182	20184	26356

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.27: Bilateral: Disasters only. Extensive margin: inflows

	All countries	AE	EME
Climatological	0.0215	0.0464	0.00700
	(0.0228)	(0.0456)	(0.0203)
Meteorological	-0.00698*	-0.0135	-0.00331
	(0.00355)	(0.00995)	(0.00310)
Hydrological	-0.00131	-0.00115	-0.00453
	(0.00291)	(0.00921)	(0.00417)
Climatological* Post COP21	-0.0230	-0.0533	-0.00743
	(0.0201)	(0.0423)	(0.0207)
Meteorological* Post COP21	0.00276	0.0143	-0.000455
	(0.00403)	(0.00916)	(0.00473)
Hydrological* Post COP21	0.000875	-0.00736	0.00269
	(0.00413)	(0.0106)	(0.00543)
Trade/GDP	0.000185	-0.000664	0.00223*
	(0.000826)	(0.000941)	(0.00123)
PPI Inflation	0.000674	0.00622	0.000891
	(0.000962)	(0.00469)	(0.00119)
Real GDP Growth	-0.00204	0.00355	-0.00694
	(0.00315)	(0.00424)	(0.00528)
N	133809	46919	68431
r2	0.148	0.190	0.176
Vulnerability	2.775	5.100	4.175
	(2.080)	(3.648)	(3.838)
Vulnerability * Post COP21	0.205	-0.0623	-0.479**
	(0.188)	(0.312)	(0.212)
Trade/GDP	0.000211	-0.000714	0.00178*
	(0.000749)	(0.00118)	(0.00101)
PPI Inflation	0.000742	0.00495	0.00116
	(0.000959)	(0.00488)	(0.000985)
Real GDP Growth	-0.00135	0.00445	-0.00575
	(0.00331)	(0.00546)	(0.00527)
N	133809	46919	68431
r2	0.148	0.187	0.179

Standard errors in parentheses

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

Table A.28: Bilateral: Disasters only. Extensive margin: outflows

	All countries	AE	EME
Climatological	-0.0205	-0.00705	-0.0116
	(0.0228)	(0.0100)	(0.0384)
Meteorological	0.00173	0.00817	-0.00407
	(0.00538)	(0.00556)	(0.00757)
Hydrological	-0.00784	-0.00827	-0.00451
	(0.00504)	(0.00746)	(0.00651)
Climatological* Post COP21	0.0191	0.0250	-0.0218
	(0.0276)	(0.0156)	(0.0683)
Meteorological* Post COP21	-0.00887	-0.0137**	-0.00367
	(0.00574)	(0.00641)	(0.00725)
Hydrological* Post COP21	0.0130***	0.0256	0.00906
	(0.00409)	(0.0160)	(0.00553)
Trade/GDP	0.000619	0.000398	-0.00128
	(0.00116)	(0.00113)	(0.00217)
PPI Inflation	-0.000820	-0.00791*	-0.00109
	(0.000947)	(0.00415)	(0.00154)
Real GDP Growth	0.00175	0.000522	0.00250
	(0.00268)	(0.00467)	(0.00420)
N	134916	47048	69110
r2	0.151	0.163	0.183
Vulnerability	-3.474*	-3.022	-1.465
	(2.001)	(3.095)	(3.939)
Vulnerability * Post COP21	-0.149	0.137	-0.0275
	(0.196)	(0.267)	(0.329)
Trade/GDP	0.000489	0.000380	-0.00157
	(0.00112)	(0.00122)	(0.00206)
PPI Inflation	-0.000915	-0.00667	-0.00106
	(0.000942)	(0.00452)	(0.00157)
Real GDP Growth	0.000967	0.000238	0.00259
	(0.00265)	(0.00460)	(0.00418)
N	134916	47048	69110
r2	0.150	0.162	0.179

Standard errors in parentheses

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

Table A.29: Firm-level: Main Effects. Intensive margin

	All countries	AE	EME
Source:			
Climatological	-0.00287	-0.0037 *	-0.00246
	(0.0017)	(0.0019)	(0.0014)
Meteorological	-0.000357	-0.00016	-0.000595
	(0.0005)	(0.0007)	(0.0004)
Hydrological	-0.000465	-0.000672	-0.000253
	(0.0005)	(0.0006)	(0.0006)
EPS	0.00232	0.0014	0.00361
	(0.0029)	(0.0036)	(0.0032)
CO2 Tax	0.00389	0.00348	0.00466 *
	(0.0035)	(0.0046)	(0.0021)
Emissions	0.0686	0.071	0.0575
	(0.0539)	(0.0718)	(0.0393)
Climate risk	-0.00165	-0.00228	-0.000239
	(0.0012)	(0.0014)	(0.0015)
Target:			
Climatological	-0.0105 ***	-0.0161 ***	0.0014
	(0.0049)	(0.0054)	(0.0022)
Meteorological	0.00082	0.000914	-0.00162 ***
	(0.0009)	(0.0015)	(0.0004)
Hydrological	-0.000721	-0.00162	0.000193
	(0.0005)	(0.0013)	(0.0004)
EPS	-0.00589	-0.00645	-0.00628
	(0.0043)	(0.0063)	(0.0037)
CO2 Tax	0.0086	0.0209	-0.00728 ***
	(0.0056)	(0.0124)	(0.0019)
Emissions	-0.239 *	-0.12	-0.0542
	(0.1260)	(0.1740)	(0.0405)
Trade/GDP	-0.000289	0.000299	-0.000187
	(0.0003)	(0.0005)	(0.0002)
Real GDP Growth	-0.00131 *	-0.00294 **	0.000247
	(0.0007)	(0.0012)	(0.0003)
PPI inflation	-0.00105 *	0.000272	-0.00021
	(0.0006)	(0.0016)	(0.0003)
Observations	91463	62922	28480
R^2	0.129	0.138	0.14

Standard errors in parentheses

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

Table A.30: Firm-level: Main Effects. Extensive margin: inflows

	All countries	AE	EME
Source:			
Climatological	-0.00459	-0.00438	-0.00591
	(0.0058)	(0.0059)	(0.0065)
Meteorological	0.00194	0.00201	0.00196
	(0.0021)	(0.0021)	(0.0025)
Hydrological	-0.00292	-0.00332	-0.00188
	(0.0027)	(0.0028)	(0.0029)
EPS	-0.0275 **	-0.0278 **	-0.0268 **
	(0.0108)	(0.0113)	(0.0110)
CO2 Tax	-0.00486	-0.0076	0.000112
	(0.0161)	(0.0165)	(0.0180)
Emissions	0.315	0.284	0.4 *
	(0.1860)	(0.1910)	(0.1930)
Climate risk	0.000446	0.00078	-0.000601
	(0.0081)	(0.0083)	(0.0084)
Target:			
Climatological	-0.00191	-0.005	0.00609
	(0.0033)	(0.0034)	(0.0053)
Meteorological	-0.000892* *	0.0000248	-0.00229 ***
	(0.0005)	(0.0013)	(0.0004)
Hydrological	-0.000806	-0.000222	-0.000862
	(0.0009)	(0.0021)	(0.0009)
EPS	0.00324	0.006 **	0.0113 **
	(0.0019)	(0.0027)	(0.0048)
CO2 Tax	0.0113 **	0.0047	0.0283 ***
	(0.0043)	(0.0086)	(0.0070)
Emissions	0.148	0.163	-0.0373 *
	(0.1120)	(0.1310)	(0.0179)
Trade/GDP	0.000475 *	0.000592 **	0.0000808
	(0.0003)	(0.0002)	(0.0007)
Real GDP Growth	-0.0009	-0.00186	-0.000486
	(0.0007)	(0.0012)	(0.0006)
PPI inflation	-0.00022	-0.000803	0.000532
	(0.0006)	(0.0007)	(0.0004)
Observations	174632	121977	52612
R^2	0.192	0.2	0.184

Standard errors in parentheses

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

Table A.31: Firm-level: Main Effects. Extensive margin: outflows

	All countries	AE	EME
Source:			
Climatological	0.00369	0.00421	0.00201
	(0.0027)	(0.0027)	(0.0030)
Meteorological	-0.000234	-0.000262	-0.00015
	(0.0011)	(0.0012)	(0.0013)
Hydrological	0.00399 *	0.0036 *	0.00473 *
	(0.0021)	(0.0020)	(0.0024)
EPS	-0.00647	-0.00575	-0.00779
	(0.0053)	(0.0056)	(0.0056)
CO2 Tax	-0.0196 *	-0.02 **	-0.0195
	(0.0096)	(0.0096)	(0.0116)
Emissions	-0.00828	-0.00659	-0.00699
	(0.1140)	(0.1140)	(0.1300)
Climate risk	0.00564	0.00876	-0.0014
	(0.0048)	(0.0049)	(0.0052)
Target:			
Climatological	0.00241 **	0.000606	0.00675 **
	(0.0010)	(0.0010)	(0.0021)
Meteorological	-0.000346 ***	-0.000552	-0.000769 ***
	(0.0001)	(0.0005)	(0.0001)
Hydrological	0.000326	-0.000292	0.000751 ***
	(0.0003)	(0.0006)	(0.0002)
EPS	0.00124	0.000764	0.00519 **
	(0.0015)	(0.0023)	(0.0020)
CO2 Tax	0.00239	0.00954 **	0.000216
	(0.0017)	(0.0041)	(0.0011)
Emissions	-0.0306 *	0.0151	-0.0755
	(0.0168)	(0.0246)	(0.0487)
Trade/GDP	0.000211	0.000218	0.000585 **
	(0.0001)	(0.0002)	(0.0002)
Real GDP Growth	-0.000437 **	-0.00106 ***	-0.000005
	(0.0002)	(0.0001)	(0.0003)
PPI inflation	-0.000412	-0.000435	-0.000269
	(0.0003)	(0.0006)	(0.0003)
Observations	159535	111456	48045
R^2	0.167	0.173	0.171

Standard errors in parentheses

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

Table A.32: Firm-level: Interactions with emission productivity. Intensive margin

	All countries	AE	EME
Source:			
Climatological$*EP^T$	-0.0135 *	-0.0161	-0.00911
	(0.0070)	(0.0109)	(0.0050)
Meteorological$*EP^T$	0.00221 *	0.00304	0.00196
	(0.0012)	(0.0021)	(0.0013)
Hydrological$*EP^T$	-0.00221	-0.00551	0.00187
	(0.0022)	(0.0033)	(0.0030)
EPS$*EP^T$	0.000077	0.00127	-0.00722
	(0.0079)	(0.0107)	(0.0130)
CO2 Tax$*EP^T$	-0.0425 ***	-0.0601 ***	-0.00242
	(0.0151)	(0.0211)	(0.0098)
Emissions$*EP^T$	0.0608 **	0.0866 **	0.0198
	(0.0234)	(0.0351)	(0.0253)
Climate risk$*EP^T$	-0.0193	-0.0252 **	-0.00679
	(0.0060)	(0.0095)	(0.0052)
Target:			
Climatological	0.000077	0.00127	-0.00722
	(0.0079)	(0.0107)	(0.0130)
Meteorological	-0.0425 ***	-0.0601 ***	-0.00242
	(0.0151)	(0.0211)	(0.0098)
Hydrological	-0.00273	-0.019 *	-0.00214
	(0.0037)	(0.0096)	(0.0014)
EPS	-0.00146	-0.00579	-0.0141 **
	(0.0030)	(0.0058)	(0.0057)
CO2 Tax	-0.0012	0.00187	0.007
	(0.0154)	(0.0314)	(0.0444)
Emissions (EP^T)	-0.128	-0.242	-0.329 **
	(0.1160)	(0.2120)	(0.1350)
Climatological$*EP^T$	-0.0148	0.088	0.0773 **
	(0.0409)	(0.0704)	(0.0328)
Meteorological$*EP^T$	0.0173 **	0.0263 **	-0.0228 **
	(0.0077)	(0.0122)	(0.0098)
Hydrological$*EP^T$	-0.00322	0.00205	0.0243 **
	(0.0088)	(0.0142)	(0.0092)
EPS$*EP^T$	-0.0246	0.00816	0.166 **
	(0.0235)	(0.0453)	(0.0565)
CO2 Tax$*EP^T$	0.0303	0.0212	-0.0248
	(0.1170)	(0.1800)	(0.4000)
Trade/GDP	-0.00015	0.000116	-0.000285
	(0.0002)	(0.0003)	(0.0002)
Real GDP Growth	-0.000302	-0.00107	0.000229
	(0.0004)	(0.0007)	(0.0002)
PPI inflation	-0.00037	-0.00000735	0.000172
	(0.0003)	(0.0006)	(0.0002)
Observations	89923	61185	27008
R^2	0.385	0.403	0.499

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.33: Firm-level: Interactions with emission productivity. Extensive margin: inflows

	All countries	AE	EME
Source:			
Climatological$*EP^T$	-0.00924	0.00178	0.0186
	(0.0195)	(0.0286)	(0.0331)
Meteorological$*EP^T$	0.00197	0.000303	-0.000718
	(0.0034)	(0.0050)	(0.0070)
Hydrological$*EP^T$	-0.00903	-0.00795	-0.00676
	(0.0053)	(0.0051)	(0.0097)
EPS$*EP^T$	-0.00632	-0.00216	0.00835
	(0.0162)	(0.0216)	(0.0397)
CO2 Tax$*EP^T$	-0.0547	-0.019	0.0303
	(0.0324)	(0.0390)	(0.0747)
Emissions$*EP^T$	0.0655	0.0293	0.31 **
	(0.0572)	(0.0660)	(0.1100)
Climate risk$*EP^T$	-0.00761	-0.0172	0.0261
	(0.0139)	(0.0182)	(0.0283)
Target:			
Climatological	-0.00632	-0.00216	0.00835
	(0.0162)	(0.0216)	(0.0397)
Meteorological	-0.0547	-0.019	0.0303
	(0.0324)	(0.0390)	(0.0747)
Hydrological	0.00654	-0.0116	0.0119
	(0.0053)	(0.0080)	(0.0071)
EPS	0.0141	0.0149	0.0273
	(0.0105)	(0.0111)	(0.0222)
CO2 Tax	0.00275	-0.0512	-0.111
	(0.0319)	(0.0859)	(0.1160)
Emissions (EP^T)	0.181	0.0954	0.237
	(0.1800)	(0.2690)	(0.2190)
Climatological$*EP^T$	-0.102 **	0.0128	-0.0344
	(0.0459)	(0.0437)	(0.0701)
Meteorological$*EP^T$	0.0302 ***	0.0284	0.0638 *
	(0.0106)	(0.0195)	(0.0319)
Hydrological$*EP^T$	0.00317	0.0493	0.00767
	(0.0179)	(0.0359)	(0.0134)
EPS$*EP^T$	-0.0579	-0.0457	-0.323
	(0.0456)	(0.0478)	(0.2780)
CO2 Tax$*EP^T$	0.0202	0.346	1.04
	(0.2390)	(0.5010)	(1.0720)
Trade/GDP	0.000595 *	0.000965 **	0.000818
	(0.0003)	(0.0004)	(0.0007)
Real GDP Growth	-0.000852	-0.00248	0.00118
	(0.0009)	(0.0016)	(0.0009)
PPI inflation	-0.000456	-0.000377	0.000491
	(0.0009)	(0.0013)	(0.0011)
Observations	172098	119100	49895
R^2	0.698	0.725	0.733

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.34: Firm-level: Interactions with emission productivity. Extensive margin: outflows

	All countries	AE	EME
Source:			
Climatological$*EP^T$	-0.0054	-0.0030	-0.0140
	(0.0041)	(0.0048)	(0.0092)
Meteorological$*EP^T$	0.0029 ***	0.0034 **	0.0028
	(0.0010)	(0.0014)	(0.0026)
Hydrological$*EP^T$	-0.0005	-0.0004	-0.0021
	(0.0032)	(0.0034)	(0.0058)
EPS$*EP^T$	0.0018	0.0038	-0.0290
	(0.0111)	(0.0115)	(0.0207)
CO2 Tax$*EP^T$	-0.0260	0.0170	-0.0748 *
	(0.0164)	(0.0213)	(0.0358)
Emissions$*EP^T$	0.1010 ***	0.1140 **	0.0882
	(0.0344)	(0.0430)	(0.0571)
Climate risk$*EP^T$	0.0334 ***	0.0366 ***	-0.0418 *
	(0.0075)	(0.0090)	(0.0202)
Target:			
Climatological	0.0018	0.0038	-0.0290
	(0.0111)	(0.0115)	(0.0207)
Meteorological	-0.0260	0.0170	-0.0748 *
	(0.0164)	(0.0213)	(0.0358)
Hydrological	0.0035 **	-0.0003	0.0033
	(0.0015)	(0.0023)	(0.0018)
EPS	0.0015	0.0016	0.0090
	(0.0024)	(0.0040)	(0.0063)
CO2 Tax	-0.0015	-0.0078	-0.2070 **
	(0.0076)	(0.0151)	(0.0756)
Emissions (EP^T)	-0.0092	-0.0183	0.1310
	(0.0391)	(0.0495)	(0.1050)
Climatological$*EP^T$	-0.0212 **	0.0028	-0.0078
	(0.0103)	(0.0114)	(0.0209)
Meteorological$*EP^T$	-0.0048	-0.0067	-0.0271 **
	(0.0029)	(0.0054)	(0.0107)
Hydrological$*EP^T$	-0.0080 ***	0.0021	-0.0041
	(0.0025)	(0.0055)	(0.0079)
EPS$*EP^T$	-0.0113	-0.0113	-0.0925
	(0.0096)	(0.0149)	(0.0777)
CO2 Tax$*EP^T$	0.0490	0.0860	1.9600 **
	(0.0524)	(0.0856)	(0.7060)
Trade/GDP	0.0001	0.0002	0.0003
	(0.0001)	(0.0001)	(0.0002)
Real GDP Growth	-0.0004 **	-0.0009 ***	0.0003
	(0.0002)	(0.0002)	(0.0002)
PPI inflation	-0.0002	-0.0004	0.00001
	(0.0002)	(0.0005)	(0.0003)
Observations	156889	108429	45176
R^2	0.724	0.749	0.747

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.35: Firm-level: Disasters only. Intensive margin

	All countries	AE	EME
Target:			
Climatological	-0.0035	-0.00557 *	0.00223 **
	(0.0021)	(0.0029)	(0.0011)
Meteorological	0.000389	0.00139 ***	-0.000992 **
	(0.0004)	(0.0004)	(0.0004)
Hydrological	-0.000247	0.00117	-0.000125
	(0.0003)	(0.0007)	(0.0001)
Climatological* Post COP21	-0.000571	0.00241	-0.00264 **
	(0.0010)	(0.0020)	(0.0011)
Meteorological* Post COP21	-0.000885 **	-0.00143 **	0.000351
	(0.0003)	(0.0005)	(0.0003)
Hydrological* Post COP21	0.000484 **	-0.00191	-0.000392 *
	(0.0002)	(0.0014)	(0.0002)
Trade/GDP	0.000114 **	0.000253 *	-0.0000549 *
	(0.0000)	(0.0001)	(0.0000)
Real GDP Growth	-0.000318 *	-0.000411	-0.000208
	(0.0002)	(0.0003)	(0.0002)
PPI inflation	-0.0000632	-0.00024	0.00000447
	(0.0001)	(0.0004)	(0.0000)
Observations	369864	199750	149900
R^2	0.401	0.414	0.497
Vulnerability	-0.146	-0.0397	0.176
	(0.2240)	(0.4680)	(0.1850)
Vulnerability * Post COP21	0.0275 ***	-0.0275	0.00858
	(0.0097)	(0.0557)	(0.0074)
Trade/GDP	0.000141 **	0.000326 *	0.0000505
	(0.0001)	(0.0002)	(0.0000)
Real GDP Growth	-0.000342	-0.000311	-0.000141
	(0.0002)	(0.0003)	(0.0001)
PPI inflation	-0.0000395	-0.000147	0.0000271
	(0.0001)	(0.0004)	(0.0000)
Observations	369864	199750	149900
R^2	0.4	0.413	0.496

Standard errors in parentheses

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

Table A.36: Firm-level: Disasters only. Extensive margin: inflows

	All countries	AE	EME
Target:			
Climatological	-0.00769	-0.0114 ***	0.0103 **
	(0.0047)	(0.0039)	(0.0043)
Meteorological	0.000324	0.00137	-0.00251
	(0.0012)	(0.0017)	(0.0018)
Hydrological	-0.00126 *	-0.000806	-0.000394
	(0.0007)	(0.0019)	(0.0005)
Climatological* Post COP21	0.000951	0.0056	-0.0129 **
	(0.0040)	(0.0054)	(0.0058)
Meteorological* Post COP21	-0.00176 ***	-0.00224	0.000521
	(0.0006)	(0.0012)	(0.0008)
Hydrological* Post COP21	-0.0000572	-0.00132	-0.00204 ***
	(0.0005)	(0.0027)	(0.0004)
Trade/GDP	-0.0000207	-0.000122	-0.000072
	(0.0002)	(0.0003)	(0.0002)
Real GDP Growth	-0.0000908	0.000473	0.000141
	(0.0004)	(0.0009)	(0.0004)
PPI inflation	-0.000587 ***	-0.00108	-0.0002
	(0.0002)	(0.0007)	(0.0002)
Observations	655845	355469	262303
R^2	0.619	0.683	0.628
Vulnerability	-0.655	-0.13	-0.372
	(0.4800)	(0.9560)	(0.5480)
Vulnerability * Post COP21	0.077 *	-0.037	0.012
	(0.0403)	(0.1240)	(0.0499)
Trade/GDP	0.000132	-0.00000541	0.000315
	(0.0002)	(0.0003)	(0.0002)
Real GDP Growth	0.00000619	0.000418	0.000235
	(0.0005)	(0.0009)	(0.0005)
PPI inflation	-0.000433 **	-0.00114	-0.000138
	(0.0002)	(0.0008)	(0.0002)
Observations	655845	355469	262303
R^2	0.619	0.683	0.628

Standard errors in parentheses

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

Table A.37: Firm-level: Disasters only. Extensive margin: outflows

	All countries	AE	EME
Target:			
Climatological	-0.000066	-0.00124 ***	0.00133
	(0.0007)	(0.0004)	(0.0008)
Meteorological	0.0000567	-0.0000405	-0.00072 **
	(0.0002)	(0.0003)	(0.0003)
Hydrological	0.0000194	-0.00021	0.000504 **
	(0.0002)	(0.0004)	(0.0002)
Climatological* Post COP21	0.0000634	0.00125	0.000182
	(0.0008)	(0.0010)	(0.0015)
Meteorological* Post COP21	-0.00051 **	0.0000279	-0.0000116
	(0.0002)	(0.0003)	(0.0003)
Hydrological* Post COP21	0.0000626	-0.00302	-0.000487 **
	(0.0002)	(0.0009)	(0.0002)
Trade/GDP	0.000002	0.000125	-0.000108 **
	(0.0000)	(0.0001)	(0.0000)
Real GDP Growth	-0.000114	0.0000856	0.0000682
	(0.0001)	(0.0002)	(0.0001)
PPI inflation	-0.000126 *	-0.000388	-0.0000619
	(0.0001)	(0.0004)	(0.0001)
Observations	618846	336052	246176
R^2	0.7000	0.7380	0.6990
Vulnerability	-0.156	-0.127	0.0344
	(0.1130)	(0.2430)	(0.1780)
Vulnerability * Post COP21	0.0229 *	0.00205	-0.011
	(0.0126)	(0.0375)	(0.0150)
Trade/GDP	0.0000365	0.000164 **	-0.0000564
	(0.0000)	(0.0001)	(0.0000)
Real GDP Growth	-0.0000652	0.0000177	0.0000677
	(0.0001)	(0.0003)	(0.0002)
PPI inflation	-0.0000858	-0.000382	-0.0000482
	(0.0001)	(0.0004)	(0.0001)
Observations	618846	336052	246176
R^2	0.7000	0.7380	0.6990

Standard errors in parentheses

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