NBER WORKING PAPER SERIES

# SHOULD THEY STAY OR SHOULD THEY GO? CLIMATE MIGRANTS AND LOCAL CONFLICTS

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Working Paper 24447
http://www.nber.org/papers/w24447

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2018

The research leading to these results has received funding from the Italian Ministry of Education, University and Research and the Italian Ministry of Environment, Land and Sea under the GEMINA project. Valentina Bosetti also acknowledges funding from the ERC Starting Grant 336703 project RISICO and thanks IGIER The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 24447
March 2018
JEL No. F22,H56,Q34,Q54

**ABSTRACT**

There is extensive evidence that higher temperature increases the probability of local conflict. There is also some evidence that emigration represents an important margin of adaptation to climatic change. In this paper we analyse whether migration influences the link between warming and conflicts by either attenuating the effects in countries of origin and/or by spreading them to countries of destination. We find that in countries where emigration propensity, as measured by past diaspora, was higher, increases in temperature had a smaller effects on conflict probability, consistent with emigration functioning as "escape valve" for local tensions. We find no evidence that climate-induced migration increased the probability of conflict in receiving countries.

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# 1 Introduction

By worsening living conditions, reducing agricultural productivity, and making some areas inhospitable, climate change and in particular temperature increases may force individuals to move out of rural and hot areas into places with cooler climate.[1] In rural and vulnerable areas, an increase in temperatures may produce a significant deterioration in living conditions (IPCC, 2014). Migration is an important margin of adaptation for the local population to these climatic changes. In both ancient and more recent history of civilizations, examples abound in which people responded to extreme weather conditions by moving out of regions into other areas (Black et al., 2011; Hartmann, 2010). For example, the urban centres of the Harrapan Society in the Indus Valley of Pakistan and Northern India were abandoned approximately 4000 years ago as the result of an intense 200-year drought (Marris, 2014). More recently, the American Dust Bowl of the 1930s led hundreds of thousands of families to abandon the US and Canadian prairies, savaged by violent dust storms and turned into deserts from intensive land use, and to move West to the states of Oregon and California (Romm, 2011; Hornbeck, 2012).

The possibility of people moving to other countries may reduce the costs of climate changes and may thus attenuate the link between climate change and conflict, allowing international migrants to diffuse potential tensions produced by scarce resources. Many countries in sub-Saharan Africa have experienced civil conflicts in recent decades and warming, droughts and extreme weather events have been identified as major drivers of these internal conflicts (Burke et al., 2009). The existence of barriers or constraints on emigration (arising, for instance, from liquidity constraints (Foresight, 2011), or lack of information about opportunities abroad) may increase population pressure and exacerbate the consequences of climate change on many outcomes, including civil conflicts.

On the other hand, increased flows of climate migrants might produce effects in destination countries. Demographic and economic pressure produced by the new arrivals in the receiving countries may trigger ethnic and cultural tensions, which could generate new conflicts or fuel existing ones. The pressure on available resources could be exacerbated if language barriers and cultural differences make the interaction between locals and immigrants difficult. The environmental conflict model (Homer-Dixon, 2001) postulates that migration induced by environmental factors will strain scarce resources in destination countries and become a primary source of instability. In addition migration may increase ethnic diversity which is a key factor for conflict (Horowitz, 2000; Fearon and Laitin, 2003), and could produce distrust and deterioration of social capital which

[1] Climate change refers to long-term gradual changes in average weather conditions, measured by temperature and precipitation, and may also include environmental shocks whose frequency can be linked to a change in average weather, such as storms, floods, droughts and rise in sea level. In the present paper we concentrate our attention on the gradual change in average weather (temperature and precipitations) and its implications for migration flows.

are also triggers of conflicts (Reuveny, 2007).

Since climate-induced migration may be an escape valve in the areas of origin and a possible driver of social unrest in the areas of destination, we investigate the following empirical questions: is there evidence in the recorded data of either of these two roles? Has one of the two prevailed, so far? And more specifically, can we identify such effects using climate variation?

The latest IPCC assessment report (IPCC, 2014), the OECD outlook on migrations (OECD, 2016), and the World Bank (Bougnoux et al., 2014), among many other international institutions, have stressed the role that climate-migrants could potentially play on social stability in the future decades. Their considerations however are general and speculative, and little scientific evidence has so far been put forward of such consequences of climate migration. The new contribution of this study is in identifying and estimating the potential effects of climate-driven migrations on conflict in sending and in receiving countries.

So far, the literature has been developing mainly along three separate routes: 1) the effect of climate change on emigration patterns; 2) the effect of climate change on civil conflicts and wars; and 3) the effect of migrations on conflicts. It seems only natural to connect these three aspects and ask whether emigration attenuates the effect of climate on conflict and/or whether it spreads to immigrant-receiving countries.

In analysing climate and migration, studies with different methodological approaches and different measures of migration have yielded conflicting results. There is general agreement that climatic shocks affect internal migration (among others Barrios et al. (2006); Gray (2009); Marchiori et al. (2012); Bohra-Mishra et al. (2014); Kelley et al. (2015)). The effect on international migration, however, is less clear (Marchiori et al., 2012; Beine and Parsons, 2015; Cattaneo and Peri, 2016; Cai et al., 2016). The limited effect of climate on international migration may be due to the higher costs and risks associated with this form of migration, as well as to the existence of restrictive immigration policies in destination countries. Beine and Parsons (2015), for example, do not find a direct impact of deviations and anomalies in temperature on bilateral migration flows. Cattaneo and Peri (2016) find that rising average temperature triggers international migration but only from middle income countries. In very poor countries higher temperature actually reduced the probability of international emigration, consistent with the presence of poverty traps due to liquidity constraints in the rural areas, which are made more severe by climate change. Cai et al. (2016) report an increase in emigration rates towards OECD destinations as a consequence of average annual temperature increase, without differentiating the response between poor and middle income countries. Internal- and international migration could be connected and complementary to one other, as in Marchiori et al. (2012), who estimate that temperature and rainfall anomalies have produced the displacement of 5 million people in Sub-Saharan Africa, and document a sequential process first toward internal- and, subsequently, toward international migration.

When analysing the connection between climate change and conflicts there seems to be compelling evidence that climate affects conflict across a variety of contexts, both at the national and at the subnational levels (Dell et al., 2014). Burke et al. (2010, 2009) find that temperature increases promoted civil wars in Africa. Hsiang et al. (2011) report that conflicts are more likely to take place during hot and dry El Nino years than during cooler La Nina years. Harari and Ferrara (2012) find that climate shocks increase conflicts in a geographically disaggregated analysis. Nevertheless, Buhaug (2010) finds that in African countries climate variability is only weakly related to armed conflict; instead, civil wars are better explained by ethno-political exclusion and low GDP. Couttenier and Soubeyran (2014) find an insignificant relationship between civil war and weather variables such as rainfall and temperature, and only a weak (positive) relationship with drought in Sub-Saharan Africa. To examine the relationship systematically, Hsiang et al. (2013) conduct a meta-analysis of all empirical studies of weather and conflict. They conclude that warmer temperatures or more extreme rainfall systematically increase the risk of conflicts.

Finally, a third avenue of research has documented that migration episodes may increase the risk of conflicts. For example, Fearon and Laitin (2011) estimate that more than 30 percent of all ethnic civil conflicts between 1945 and 2008 were between indigenous local populations and recent immigrants. These conflicts, which combine an ethnic component and an indigenous component (Cote and Mitchell, 2015), have been labelled "Sons of the Soil" conflicts. Violence typically arises between a minority ethnic group that feels an entitlement to the local land and migrants who originate from a different part of the same country. Some studies have also been conducted on the link between refugees and international conflicts. Salehyan and Gleditsch (2006) find that refugees from neighbouring countries increase the probability of civil war in host countries, while Salehyan (2008) finds that refugees significantly increase the likelihood of militarised interstate disputes between the source and the destination of the refugee flows. Docquier et al. (2017) find a positive impact of migration on militarised interstate dispute between pairs of countries.

The triple connection from climate to migration and conflict, which we analyse in this paper, has been envisaged and discussed in the literature only in a theoretical setting (Prieur and Schumacher, 2016) or by using a qualitative approach (Reuveny, 2007). However, a clean causal empirical connection, as far as we know, has not been adequately tested (Withagen, 2014). Some of the existing empirical studies that find strong causal evidence linking climatic events to conflicts argue that a large influx of climate-induced migrants could be a possible mechanism of transmission of conflict (Hsiang et al., 2013). This channel, however, remains speculative in their analysis and it is not tested directly. The only exception is Ghimire et al. (2015), who analyse the link between the number of people displaced by floods and civil conflicts using a statistical model for more than 100 countries during 1985–2009. The authors find that flood-induced human displacement fuels existing conflicts but does not produce new ones. This paper, however, focuses only on displacement of people due to floods, and instruments them with measures of rainfall. Moreover, the paper considers only internally displaced people and neither the potential for international migration nor possible spillover effects of the outflows on conflicts in foreign destination countries.

Our analysis is the first to consider simultaneously two potential mechanisms, one in the origin and one in the destination areas, for climate change to affect conflict through migration. To do this we use a panel of country-level data on climate, conflict, emigration and immigration, encompassing 126 countries over a period of forty years, 1960-2000. Our identification approach uses climate change as the exogenous push factor, and the presence of historical migrant networks (in the form of pre-existing diaspora of migrants at the beginning of the period under analysis) as an indicator of "propensity to emigrate" from a specific country. After confirming that raises in temperatures increase the probability of conflicts in poor countries, we analyse whether the response of conflict is stronger in countries where the propensity to emigrate is lower. We find significant evidence that this is the case, supporting the hypothesis of emigration acting as an escape valve for conflict. We then use a climate- and a geography-based gravity model to predict the flow of bilateral climate migrants and we analyse whether these flows affect conflict probability in the receiving countries. We do not find any significant effect of predicted climate migrant inflows on conflicts, once we control for the direct effect of climate in the receiving countries and other geographic variables.

Both results are interesting and important. They imply that during periods of temperature increases in poor countries, higher international mobility reduces the probability of civil conflicts at origin, without significantly increasing it in the destination countries. To summarise our results, we find that an increase in temperature by one degree Celsius increases the probability of civil conflict in a poor country by eight percentage points (the average probability is 26 percent in any given year for a poor country). However, if the country is poor and in the lowest quartile of international diaspora, that probability increases to 14-17 percentage points. At the same time, such increased emigration flows do not seem to affect the probability of conflict in the receiving countries.

The rest of the paper is organised as follows. Section 2 presents a description of the data and variables. Section 3 presents the empirical methodology used to identify the relationship between migration and conflict in countries of origin, and shows the main results of our estimations. Section 4 describes the empirical approach and shows the main findings of climate-induced migration and conflict in receiving countries. Section 5 concludes the paper.

## 2 Data and Stylised Facts

To perform the relevant empirical analysis we organise and harmonise three datasets that are briefly described here. They include information on bilateral migrations, temperature and precipitation, and internal conflicts. The migration data are taken from Ozden et al. (2011), who report stocks of migrants from 226 origin to 266 destination countries for each of the five census rounds between 1960 and 2000. The advantage of these data is that it covers all possible pairs of origin and destination countries in the world, rather than only OECD destinations. Another advantage is that, since the sources of these data are national Censuses, the data are more accurate in counting foreign-born individuals as compared to noisier yearly data on the flows of migrants between two countries. The data are only available every ten years and hence we interpolate them when we construct yearly datasets to match the data on temperature and conflict. We will also perform the analysis using decennial intervals. Starting from the bilateral data, we compute net bilateral migration flows between each country pair as the difference between bilateral stocks in two consecutive Census years as in Beine and Parsons (2015) and Cattaneo and Peri (2016).[2] We then use the sum of all net flows for the same destination countries to compute total net immigration in a decade. We compute immigration rates as the ratio between the aggregate net inflows of migrants in the decade and the destination country's population at the beginning of the decade. The computed immigration flows and rates cover the period from 1960 to 2000.

The same dataset is also used to measure emigration rates and the pre-existing "propensity to emigrate" in different countries. The 1960 stock of expatriates relative to the size of the total population in the country of origin in the same year is what we call "diaspora" and it captures the past intensity of emigration. The "diaspora" measure" can be seen as a proxy for the pre-1960 propensity to emigrate from a given country. It would facilitate emigration for a series of reasons. First, the existence of a large network of nationals abroad reduces the costs of moving and increases the information available to perspective emigrants, increasing the probability that they respond to migration incentives. Second, there are often family ties between the diaspora and people in the country of origin. Many developed countries select a large proportion of immigrants on the basis of family reunification, hence this creates an easier channel of migration. Finally, the diaspora variable also measures how likely emigration was in the past, capturing some of the potential barriers to emigration that are specific to a given country of origin and likely to persist.

The second dataset measures temperatures and precipitations. The information is from the data collection system called GLDAS v2. GLDAS provides gridded climatic data obtained by combining satellite and ground-based observational data. We start from data

[2] Bilateral net flows that are negative (usually very small numbers) are set to 0. They are due to mortality of the stock of emigrants abroad and return migration.

at 1 x 1 degree resolution over the whole world about precipitation and temperature taken every 3 hours. The gridded data are then aggregated into country-year averages using the population weights for the year 2000 (aggregated to 1 x 1 degree resolution) from the Gridded Population of the World v3. This constitutes our panel of data on temperature and precipitation for each year and country.

The data on civil conflicts are from the *Uppsala Conflict Data Program*, developed in collaboration with the *Peace Research Institute Oslo*. The UCDP/PRIO Armed Conflict Dataset is the most widely used source of conflict data at the country level. The dataset offers a yearly binary indicator equal to one when there exists a conflict in a specific country, based on the number of deaths per year. We consider only conflicts coded under the types 3 and 4 of the UCDP/PRIO database, which represent civil conflicts.[3] As our interest is mainly in low income countries and on conflict that may arise over competition for limited local resources, following previous literature we concentrate on this form of violence, which is more widespread and endemic in poor countries. Other types of conflict, such as inter-country conflicts or multi-country conflicts, may reflect international disputes which should be affected to a smaller extent by economic hardship produced by climate change. We will examine those conflicts in robustness checks.

The summary statistics for our key variables are reported in Table 1. Country-year observations are the units of our analysis. Notice two important stylised facts emerging already from the summary statistics. First, the average temperature across countries has increased between the periods 1960-1980 and 1981-2000 by almost 0.36 degrees Celsius. More interesting, however, is the heterogeneity in this variation: the country where the temperature increased the most between the two periods registered a + 0.76 degree Celsius change, while some countries saw an average decrease in temperature. This panel variation is the source of differences that will identify our effects. Second, there is also a very large variation across countries in the intensity of the diaspora in 1960. In some countries the percentage of citizens abroad is as high as 26% of their resident total population. Other countries had almost no diaspora at all. Similarly, immigration and emigration rates vary quite widely. Finally, the annual incidence of conflict is 0.18, implying that 18% of the world's countries are in a conflict situation in an average year, while over a ten year horizon 35% of countries spend at least one year in conflict.

Figures 1 and 2 show the simple correlation between a measure of conflict, namely the share of years with conflict over the 1960-2000 period, and two measures of migration to and from that country. In particular, Figure 1 shows the correlation between the natural logarithm of total immigration flows and the presence of conflict, across countries. Granted that these are total migrants and many factors affect this relation, the scatter-

[3] Type 3 conflicts are internal armed conflicts that occur between the government of a country and one or more internal opposition group(s) without intervention from other countries. Type 4 are internationalized internal armed conflicts that occur between the government of a country and one or more internal opposition group(s) with intervention from other states (secondary parties) on one or both sides.

plot does not suggest any significant correlation and, in particular, no positive association is shown. The OLS coefficient of the regression line is -0.01 with a standard error of 0.011. Figure 2 shows instead the same dependent variable (percentage of years in conflict during the 1960-2000 period) against the measure of diaspora intensity as of 1960, namely the population from one country living abroad relative to the total resident population in 1960. This variable is strongly associated with the propensity of people from a country to migrate abroad and, as we will see, it is strongly associated with emigration rates between 1960 and 2000. The scatterplot shows a negative and statistically significant association of diaspora with civil conflicts. The coefficient is equal to -1.16 with a standard error of 0.37. Again this is a pure correlation of raw variables and one cannot read much into it. It is, however, consistent with the idea that larger emigration propensity may attenuate the probabilities of local conflict.

The reasons for the negative association shown above can be many. In the next set of figures we provide more information on the role of temperature increase for different levels of the diaspora variable. In the five panels of Figure 3 we show the correlation between average temperature during the period and the share of years in conflict, separating the countries among quintiles of the intensity of their diaspora. The top three panels show those countries with diaspora in the lower three quintiles, the bottom panels show countries with diaspora in the top two quintiles. While the scatter-plots are rather noisy, we can see a positive relation between temperature and conflict frequency which is stronger and more significant among countries with small diaspora levels (top 3 panels) relative to those with larger diaspora levels (bottom 2 panels). The regression coefficient is 1.38, 0.56 and 1.24 in the top three panels and significant at the 5% level in one of the three, while it is 0.17 and 0.52 in the bottom two, never significant at any level. These graphs together suggest that the potential positive correlation between temperature and conflict is attenuated in those countries where a large diaspora decreases migration costs and allows more people to emigrate. This fact, while merely suggestive, is consistent with the hypothesis of migration acting as an escape valve for tensions connected to higher temperatures.

# 3 Warming, Diaspora and Conflict in the Countries of Origin

The first objective of this paper is to test the hypothesis that migration may mitigate the negative consequences of temperature increases. In particular, for countries with small networks of past emigrants (diaspora), which we take as a pre-determined proxy of higher emigration costs and lower "propensity" for international emigration, we test whether the relation between warming and social unrest is positive and stronger relative to countries with large diaspora. This would be consistent with a scenario in which emigration attenuates the effect of climate change on internal civil conflict and works as an escape valve for people affected negatively by the change in climate. If family migration is an insurance mechanism against very bad outcomes connected to climate change, then in periods of low agricultural production some families may have members migrating to earn extra income in another country or may even emigrate in their entirety. More families with such opportunities would imply fewer of them strained by economic hardship.

## 3.1 Basic Specification without Diaspora

Before tackling our main question, however, we reproduce some results from the existing empirical literature that analyses how temperature and precipitation affect the risk of civil conflicts. We estimate a reduced-form relationship between temperature, precipitation and conflict controlling only for country, year and region by time fixed effects. We avoid including controls variables such as socio-demographic and economic factors, as those are endogenously affected by climate and potentially channels of the total impact of climate on migration. Temperature and precipitation affect many socioeconomic factors which in turn affect the probability of conflict and are typically included in equations predicting conflict (Fearon and Laitin, 2003; Collier and Hoeffler, 2004; Montalvo and Reynal-Querol, 2005; Cederman and Girardin, 2007; Collier and Rohner, 2008; Esteban et al., 2012; Morelli and Rohner, 2015). Our objective is to obtain an estimate of the total impact of temperature increases on conflicts through all possible channels. Hence, following the majority of studies in this literature (Burke et al., 2009; Hsiang et al., 2011; Dell et al., 2012; Hsiang et al., 2013), we use a parsimonious specification with no additional controls beyond a rich set of fixed effects to estimate the total impact of temperature and precipitations on conflicts.

One fact we account for, is the potentially differential response to climate change between poor and rich countries. Economically developed countries have lower rates of conflicts due to institutional reasons linked to their greater financial, economic, administrative and military stability and because the opportunity costs and the stakes of joining a conflict are higher (Fearon and Laitin, 2003). They also have economies that are less exposed to the effects of changes in climate, as they are less dependent on agriculture which is the most affected sector. Therefore, we allow the estimated effects of temperature and precipitation on the probability of conflict to vary between rich and poor countries. We do this in a relatively stark way by distinguishing low income countries from all other countries. We use the World Bank income group classification (World Bank, 2015) and create a dummy variable equal to one for low income countries, which includes roughly the bottom quartile of countries in the ranking of gross national income per capita in year

2000.[4] We test the robustness of our results to different definition of "poor" countries.

Our data produce an unbalanced panel dataset for a sample of 126 countries over the period 1960-2000. The empirical specification that we estimate, with the indicator of conflict as our dependent variable, is the following:

$$C_{jt} = \alpha T_{jt} + \beta T_{jt} * D_j + \gamma P_{jt} + \vartheta P_{jt} * D_j + \nu_j + \pi_t + \phi_{rt} + \varepsilon_{jt} \quad (1)$$

$C_{jt}$ is a dummy variable, equal to one if at least one civil conflict (i.e. internal to that country) occurred during year $t$ in country $j$, and zero otherwise. Civil conflicts, as measured in our dataset, involve battles with at least 25 deaths in a given year. We then include country fixed effects ($\nu_j$), capturing characteristics such as geography and institutions that may affect conflict but do not change (or change very slowly) over time. We also include year fixed effects ($\pi_t$), capturing common world trends in temperature and conflicts. We also have dummies that interact year and region fixed effects ($\phi_{rt}$) to control for regional, time-varying factors in geo-politics and socio-economic conditions over the considered time span.[5]

$T_{jt}$ is the annual average temperature of country $j$ measured in degrees centigrade while $P_{jt}$ measures the average annual precipitation in hundreds of millimetres per year. $D_j$ is a dummy variable that equals one if country $j$ is categorised as low income according to the World bank definition. The dummy is equal to zero for middle income and rich countries.

In Table 2 we report the estimates of the coefficients of interest from Equation (1). We use three specifications that differ in terms of timing of the variables. In Specification 1 (column (1)) we use annual data, which is the frequency at which the conflict and temperature data are available. In Specification 2 (column (2)) we use temperature and precipitation lagged one year, $T_{jt-1}$ and $P_{jt-1}$, as explanatory variables, allowing for some delay in the effect of temperature and precipitation on conflict. This is motivated by the idea that a bad harvest may produce the largest negative effects on available agricultural goods in the following year. As the yearly changes may capture short-run responses but omit slower and possibly more significant effect arising over decades, in Specification 3 (column (3)) we estimate Equation (1) using variables measured only in each census year, hence at decade intervals rather than each year. In this specification $C_{jt}$ is a dummy variable equal to one if at least one civil conflict occurred during the decade beginning with year $t = (1960, 1970, 1980, 1990)$ in country $j$, and zero otherwise. In this last specification, controls are also averaged over a time period of 10 years beginning in year $t$.

[4] The World Bank identifies four income groups, namely high income, upper-middle income, lower-middle income and low income, based on GNI thresholds.

[5] The world regions we use for the dummies are the following: Middle East and North Africa; Sub-Saharan Africa; Latin America and Caribbean; Western Europe and North America; Eastern Europe and Central Asia; East Asia and Pacific Islands.

The method of estimation we use is Least Squares and we cluster the standard errors at the country of origin level in order to allow for correlated country-specific shocks that may affect the probability of conflict in a country across years. Our measure of civil conflict is a binary variable. Our choice of a linear probability model (rather than a probit or a logit model) is due to the robustness of this method, the possibility to include a large set of dummies, and to the fact that the marginal effects have clearer interpretation in a linear model (Wooldridge, 2010; Bazzi and Blattman, 2014). We test non linear logit specifications in our robustness checks.

The estimates using the three specifications are reported in the three columns of Table 2. While increases in temperature had a negligible and not statistically significant effect on the risk of conflicts in rich and middle-income countries, the interaction between temperature and the low income dummy is positive, non negligible and statistically significant in two of the three specifications. When combining the main effect and the interaction of temperature and precipitation with the poor country dummy (shown in the bottom two rows of Table 2), we find in the lagged specification that an increase of temperature by one degree Celsius would increase the probability of conflict in poor countries by eight percentage point. This is a large increase considering that the average probability of conflict in low income countries in a given year is equal to 26 percent.

The effect is larger and more significant when considering the decade specification in column (3). The longer time differences allow us to compute the long-run elasticity of conflict probability to temperature change. The estimate shows that an increase in temperature of one degree centigrade in poor countries would increase by 50 percentage points the probability of a conflict in any of the years during the decade. This is an impact six to seven times stronger than within one year. This may be due to the fact that the deterioration of productive conditions due to temperature has a cumulative nature so that its effects on the probability of conflict accumulates over time.

In an alternative specification, we use as dependent variable the number of years of conflict in a decade, instead of the binary conflict variable. This is a measure of the intensity of conflicts in a decade. The results are presented in column (1) of Table A1 in the Appendix and suggest that an increase of one degree Celsius in temperature would be associated, in poor countries, with two additional years of conflict per decade, on average and ceteris paribus.

We also conduct a robustness check on possible non-linearity in the effect of temperature on conflict. There is some evidence that the relationship between temperature and productivity is non-linear IPCC (2014) and warming is more damaging for agricultural output above a certain threshold, or in relation to extreme temperature days. Therefore, the effect of an increase in temperature on conflict in poor countries could be partly due to a significant non-linearity of the main effect of temperature. If poor countries start from a baseline temperature higher than middle-income and rich countries, then differing impacts of temperature on conflict could be simply explained by this non-linear productivity effect. To test this hypothesis, we add squared terms for temperature and precipitation, without interacting them with the low income dummy in the contemporaneous, lagged and decade specifications. Table A2 presents the estimated coefficients. The coefficients of the squared terms are not statistically significant in any of the specifications, suggesting that a simple non-linearity in temperature would not explain the additional marginal impact of temperature on conflict in poor countries.

Summarizing the findings of Table 2, a one degree Celsius increase in average yearly temperature in a country is associated with an increase in the probability of a conflict arising in poor countries of six percentage points within one year in the contemporaneous specification, of eight percentage points the following year in the lagged specification, and of 50 percentage points if we consider the decade analysis of the decennial specification. The estimates obtained in columns (1) and (2) are not too far from the values shown for sub-Saharan Africa in the meta-analysis of Hsiang et al. (2013). Indeed, their regional focus selects African countries that are mainly overlapping with those in the "poor" country group used in our study. Hsiang et al. (2013) show an average effect of increasing the probability of conflict by 40% of the mean for a one degree Celsius increase in the temperature. Our one year lagged estimate implies an increase of eight percentage point relative to an average conflict probability of 26 percentage points in poor countries, which implies an effect equal to 34% of the mean conflict probability. Hence our estimates are somewhat smaller but not too distant from previous estimates.

## 3.2 Basic Specification with Diaspora Interaction

The focus of this paper is on the role of international migration in mediating the impact of climate change on conflict. We thus move to our main specification, which allows us to investigate whether, as warming affects the risk of conflict in a country, the propensity to emigrate of its citizens works to attenuate this effect (Black et al., 2011). We use the bilateral migration data from Ozden et al. (2011) to compute the diaspora in 1960 as a proxy for a country's propensity to emigrate. The diaspora, as defined above, is the stock of migrants born in country $j$ and living abroad in 1960 as a share of the resident population of country $j$ in the same year. This variable is pre-determined. A larger diaspora likely decreases the cost of, and increases the opportunities for, new migration. As there is abundant evidence that the network of family, friends and community members established abroad facilitates emigration of those left home, the diaspora variable is correlated with a country's propensity to emigrate. Figure 4 displays the average emigration rates between 1960 and 2000 for countries in each quintile of the diaspora measure. The average emigration rates between 1960 and 2000 was 0.03 (3 percent per decade) for countries in the bottom quintile of the diaspora in 1960, and 0.14 (14 percent per decade) for countries in the top quintile. This positive correlation indicates that the larger the diaspora, the larger the subsequent emigration rates. In our main regressions (Equation 2 below), we define a dummy for low diaspora countries as equal to one for those countries in the lowest quintile of the diaspora measure. In subsequent analyses we test for the robustness of results to changes in the threshold defining "low diaspora" countries (as those below 25th or 30th percentile of the diaspora distribution).

We estimate a variation of Equation (1), in which we add interaction terms between temperature and the low diaspora dummy, $(T_{jt} * E_j)$, and between precipitation and the low diaspora dummy$(P_{jt} * E_j)$ over the period 1960-2000. The estimating equation is:

$$C_{jt} = \alpha T_{jt} + \beta T_{jt} * D_j + \theta T_{jt} * E_j + \gamma P_{jt} + \vartheta P_{jt} * D_j + \lambda P_{jt} * E_j + \nu_j + \pi_t + \phi_{rt} + \varepsilon_{jt} \quad (2)$$

In particular, $E_j$ takes a value of one if country $j$ is in the bottom quintile of the diaspora distribution. For all other countries the diaspora dummy takes a value of 0. Following the same structure described above, we estimate Equation (2) and report the main coefficients on temperature, precipitation and their interactions with the low income and low-diaspora dummies in Table 3. As before, we consider three alternative specifications that differ by the timing of the variables: yearly contemporaneous, yearly lagged one year, and decennial.

The main effect of temperature on the risk of conflicts, captured by the coefficients in the first row of the table, measures the basic effect in non-poor, non-low-diaspora countries and it is not statistically different from zero in any specification. In poor countries, however, even those with medium to high levels of diaspora, increases in temperature lead to an increase in the probability of conflict. The coefficient on the Temperature-Poor country dummy interaction is positive and statistically significant in two out of three specifications. The coefficient capturing the effect of interest is the one on the interaction between the “low diaspora” dummy and temperature. This is positive and statistically significant in the short-run specifications of columns (1) and (2), where the lack of diaspora generates an additional 9 to 10 percentage point increase in the probability of conflict. The coefficient is also borderline significant in the decennial specification of column (3), where the lack of diaspora increases the effect of a one degree rise in temperature on the probability of conflict by 36 percentage points. At the bottom of the table we report the marginal effect of temperature on the incidence of civil conflicts in low diaspora countries, in low income countries, and in countries characterised by both low diaspora and low income. The estimates show the association between low diaspora and increasing the risk of conflict in all specifications, both in the short and in the long-run. In poor countries, with middle to high diaspora, an increase in temperature by one degree Celsius increases the risk of conflict in the short-run by five to seven percentage points and the effect is not significant. However for poor countries with low diaspora the effect is 13.7 to 17.3 percentage points increase and statistically significant. The effect in the bottom line is obtained by adding $\alpha$, $\beta$ and $\theta$ from the estimates of Equation (2). This result is consistent with the hypothesis that, for poor countries, where an increase in temperature is more likely to create the conditions for higher conflict potential, an easier option of emigrating moderates the effect of climate change on the risk of conflict.

The long-run effects, estimated on the decade-data in column 3, are less precise, but they show a consistently larger effects. Over a decade, a cumulative temperature increase of one degree Celsius may increase the risk of conflict by 48 percentage points in poor countries and as much as 85 percentage point in poor and low diaspora countries. The coefficients of both interactions are statistically significant. These effects are very large but still reasonable for variations in temperature of a few fractions of a Celsius degree, as observed in most countries.

The empirical findings indicate that countries that are both among the "poor" and "low diaspora" not only have higher base rates of conflicts, but also have experienced a significant increase of such internal conflicts as a consequence of the increase in temperature in the considered period.[6] While the main correlation between poverty, low diaspora and conflict is captured by the country-level fixed effects, the variation that identifies our estimated effect is the interaction between low diaspora with temperature changes, namely the differential response of conflict probability to increased temperatures between low and high diaspora countries.

Considering our estimates and definition in Table 3, 32 countries in our sample are classified as low diaspora, and within this group seven are classified as poor. These are Afghanistan, Bangladesh, Cambodia, Ethiopia, Madagascar, Myanmar, Sierra Leone. This group of countries, according to our estimates, has been put at a significantly higher risk of conflict by temperature increases relative to other country-groups. For example Ethiopia experienced an average temperature increase between the period 1960-1980 and 1981-2000 of 0.76 degrees Celsius, which is well above the average, and an average incidence of conflict of 0.83 (between 1960 and 2000, Ethiopia registered 32 years of conflicts and eight years of peace) which is also well above the average of poor countries. This is just an example but it is illustrative of the intensity of the effect we estimate.

## 3.3 Checks and Extensions

The choice of the lowest quintile as specific threshold to separate low diaspora from medium and high diaspora countries might sound somewhat arbitrary. As a sensitivity

[6] Table A3 reports the incidence of conflict in the sample by country type. The annual incidence is 0.18 for poor countries with high diaspora but it increases to 0.57 for poor countries in the low diaspora group. Even among the non-poor countries, those with low diaspora have much higher risk of civil conflict compared to high diaspora ones.

check we repeat our analysis placing the threshold for "low diaspora" at different percentiles of the diaspora distribution. While in the main regressions the low emigration dummy counts countries in the bottom quintile of the diaspora distribution, we also test results using the bottom 25% and the bottom 30% of the diaspora distribution, making larger the number of countries included in the "low diaspora" group. Table 4 reports the estimated results for the yearly specification (columns (1) and (2)), the lagged specification (columns (3) and (4)) and the decennial specification (columns (5) and (6)). The results for the one-year effects are rather stable and robust to the choice of the threshold. The results confirm the positive and significant effect of the interaction of temperature and low emigration dummy for the yearly specifications, with a slightly smaller coefficient compared to the estimates of Table 3. This indicates that the strongest effect in increasing chances of conflict with higher temperature may come from countries with extremely low levels of diaspora. The results for the decade specification are somewhat more sensitive to the choice of the threshold. The coefficient on the interaction is significantly reduced when choosing a higher threshold and the precision of the estimates become smaller, so that the interaction effect is no longer significant. The combined effect of poor and low diaspora still has a significant positive impact on increasing the probability of conflict as a consequence of temperature increase over a decade. However, the higher sensitivity to the threshold and the lower precision of the estimates for long-run effects may indicate more heterogeneity in those effects.

In column 2 of Table A1 we present results for Equation (2) using the number of years of conflict in a decade as dependent variable. The positive and statistically significant effect of the interaction between temperature and low diaspora is robust to this specification. An increase in one degree Celsius in temperature is associated with five more years of conflict in poor-low diaspora countries during the decade.

In order to test whether having low diaspora is really crucial in the increased probability of conflict in response to warming, we have tested it against other country-persistent characteristics that may affect the probability of conflict. In Table 5 we add interaction terms between temperature and dummies that capture differences in geography, institutions and human capital across countries. The objective is to test if the conflict-moderating effect of the diaspora is robust while controlling for potential heterogeneity in the response of conflict along these other dimensions. Table 5 shows the coefficients of the same variables reported in Table 3, for specifications that control alternatively (in columns (1)-(3) and (5)-(7)) or together (in columns (4) and (8)) for the interactions of temperature with these other dummies. Columns (1)-(4) use the lagged specification and (5)-(8) the decade specification. We only report the estimates for the diaspora dummy when we include the other interactions as control. The Temperature-Low Diaspora coefficient estimates remain very stable and significant in both the yearly and the decennial specifications.[7]

Describing in detail each specification, in columns (1) and (5) we add the interaction of temperature with a dummy for the country being land-locked. Being land-locked reduces emigration rates and also affects trade, and connections with other countries, and may be a factor of further stress in the presence of declining agricultural productivity. The introduction of the additional interaction does not alter the coefficient of temperature and low diaspora, which remains positive and statistically significant.

In columns (2) and (6) we include an interaction between temperature and a dummy capturing low institutional quality. Emigration may be constrained in countries characterised by bad institutions and autocratic regimes. At the same time, bad institutions prevent a country from managing a crisis which is brought by climate change, and thus exacerbate the risks of civil conflicts. Specifically, we construct the dummy using the Polity-2 score from the Polity IV database (PolityIV, 2014), including political participation. The score ranges from -10 to +10. An index greater than 6 captures democracies. An index lower than -6 measures autocracies, while an index between -5 and +5 identifies an intermediate regime, defined as anocracy. We compute a dummy variable equal to 1 for autocratic regimes and interact this dummy with the temperature variable. The moderating effect of the diaspora is robust to the inclusion of a control for bad institutions.[8]

Finally we introduce in columns (3) and (7) an interaction with a dummy capturing the countries with the lowest levels of human capital, measured as the share of residents aged 15 and over with tertiary (or college) education. The data is taken from Barro and Lee's database (Barro and Lee, 2013).[9] For consistency with our definition of low diaspora countries, we define low human capital countries those in the bottom 20% of the distribution in the average share of tertiary educated between 1970 and 2000. The coefficient of temperature and low diaspora remains positive and statistically significant. The magnitude of the coefficients does not change much, even when including these three additional interactions together (Columns 4 and 8).

Table 6 presents a set of additional robustness checks aimed at exploring how robust is the interaction effect between temperature and low diaspora. We use in all columns the short-run specification, using the lagged explanatory variable. In column (1) we exclude from the analysis the OECD countries. They represent the more industrialised and rich nations in the world and should not contribute much to identify the effect, as

[7] Results for the contemporaneous specification, which have been omitted for space constraints, are very similar to results from the lagged specification.

[8] Fearon and Laitin (2003) find that intermediate regimes are more at risk of conflicts, because democracies can effectively handled dissent and authoritarian regimes can suppress turbulence. In a robustness check, available upon request, we interact temperature and precipitation with both the autocracy and the "anocracy" dummy variables. The empirical findings are robust to this specification.

[9] In a robustness check, available upon request, we used tertiary gross enrollment ratio, from WDI (World Bank, 2015) to compute the dummy for low schooling countries. The two variables are highly correlated. While the Barro and Lee's dataset provides a better measure in terms of level of schooling, it has a larger number of missing countries. Results are very similar.

conflicts are not predominant in those places. The findings of the baseline specification are not affected by this modification. Both the coefficient on the interaction and the overall marginal effect of temperature in low diaspora and low income countries remain stable around 0.13 and 0.19 respectively, not very different from their value in Table 3 column (2). Column (2) in Table 6 removes from the sample the countries that are geographically largest (namely Australia, Brazil, USA, China and Canada) because for those the average country-level temperature is a very imprecise measure of the climate induced stress perceived in the various parts of the country. In the US, for instance, global warming has likely decreased the average temperature on the East coast and increased it on the West Coast, so that an average measure will not be representative of the conditions in large part of the country. The estimated coefficient on the interaction term and on the effect of temperature on low diaspora-low income countries remains very stable. We then test whether excluding the interaction between temperature and poor country dummy (column (3) of Table 6) and whether omitting all other interactions affects (column (4)), the sign and significance of the temperature-low diaspora interactions remains stable. The estimated effect is now around 0.10, implying that even a regression with very few controls and interactions shows the amplifying impact of low diaspora on the temperature. In column (5) we use alternative data to measure temperature and precipitation. These data are taken from Dell et al. (2012). The authors use the (terrestrial) monthly mean temperature and precipitation data at 0.5x0.5 degree resolution from weather stations (Matsuura and Willmott, 2007) and aggregate them into country-year averages using the population in 1990 at 30 arc second resolution as weights. These data may be somewhat more noisy as the original data are not as detailed, however the estimated effect of interest is still significant. The interaction between low diaspora and temperature has a coefficient of 0.06 and the impact of temperature for low diaspora and poor countries is about 10 percentage points larger than for low diaspora and rich countries. The sign and magnitude of the coefficients of the interaction between temperature and low emigration dummy are in line with the baseline results presented in Table 3. Finally, column (6) includes both the contemporaneous and the lagged main effect and interaction effect of temperature on conflict. Interestingly, in this case both the contemporaneous and lagged effect are significant and have similar coefficients (0.07 for the contemporaneous and 0.09 for the lagged). This result suggests the possible accumulation of risk in consecutive years of high temperature, and also justifies the larger long-run effect estimated (albeit not very precisely) in the decade specification.

All the estimates we have produced so far have used a linear estimator (linear probability model). The robustness of this estimator and the possibility of using a very rich set of fixed effects, as well as the ease of interpretation of the marginal effects it produces, are all excellent reasons to use it, rather than a nonlinear model. However, as the variable is dichotomous (it only takes values of 0 and 1) we have also produced estimates using a

Logit model with fixed effects.[10] The full estimation results, including the marginal effects calculated at the mean of the sample (in square brackets), are reported in Table A4 in the Appendix. The estimated coefficients on the low diaspora-temperature interactions are significant in the yearly and lagged specifications, while they are not for the decade specification. The marginal effects on the yearly specifications are around 0.19-0.21. In general, these results show significant coefficients on the interactions of temperature with the poor country and low diaspora dummies, and imply higher risks of civil conflict as a consequence of warming in poor and low diaspora countries.

Finally, in the previous analysis we have defined "conflict" based on measures of within-country civil conflict. We have argued that hotter climate and worsening agricultural productivity might have generated internal tensions or rebellion to the government. Civil conflicts refer to battles with at least 25 deaths in a given year. In this section we use measures of two forms of more extensive conflicts as dependent variable. First, we capture full-scale civil wars, which are battles with at least 1'000 deaths in a given year. While civil wars can be thought of an extreme case of civil conflicts, hence less likely and more extreme, they can potentially stem from similar causes to those generating civil conflicts. Second, we consider inter-country conflicts, which are disputes that involve two or more nations. Broader geopolitical issues, diplomatic, political and ideological tensions are more likely to trigger this type of full blown inter-country conflict. It is less likely that inter-country conflicts are triggered by increases in temperature, and they are certainly less likely to be alleviated by emigration. In order to test whether warming interacted with low diaspora affects full scale civil wars in a country (rather than more limited civil conflict) or inter-country conflict, in Table 7 we use these alternative dependent variables, adopting the same specifications as for Table 3. The temperature-low diaspora interaction effect in the civil war specification is weaker and less significant than for civil conflicts but has the same sign and it is significant at the 10% level in the decade specification. This would be consistent with civil wars being sometimes triggered by civil conflict, but being less likely. On the other hand, the interaction effect has no explanatory power on the inter-country conflict specification, confirming that migration has probably no attenuating effect on conflicts involving geo-political confrontations across countries.

The balance of the evidence presented is that the propensity to emigrate, as captured by the scale of a country's diaspora, plays a significant role in attenuating the risk of internal conflict following temperature increase, especially in poor countries. Countries that are poor and where the size of the diaspora is low are those at highest risk of conflict when warming brings potential loss in agricultural productivity. While there is no definitive proof that the connection is causal, the exogeneity of temperature change,

[10] The fixed effect logit estimator does not include the interaction between year and region fixed effects ($\phi_{rt}$) because the logit estimator fails to reach convergence when including the region-year fixed effects. Moreover, the inclusion of two different large sets of fixed effects in logit models, such as the country and the region-year fixed effects, may lead to an incidental parameter problem.

together with the fact that we measure the diaspora well before the considered period of temperature increase, reduce the risk of reverse causality in the evidence we present. Specifications using several controls and other interactions, as well as country-specific and region-time effects, rule out several other explanations and lean in favour of this attenuating effect of diaspora on the harmful effect of temperature on conflict.

# 4 Climate-Driven Migration and Conflict in the Countries of Destination

Emigration acts as an effective valve to dissipate possible conflict following years of high average temperature. It is natural, therefore, to ask whether this happens at the expense of increasing the risk of conflict in the receiving countries, which may be pressured or overwhelmed by climate-induced migrants. In order to answer this question, we modify somewhat our approach and estimate the conflict Equation (1), adding a control for the inflows of climate-migrants. In particular, we construct a measure of climate-driven migrants and analyse the impact of this constructed inflow on the probability of conflict in receiving countries. Migrants who moved in response to changes in temperature and precipitation are not observable directly, and even if one could observe the reason for migration, climate change may indirectly affect migration decisions (through lower productivity, higher local pressure on natural resources, etc.), so migrants may not list climate directly as a cause of migration. Hence, we construct an estimate of climate-induced migrants. To do this, we rely on a "gravity" approach that predicts bilateral migrants based on a variety of origin-destination characteristics, and we augment the specification with the bilateral temperature differential. If people move out of countries that are becoming hotter and into countries which are not experiencing such a phenomenon, temperature differentials (rather than levels) are determinants of bilateral migration. We will use these differences to predict climate migrants between two countries.

Originally used in the trade literature, first in the pioneering work of Frankel and Romer (1999) and, subsequently by Rodriguez and Rodrik (2001), and Rodrik et al. (2004), gravity models were used to impute trade flows predicted using only geographic characteristics in order to estimate the impact of trade on GDP growth. This method has later been used in the migration literature (Ortega and Peri, 2014; Alesina et al., 2016; Docquier et al., 2016) to predict the geography-driven portion of migrants' flows. Those predicted flows have been then used to estimate the impact of migration on receiving countries' economic performance. Given the time-invariant nature of the geographic controls, this method has been mainly applied in a cross-section context. Feyrer (2009a,b) apply a similar approach but extended to a panel context. Feyrer (2009a) generates a time-varying geographic instrument, based on temporary change in the "geography of trade" due to the closing of the Panama canal. This specific episode, which forced ships to take longer routes to go from some destination to others (on opposite sites of the American continent) has produced a change in "effective geography". It is therefore used to identify in a panel setting the impact of trade on GDP. The author estimates a gravity model with controls for geographic time invariant characteristics of the pair and includes time varying effects computed as the interactions between the change in effective geographic distance (before and after the Panama Canal Closure) and time dummies. Feyrer (2009b) uses a similar methodology, but rather than using a specific episode connected to the closing of the Panama canal, exploits for identification the improvements in aircraft technology that allowed a stable increase in world trade carried by air.

In our paper, while we control for fixed geographic characteristics, we use time-varying climatic variables to predict the flow of migrants. We obtain panel-level identification of migration flows produced by changes in temperature differences between origin and destination countries and precipitation differences. We first estimate the following parsimonious bilateral gravity equation:

$$ln(M_{cjt}) = \delta lnD_{cj} + \gamma B_{cj} + \psi L_{cj} + \theta C_{cj} + \vartheta dT_{cjt} + \xi dP_{cjt} + \pi_t + \omega_c + \chi_{rt} + \varepsilon_{cjt} \quad (3)$$

The dependent variable $lnM_{cjt}$ is the natural logarithm of the flows of migrants from origin $c$ to destination $j$ in the decade beginning with year $t = (1960, 1970, 1980, 1990)$. We include bilateral controls that are time invariant and affect the cost of moving from one country to another, such as the natural logarithm of bilateral (geodesic) distance ($D_{cj}$), a dummy capturing the presence of a common border ($B_{cj}$), a dummy for a common official language ($L_{cj}$), and one for common colonial history ($C_{cj}$). The geographical controls are from the BACI dataset and provided by CEPII. To predict variation over time of migrant flows related to climate change, we include the difference in temperature ($dT_{cjt}$) and precipitation ($dP_{cjt}$) between origin country $c$ and destination country $j$ in the decade $t$. Given that migration flows are measured only over decades, temperature and precipitation are averaged over the 10 years of decade $t$. Differences in temperature are driven by higher temperature in the origin country, which are documented to increase emigration especially from middle income countries (Cattaneo and Peri, 2016), and also lower temperature at destination, which would imply more migrants going to countries that are not experiencing temperature increases. The bilateral difference in average temperature and its variation are the determinants of changes in the climate-related migrant flows.

In the gravity regression we also include country of origin fixed effects ($\omega_c$), decade fixed effects ($\pi_t$) and region of origin-time fixed effects to capture regional trends ($\chi_{rt}$).[11]

[11] Countries are grouped in seven different regions, which are East Asia and Pacific; Europe and Central Asia; Latin America and Caribbean; Middle East and North Africa; North America; South Asia; Sub-Saharan Africa.

While all the additional variables will increase the fit of the gravity regression, the only origin-destination specific variables that vary over time are the differences in temperature and precipitations. Hence predictions from this equation, aggregated at the country of destination level, will be the only part of the predicted flows varying over time and across destinations. We do not include in the gravity model any other destination-time varying variables, even if these would account for multilateral resistance. These terms would be correlated with destination specific conditions, which could affect conflict. Standard errors are clustered by origin-destination country pairs. We run both an OLS and Poisson regressions using a pseudo-maximum likelihood estimator (PPML). PPML provides accurate estimates when a large number of zeros would introduce a large decrease in observations, due to the use of the logarithm of migrant flows as dependent variable. Since the work of Silva and Tenreyro (2006), PPML has been largely used to estimate gravity regressions.

As described above, once we estimate the gravity equation and we produce geography and climate-predicted values for the bilateral flows of migrants, we aggregate them across countries of origin $c$, to obtain the predicted migration inflows for each decade $t$ and country of destination $j$. This predicted values are used as instrument for the inflows of climate-driven migrants in a conflict equation where the units of observations are destination countries.

In particular, define $\mathbf{X}$ as the matrix of geographic explanatory variables plus temperature and precipitation differences included in the gravity regression (3) and $\alpha$ as the vector of estimated parameters in the same regression. The migration inflows predicted for country $j$ in decade $t$ is $M\hat{i}g_{jt} = \sum_{c \neq j} exp(\mathbf{X}'\alpha)$.

We then estimate Equation (4) over the period 1960-2000:

$$C_{jt} = \alpha T_{jt} + \beta T_{jt} * D_j + \gamma P_{jt} + \vartheta P_{jt} * D_j + \theta ln(Mig_{jt}) + \nu_j + \pi_t + \phi_{rt} + \varepsilon_{jt} \quad (4)$$

where $ln(Mig_{jt})$ is the natural logarithm of the inflows of migrants to country $j$ that we instrument with the natural logarithm of the climate-predicted flows, $ln(M\hat{i}g_{jt})$. We estimate Equation (4) following the same specifications as used in Tables 2 and 3, with contemporaneous yearly, lagged yearly and decade specifications. Given that the number of immigrants is available on a decade basis, in order to estimate the yearly specifications we annualise the inflows of migrants and the predicted migration inflows, dividing the variables by ten.

As in Table 3, we estimate a linear probability model. Our method of estimation is two stage least squares, using as instrumental variables the above-described geography and climate-predicted migrant flows. The use of a linear probability model with instrumental variable is typically preferred to a non-linear instrumental variable procedure, even in the case of a dichotomous dependent variable in the second stage, such as our measure of civil conflict.[12]

A potential violation of the exclusion restriction could arise if geographic and climatic variables in nearby countries are correlated to conflicts in the countries of destination through channels other than their effect on migration flows. This concern in reduced in our approach for two reasons. First, we include in Equation (4) temperature and precipitation in the receiving country, which should capture direct climate effects. We also include country fixed effects ($\nu_j$), which absorb the long-run effects of climate on the receiving country through colonization history, disease environment, geographical accessibility, as well as the country's institutions. Second, recall that the gravity equation is estimated using temperature and precipitation differences between origin country $c$ and destination country $j$. Migration responds to differences in temperature and precipitation, but it should be the absolute temperature that affects other aspects of the receiving country society.

Table 8 reports the estimated parameters from the OLS (column (1)) and PPML (column (2)) estimates of the gravity models defined in Equation 3. The point estimates have the same sign and magnitude using both estimation methods, and have the expected effects. Bilateral distance has a strong and negative statistically significant coefficient, while the sharing of a border, a language and a colonial past are associated with larger migration flows. Temperature differences between origin $c$ and destination $j$ (origin minus destination) are associated with significantly larger emigration flows. This is an interesting and not so well known fact. If the difference in temperature between the origin and the destination increases by one degree Celsius, the bilateral migration flows between the two countries increases by 6.7 or 3.4 percent depending on whether we use the OLS (Column 1) or the PPML (column 2) method.

Table A5 of the Appendix reports the first stage coefficients on the OLS-gravity predicted flows. The coefficients are very significant and the F-stat of the first stage is above 10 for all specifications. The F-statistic exceeds the Stock and Yogo (Stock et al., 2005) critical value in both the annual (contemporaneous and lagged) and decade specifications. The instrument constructed using the PPML gravity predictor is somewhat less powerful, with the F-statistic being below the critical value. Hence we use the OLS-gravity predicted instrument in the main specifications. Figure 5 shows a scatterplot of the actual versus OLS predicted immigrant flows, using the gravity regression, aggregating the 1960-2000 period. The figure shows reasonably strong predictive power, although some countries are predicted very imprecisely. The regression line coefficient is equal to 0.89 and its standard error is 0.36.

Table 9 provides the 2SLS estimated coefficients of climate-driven immigration in

[12] The use of the natural logarithm of the inflows of migrants is not problematic as, by aggregating all pairs information, there are no zero observations in the flows by receiving country-year. On the contrary, migration flows are equal to zero for some country pairs, hence the use of PPML estimates in the gravity regression.

destination countries on the probability of conflicts. In columns (1), (3) and (5), we show total inflows of migrants as explanatory variable. Alternatively, in columns (2), (4) and (6), we use the immigration rates, defined as the ratio between the aggregate net flows of immigrants in the year (or the decade), divided by the destination country's initial population, and instrument this variable with the imputed immigration rates. The estimated parameters of total inflows of migrants and inflows of migrants per capita are not statistically different from zero, suggesting that people migrating because of variation in temperature differences do not represent a significant driver of conflict in destination countries. The effect remains small and non-significant in all the different specifications.

The null effect of climate induced migration flows and rates is confirmed if we replace the incidence of conflicts with the number of years of conflict in a decade as dependent variable (columns (3) and (4) of Table A1).

The 2SLS method we use is based on constructed instruments. Given the constructed nature of the variable, some papers adjust the 2SLS standard errors by applying a correction that takes into consideration information drawn from the first step gravity equation. In these papers, the correction produced only a small increase in the standard errors (Frankel and Romer, 1999; Irwin and Tervio, 2002; Feyrer, 2009a,b). We do not apply any correction here, because the correction is only necessary in the case of a generated regressor. In the case of a generated instrument, the 2SLS standard errors and test statistics are asymptotically valid (Wooldridge, 2010).[13]

We conduct some robustness checks for the coefficient on the imputed inflow of immigrants along the lines of those produced in Section 3, and we show them in Table 10. We exclude OECD countries from the analysis (column (1)), omit large receiving countries (column (2)), and omit the interaction between temperature and the "Poor" country dummy, showing a simple specification that only includes temperature and precipitation as a linear variable (column (3)). We consider the yearly specification with lagged explanatory variable. The coefficient estimated on climate-migrants is always very small and it never approaches statistical significance. Column (4) in Table 10 shows the estimates using the alternative climate database described in Section 3, and the last column (5) includes both contemporaneous and lagged temperature as explanatory variables. In neither specification does the climate-driven immigration have a significant coefficient. In summary, the estimates presented in this section do not show any evidence that increased migrant flows driven by changes in temperature and precipitation increase conflict in the receiving country.

Combining the two empirical results migration acts as an escape valve, reducing pressure generated by climate change in countries of origin and it does not seem to increase the

[13] Moreover, the incorporation of the sampling error of the estimated instrument would simply produce a larger estimated variance and this would drive in the direction of not rejecting the null of $\theta$ equals to zero.

risk of conflict in the receiving countries. In order to account for the simultaneous working of the two mechanisms, we include these two effects together, and we jointly estimate a conflict equation. In Table 11 we estimate a specification that combines Equations (2) and (4). Namely, for each country we include both the immigration measure (instrumented by the imputed geography and climate-driven immigration) and the interaction between low diaspora dummy and temperature (that captures the attenuating effect of emigration) as explanatory variables. This specification tests whether the positive coefficient identified for low diaspora-temperature interaction is robust to the inclusion of the imputed inflow of climate migrants.

The estimates, reported in Table 11, confirm both the higher risk of civil conflicts when temperature increases in low diaspora countries, as well as the null effect of the inflows of migrants on conflict. The estimates presented in the yearly specifications of Table 11 imply that the effect of an increase in temperature by one degree in poor countries with low diaspora increases the risk of civil conflict by 16-19 percentage points. At the same time, the increase of climate immigration by one percent has no significant impact on the risk of conflict of the country. The joint estimation implies that these two effects are not too strongly correlated as thee joint estimates are similar to those obtained including only one variable at a time.

# 5 Summary and Conclusion

Human migration is an important response to climate change, and climate change is an important driver of country-level civil conflict. By increasing competition over resources, climate change can significantly increase tensions in poor parts of the world, especially along ethnic and cultural lines. The human migration response to these phenomena can spread the tensions to other countries, by overcrowding receiving regions. It can also dissipate the tensions in sending regions by alleviating the reasons for scarcity and conflict. In this paper, we test both these possibilities by looking at four decades of data on temperature, migration and conflicts across a sample of 126 countries in the world. Our goal is to analyse whether emigration reduces the conflict response to climate change in the country of origin and/or whether the induced emigration response to climate change brings higher probability of conflict in countries of destination, possibly by worsening tensions there.

Most of our findings are consistent with emigration reducing the negative effect of climate change on conflicts in origin countries. This finding supports the idea of migration as a mechanism of adaptation and conflict mitigation (Black et al., 2011; Hartmann, 2010). This result is particularly critical for poor countries, where warming is associated with a higher risk of civil conflict. At the same time, the existing literature has found that climate change reduces emigration from poor countries (Cattaneo and Peri, 2016). In turn, larger climate-related humanitarian emergencies may arise in places where people are trapped rather than in places where people can move out easily (O'Brien et al., 2008).

We find no statistically significant effect of climate migrants on conflicts in countries of destination. Using the portion of migration flows predicted by temperature and precipitation differentials, we do not identify any significant effect on receiving countries' conflicts. This result is robust to alternative specifications.

These findings suggest an important and positive role of migration. First it undermines the hypotheses of the environmental conflict model (Homer-Dixon, 2001) and the degradation narratives claiming that migrants induced by environmental factors strain scarce resources in destination countries and become a primary source of instability. This literature neglects the role that resource abundance, rather than scarcity, may have on violence and conflicts (Collier and Hoeffler, 2004).

Moreover, this literature fails to consider the potentially positive role of migrants in the destination areas. As an example, Juul (2005) reports that drought-related migrants in Senegal contributed to developing better strategies to manage herds and to expanding agriculture and trade in destination communities. It is also possible that as a consequence of the inflows of migrants, population density increases and agricultural intensification starts. New knowledge and new skills introduced by migrants can accelerate the technology shift and this process counteracts potential negative impact through land scarcity. Migrants may introduce new crops from their home area (Hill, 1963) or may have higher marginal productivity of labour relative to long-time residents, and this raises overall economic efficiency (Kondylis, 2008).

More broadly, migration may alleviate pressure where it would be more damaging because of climate induced economic strains. At the same time it may bring advantages to other countries, where immigrants can progressively become an asset.

One possible critique of this analysis is that it does not include fast-onset events, such floods or other types of climate events, such as massive drought or extreme heat, which may produce massive waves of migrants in a very short period of time. A careful investigation of the effects of more sudden and extreme types of events is an important next step forward. By the end of the century, even with drastic cuts to global emissions, average global temperature is projected to increase by two degrees Celsius. In the absence of climate policies, this increase could go up to four degrees Celsius or higher. These are large and drastic variations in temperature. Our results predict large effects on conflict probability in poor countries that will be further enhanced if policies affecting migrant admission become even more restrictive, especially in rich countries.

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## Tables

**Table 1: Summary Statistics, Temperature, Migration and Conflict Variables**

| Variable | Number of Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **Yearly measures** | | | | | |
| Temperature (°C) | 4942 | 20.249 | 7.656 | -1.129 | 33.021 |
| Precipitation (100s mm/year) | 4942 | 10.959 | 6.849 | 0.052 | 45.051 |
| Diaspora | 4942 | 0.046 | 0.050 | 0.0004 | 0.255 |
| Conflict incidence | 4942 | 0.185 | 0.185 | 0 | 1 |
| Immigration rate | 4843 | 0.003 | 0.015 | 0 | 0.281 |
| Emigration rate | 4843 | 0.002 | 0.004 | 1.63E-05 | 0.041 |
| **Decade measures** | | | | | |
| Temperature (°C) | 492 | 20.323 | 7.623 | -0.224 | 32.214 |
| Precipitation (100s mm/year) | 492 | 10.993 | 6.702 | 0.282 | 33.775 |
| Conflict incidence | 492 | 0.352 | 0.478 | 0 | 1 |
| Immigration rate | 492 | 0.029 | 0.153 | 0 | 2.810 |
| Emigration rate | 492 | 0.023 | 0.040 | 0.0002 | 0.414 |
| **1960-2000 changes** | | | | | |
| Change temperature | 4905 | 0.359 | 0.231 | -0.157 | 0.756 |
| Change precipitation | 4905 | -0.246 | 0.744 | -3.169 | 2.379 |
| Change conflict incidence | 4905 | 0.082 | 0.214 | -0.600 | 0.855 |

**Note:** the description of each variable and of its source is in the text. The top part of the Table includes variables that are measured yearly, the middle part of the Table includes variables that are measured every decade. The bottom part of the Table shows the changes in the climate variables between 1960 and 2000.

**Table 2: Correlation between Temperature and Conflict**

| **Dependent variable: Civil Conflict indicator** | **Contemporaneous specification** | **Lagged Specification** | **Decade Specification** |
|---|---|---|---|
| | (1) | (2) | (3) |
| Temperature | -0.006 | -0.003 | -0.010 |
| | (0.014) | (0.016) | (0.116) |
| Precipitation | -0.005* | -0.007** | -0.043 |
| | (0.003) | (0.003) | (0.030) |
| Temperature X Poor | 0.062 | 0.083* | 0.507** |
| | (0.042) | (0.046) | (0.215) |
| Precipitation X Poor | 0.006 | 0.015** | -0.062 |
| | (0.006) | (0.007) | (0.056) |
| Observations | 4,942 | 4,816 | 492 |
| R-squared | 0.063 | 0.062 | 0.083 |
| Number of countries | 126 | 126 | 126 |
| Country FE | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes |
| Region by time effects | Yes | Yes | Yes |
| Temperature effect in poor countries | 0.055 | 0.080* | 0.498** |
| Precipitation effect in poor countries | 0.001 | 0.008 | -0.105** |

**Note:** The dependent variable in columns (1) and (2) is a dummy equal to 1 if the country has experienced a civil conflict during the year and 0 otherwise. In column (3), where data are decennial the dummy is one if the country has experienced one or more civil conflicts in any year of the decade. The last two rows show the calculated effect of increase in temperature and precipitation on poor countries. Standard errors are clustered by country. **,* indicate significance at the 5, 10% level.

### Table 3: Temperature, Conflict and Low-Diaspora interaction

| **Dependent variable: Civil Conflict indicator** | **Contemporaneous, yearly specification** | **Lagged, yearly Specification** | **Decade Specification** |
|---|---|---|---|
| | (1) | (2) | (3) |
| Temperature | -0.018 | -0.017 | -0.069 |
| | (0.015) | (0.016) | (0.122) |
| Precipitation | -0.003 | -0.004 | -0.060* |
| | (0.003) | (0.003) | (0.034) |
| Temperature X Poor | 0.066 | 0.088* | 0.552** |
| | (0.042) | (0.046) | (0.221) |
| Precipitation X Poor | 0.006 | 0.015** | -0.051 |
| | (0.006) | (0.007) | (0.055) |
| Temperature X Low Diaspora | 0.089** | 0.101** | 0.363* |
| | (0.042) | (0.043) | (0.207) |
| Precipitation X Low Diaspora | -0.008 | -0.011 | 0.056 |
| | (0.006) | (0.008) | (0.061) |
| Observations | 4,942 | 4,816 | 492 |
| R-squared | 0.066 | 0.066 | 0.092 |
| Number of countries | 126 | 126 | 126 |
| Country FE | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes |
| Region by time effects | Yes | Yes | Yes |
| Temperature effect in low diaspora (and non-poor) countries | 0.071* | 0.085** | 0.294 |
| Temperature effect in poor (and non-low diaspora) countries | 0.048 | 0.072 | 0.483 |
| Temperature effect in low diaspora and poor countries | 0.137** | 0.173*** | 0.846*** |

**Note:** The dependent variable in columns (1) and (2) is a dummy equal to 1 if the country has experienced a civil conflict in the year and 0 otherwise. In column (3), where data are decennial the dummy is one if the country has experienced at least one civil conflicts in the decade. The last three rows show the calculated effect of an increase in temperature by one degree Celsius on the probability of conflict in low-diaspora, in poor countries and in low-diaspora and poor countries. Standard errors are clustered by country of origin of migrants. ***, **,* indicate significance at the 1, 5 and 10% level.

**Table 4: Temperature, Conflict and Low-Diaspora interaction. Different thresholds for low diaspora**

| **Dependent variable: Civil Conflict indicator** | **Contemporaneous, yearly specification** | | **Lagged, yearly Specification** | | **Decade Specification** | |
|---|---|---|---|---|---|---|
| | (1) Cut off: 25 % | (2) Cut off: 30 % | (3) Cut off: 25 % | (4) Cut off: 30 % | (5) Cut off: 25 % | (6) Cut off: 30 % |
| Temperature | -0.019 | -0.021 | -0.016 | -0.016 | -0.050 | -0.054 |
| | (0.015) | (0.016) | (0.017) | (0.017) | (0.124) | (0.125) |
| Precipitation | -0.003 | -0.004 | -0.003 | -0.004 | -0.057 | -0.073* |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.035) | (0.040) |
| Temperature X Poor | 0.061 | 0.063 | 0.082* | 0.084* | 0.533** | 0.538** |
| | (0.040) | (0.040) | (0.045) | (0.044) | (0.218) | (0.217) |
| Precipitation X Poor | 0.006 | 0.006 | 0.014* | 0.014* | -0.053 | -0.040 |
| | (0.006) | (0.006) | (0.007) | (0.007) | (0.055) | (0.056) |
| Temperature X Low Diaspora | 0.069* | 0.071** | 0.071* | 0.067* | 0.199 | 0.110 |
| | (0.036) | (0.032) | (0.038) | (0.036) | (0.197) | (0.187) |
| Precipitation X Low Diaspora | -0.006 | -0.003 | -0.011 | -0.007 | 0.042 | 0.057 |
| | (0.006) | (0.005) | (0.007) | (0.006) | (0.057) | (0.048) |
| Observations | 4,942 | 4,942 | 4,816 | 4,816 | 492 | 492 |
| R-squared | 0.065 | 0.066 | 0.065 | 0.064 | 0.087 | 0.087 |
| Number of countries | 126 | 126 | 126 | 126 | 126 | 126 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Region by time effects | Yes | Yes | Yes | Yes | Yes | Yes |
| T effect in low diaspora countries | 0.050 | 0.050* | 0.056 | 0.050 | 0.149 | 0.056 |
| T effect in poor countries | 0.042 | 0.042 | 0.067 | 0.067 | 0.483** | 0.484** |
| T effect in low diaspora and poor countries | 0.111** | 0.113** | 0.138*** | 0.134*** | 0.682** | 0.594** |

**Note:** The dependent variable in columns (1) to (4) is a dummy equal to 1 if the country has experienced a civil conflict in the year and 0 otherwise. In columns (5) and (6), where data are decennial, the dummy is one if the country has experienced one or more civil conflicts in the decade. The last three rows show the calculated effect of an increase in temperature by one degree Celsius on the probability of conflict in low-diaspora, in poor countries and in low-diaspora and poor countries. Standard errors are clustered by country. ***, **,* indicate significance at the 1, 5 and 10% level.

**Table 5: Temperature, Conflict and Low-Diaspora. Additional interactions**

| Dep. variable: Civil Conflict | Lagged, yearly Specification | | | | Decade Specification | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) Land-locked | (2) Low-quality institution | (3) Low human capital | (4) All | (5) Land-locked | (6) Low-quality institution | (7) Low human capital | (8) All |
| Temperature | -0.014 | -0.014 | -0.019 | -0.010 | -0.044 | -0.056 | -0.093 | -0.021 |
| | (0.018) | (0.018) | (0.017) | (0.020) | (0.130) | (0.131) | (0.126) | (0.138) |
| Precipitation | -0.004 | -0.005* | -0.003 | -0.005* | -0.049 | -0.080** | -0.060* | -0.055 |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.034) | (0.038) | (0.034) | (0.037) |
| Temperature X Poor | 0.094** | 0.092* | 0.066 | 0.071 | 0.606*** | 0.553** | 0.270 | 0.231 |
| | (0.043) | (0.048) | (0.069) | (0.065) | (0.214) | (0.223) | (0.368) | (0.352) |
| Precipitation X Poor | 0.015** | 0.014* | 0.019** | 0.020** | -0.034 | -0.054 | -0.091 | -0.096* |
| | (0.007) | (0.007) | (0.008) | (0.008) | (0.054) | (0.054) | (0.061) | (0.049) |
| Temperature X Low Diaspora | 0.101** | 0.104** | 0.104** | 0.106** | 0.392* | 0.365* | 0.405* | 0.482** |
| | (0.043) | (0.044) | (0.046) | (0.046) | (0.207) | (0.207) | (0.223) | (0.231) |
| Precipitation X Low Diaspora | -0.011 | -0.012 | -0.011 | -0.012 | 0.049 | 0.056 | 0.049 | 0.024 |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.060) | (0.062) | (0.065) | (0.066) |
| Observations | 4,816 | 4,741 | 4,717 | 4,661 | 492 | 484 | 482 | 476 |
| R-squared | 0.066 | 0.067 | 0.069 | 0.070 | 0.102 | 0.105 | 0.103 | 0.139 |
| Number of countries | 126 | 123 | 123 | 121 | 126 | 123 | 123 | 121 |
| T effect in low diaspora | 0.088** | 0.090** | 0.085** | 0.096** | 0.348* | 0.309 | 0.312 | 0.461* |
| T effect in poor countries | 0.081** | 0.078 | 0.047 | 0.060 | 0.562*** | 0.497** | 0.177 | 0.210 |
| T eff in low diaspora and poor | 0.182*** | 0.183*** | 0.151* | 0.167** | 0.954*** | 0.862*** | 0.582 | 0.692 |

**Note:** The dependent variable in columns (1) to (4) is a dummy equal to 1 if the country has experienced a civil conflict in the year and 0 otherwise. In columns (5) to (8), the dependent variable is 1 if the country has experienced one or more civil conflicts in the decade. Columns (1), (4), (5) and (8) also include the interactions between temperature/precipitation and a dummy for a country being landlocked. Columns (2), (4), (6) and (8) also include the interactions between temperature/precipitation and a dummy for bad institutions. Columns (3), (4), (7) and (8) also include the interactions between temperature/precipitation and a dummy for low human capital. Standard errors are clustered by country. Country fixed effects, time fixed effects and Region by time fixed effects are always included. The last three rows show the calculated effect of an increase in temperature by one degree Celsius on the probability of conflict in low-diaspora, in poor countries and in low-diaspora and poor countries. ***, **,* indicate significance at the 1, 5 and 10% level.

**Table 6: Additional Robustness checks**

| Dependent variable: Civil Conflict indicator | Lagged, yearly Specification | | | | | |
|---|---|---|---|---|---|---|
| | (1) Exclude OECD | (2) Exclude big countries | (3) No T X P | (4) Only T X Low Diaspora | (5) Different dataset for T and P | (6) Model with temp and lagged temp |
| Temperature | -0.034 | -0.017 | -0.003 | -0.005 | -0.022 | -0.017 |
| | (0.030) | (0.018) | (0.016) | (0.016) | (0.017) | (0.012) |
| Temperature X Poor | 0.095* | 0.087* | | | 0.099* | 0.040 |
| | (0.050) | (0.047) | | | (0.054) | (0.033) |
| Temperature X Low Diaspora | 0.126** | 0.112** | 0.097** | 0.103** | 0.060* | 0.071** |
| | (0.052) | (0.047) | (0.043) | (0.043) | (0.035) | (0.035) |
| L1: Temperature | | | | | | -0.011 |
| | | | | | | (0.014) |
| L1: Temperature X Poor | | | | | | 0.062 |
| | | | | | | (0.039) |
| L1: Temperature X Low Diaspora | | | | | | 0.088** |
| | | | | | | (0.035) |
| Observations | 3,696 | 4,616 | 4,816 | 4,816 | 4,805 | 4,816 |
| R-squared | 0.075 | 0.068 | 0.063 | 0.062 | 0.062 | 0.066 |
| Number of countries | 98 | 121 | 126 | 126 | 126 | 126 |
| Temp effect in low diaspora countries | 0.092** | 0.095** | 0.094** | 0.098** | 0.038 | |
| Temp. effect in low diaspora and poor (contemporaneous) | 0.187*** | 0.182*** | | | 0.137** | 0.093** |
| Temp. effect in low diaspora and poor (lagged) | | | | | | 0.139*** |

**Note:** The dependent variable is a dummy equal to 1 if the country has experienced a civil conflict in the year and 0 otherwise. The third and the two to last rows show the calculated effect of an increase in temperature by one degree Celsius on the probability of conflict in low-diaspora countries and in low-diaspora and poor countries. The last row shows the calculated effect of an increase in previous year temperature by one degree Celsius on the probability of conflict in low-diaspora and poor countries. Standard errors are clustered by country. Columns (1), (2) and (5) also include Precipitation, Precipitation X Poor and Precipitation X Low Diaspora. Column (3) also includes Precipitation and Precipitation X Low Diaspora. Column (4) also include Precipitation. Column (6) also includes Precipitation and one year lagged Precipitation. Country fixed effects, time fixed effects and Region by time fixed effects included. ***, **,* indicate significance at the 1, 5 and 10% level.

**TABLE 7: Temperature, Conflict and Low Diaspora: Alternative definitions of Conflict**

| | Contemporaneous, yearly | | Lagged, yearly Specification | | Decade Specification | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | Civil War | Inter-country conflicts | Civil War | Inter-country conflicts | Civil War | Inter-country conflicts |
| Temperature | -0.025 | -0.011* | -0.020 | -0.002 | -0.112 | 0.049 |
| | (0.015) | (0.006) | (0.016) | (0.006) | (0.093) | (0.072) |
| Precipitation | 0.000 | -0.001 | 0.001 | 0.001 | -0.025 | 0.000 |
| | (0.002) | (0.001) | (0.002) | (0.001) | (0.022) | (0.021) |
| Temperature X Poor | 0.079* | -0.026 | 0.069 | -0.044 | 0.401** | -0.143 |
| | (0.044) | (0.029) | (0.047) | (0.036) | (0.169) | (0.124) |
| Precipitation X Poor | 0.004 | -0.001 | 0.005 | -0.001 | -0.035 | -0.030 |
| | (0.006) | (0.003) | (0.006) | (0.002) | (0.040) | (0.023) |
| Temperature X Low Diaspora | 0.036 | -0.015 | 0.054 | -0.000 | 0.301* | -0.004 |
| | (0.043) | (0.022) | (0.043) | (0.024) | (0.165) | (0.160) |
| Precipitation X Low Diaspora | -0.011* | 0.002 | -0.011 | -0.002 | 0.011 | 0.009 |
| | (0.006) | (0.001) | (0.007) | (0.003) | (0.048) | (0.025) |
| Observations | 4,941 | 4,942 | 4,816 | 4,816 | 492 | 492 |
| R-squared | 0.069 | 0.081 | 0.065 | 0.080 | 0.099 | 0.100 |
| Number of countries | 126 | 126 | 126 | 126 | 126 | 126 |
| T effect in low diaspora c. | 0.011 | -0.026 | 0.034 | -0.002 | 0.189 | 0.045 |
| T effect in poor countries | 0.055 | -0.037 | 0.049 | -0.046 | 0.289* | -0.094 |
| T effect in low diaspora and poor countries | 0.090 | -0.052** | 0.102* | -0.046 | 0.590** | -0.098 |

**Note:** The dependent variable in columns (1) and (3) is a dummy equal to 1 if the country has experienced a civil war in the year and 0 otherwise. In columns (2) and (4) is a dummy equal to 1 if the country has experienced an interstate conflict in the year and 0 otherwise. In column (5) the dummy is one if the country has experienced one or more civil wars in the decade and in column (6) if the country has experienced one or more interstate conflicts in the decade. Country fixed effects, time fixed effects and Region by time fixed effects included. The last three rows show the calculated effect of an increase in temperature by one degree Celsius on the dependent variable in low-diaspora countries, in poor countries and in low-diaspora and poor countries. **,* indicate significance at the 5 and 10% level.

**Table 8: Gravity model for migration and climate**

| **Dependent variable: Bilateral migration flows** | **OLS** | **PPML** |
|---|---|---|
| | (1) | (2) |
| Temperature difference | 0.067*** | 0.034*** |
| | (0.003) | (0.010) |
| Precipitation difference | 0.000*** | 0.000** |
| | (0.000) | (0.000) |
| Ln(distance) | -0.904*** | -0.569*** |
| | (0.035) | (0.148) |
| Contiguity | 2.192*** | 1.708** |
| | (0.152) | (0.722) |
| Common language | 1.354*** | 0.683* |
| | (0.074) | (0.361) |
| Common colonial history | 2.377*** | 1.632*** |
| | (0.194) | (0.303) |
| Observations | 34,546 | 94,248 |
| R-squared | 0.299 | 0.055 |
| Number of country pairs | 9602 | 11,781 |
| Origin FE | Yes | Yes |
| Time fixed effects | Yes | Yes |
| Region of origin by time effects | Yes | Yes |

**Note:** The dependent variable is the natural logarithm of the bilateral migration flows in column (1) and the bilateral migration flows in column (2). Standard errors are clustered by origin-destination country pairs. ***, **,* indicate significance at the 1, 5 and 10% level.

**Table 9: Conflict and climate-induced migration. 2SLS**

| Dependent variable: Civil Conflict indicator | Contemporaneous, yearly specification | | Lagged, yearly Specification | | Decade Specification | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Ln (inflows) | -0.018 | | -0.019 | | 0.073 | |
| | (0.042) | | (0.042) | | (0.068) | |
| Ln (inflows per capita) | | -0.017 | | -0.018 | | 0.061 |
| | | (0.037) | | (0.037) | | (0.058) |
| Temperature | -0.004 | -0.004 | 0.000 | 0.000 | -0.020 | -0.026 |
| | (0.014) | (0.014) | (0.016) | (0.016) | (0.122) | (0.122) |
| Precipitation | -0.005* | -0.005* | -0.007** | -0.007** | -0.030 | -0.031 |
| | (0.002) | (0.002) | (0.003) | (0.003) | (0.028) | (0.028) |
| Temperature X Poor | 0.074** | 0.074** | 0.106*** | 0.106*** | 0.617*** | 0.626*** |
| | (0.035) | (0.035) | (0.039) | (0.039) | (0.192) | (0.193) |
| Precipitation X Poor | 0.003 | 0.003 | 0.013* | 0.013* | -0.092 | -0.093 |
| | (0.006) | (0.006) | (0.008) | (0.008) | (0.083) | (0.083) |
| Observations | 4,161 | 4,161 | 4,143 | 4,143 | 414 | 414 |
| R-squared | 0.073 | 0.073 | 0.075 | 0.076 | 0.080 | 0.088 |
| Number of countries | 124 | 124 | 124 | 124 | 116 | 116 |
| First st. F-stat | 10.919 | 14.663 | 10.825 | 14.419 | 11.570 | 15.421 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Region by time effects | Yes | Yes | Yes | Yes | Yes | Yes |
| T effect in poor countries | 0.070** | 0.070** | 0.106*** | 0.106*** | 0.597*** | 0.599*** |

**Note:** The dependent variable in columns (1) to (4) is a dummy equal to 1 if the country has experienced a civil conflict in the year and 0 otherwise. In columns (5) and (6), where data are decennial, the dummy is one if the country has experienced one or more civil conflicts in the decade. The last row shows the calculated effect of an increase in temperature by one degree Celsius on the probability of conflict in poor countries. Standard errors are clustered by country. ***, **,* indicate significance at the 1, 5 and 10% level.

**Table 10: Additional Robustness checks. 2SLS**

| **Dependent variable: Civil Conflict indicator** | **Lagged, yearly Specification** | | | | |
|---|---|---|---|---|---|
| | (1)<br>Exclude OECD | (2)<br>Exclude big countries | (3)<br>No T X P | (4)<br>Different dataset for T and P | (5)<br>Model with temp and lagged temp |
| Ln (inflows) | -0.011 | -0.017 | -0.019 | -0.017 | -0.018 |
| | (0.043) | (0.044) | (0.043) | (0.042) | (0.042) |
| Temperature | -0.002 | 0.001 | 0.014 | -0.018 | -0.005 |
| | (0.030) | (0.017) | (0.015) | (0.016) | (0.012) |
| Temperature X Poor | 0.107** | 0.106*** | | 0.125*** | 0.046 |
| | (0.044) | (0.039) | | (0.048) | (0.030) |
| L1: Temperature | | | | | 0.003 |
| | | | | | (0.014) |
| L1: Temperature X Poor | | | | | 0.081** |
| | | | | | (0.033) |
| Observations | 3,063 | 3,943 | 4,143 | 4,133 | |
| R-squared | 0.086 | 0.078 | 0.072 | 0.075 | |
| Number of countries | 96 | 119 | 124 | 123 | |
| First st. F-stat | 13.047 | 9.913 | 10.67 | 10.742 | |
| Temp effect in poor countries(contemporaneous) | 0.105 | 0.107 | | 0.107 | 0.041 |
| Temp. effect in poor countries (lagged) | | | | | 0.084*** |

**Note:** The dependent variable is a dummy equal to 1 if the country has experienced a civil conflict in the year and 0 otherwise. The two to last row shows the calculated effect of an increase in temperature by one degree Celsius on the probability of conflict in poor countries. The last row shows the calculated effect of an increase in previous year temperature by one degree Celsius on the probability of conflict in poor countries. Standard errors are clustered by country. Columns (1), (2) and (4) also include Precipitation, Precipitation X Poor. Column (3) also includes Precipitation. Column (5) also includes Precipitation and one year lagged Precipitation. Country fixed effects, time fixed effects and Region by time fixed effects included. ***, **,* indicate significance at the 1, 5 and 10% level.

**Table 11: Temperature, Conflict and Low Diaspora. Control for climate induced migration. 2SLS**

| Dependent variable: Civil Conflict indicator | Lagged, yearly Specification | | Lagged, yearly Specification | | Decade Specification | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Ln (inflows) | -0.017 | -0.018 | -0.017 | -0.018 | 0.073 | 0.054 |
| | (0.042) | (0.043) | (0.042) | (0.043) | (0.070) | (0.070) |
| Temperature | -0.017 | -0.005 | -0.012 | 0.004 | -0.089 | 0.056 |
| | (0.015) | (0.014) | (0.017) | (0.015) | (0.127) | (0.117) |
| Precipitation | -0.003 | -0.003 | -0.004 | -0.002 | -0.044 | -0.070* |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.038) | (0.042) |
| Temperature X Poor | 0.082** | | 0.113*** | | 0.697*** | |
| | (0.035) | | (0.038) | | (0.197) | |
| Precipitation X Poor | 0.004 | | 0.013* | | -0.077 | |
| | (0.006) | | (0.008) | | (0.081) | |
| Temperature X Low Diaspora | 0.090** | 0.083** | 0.088** | 0.078* | 0.466** | 0.380* |
| | (0.038) | (0.039) | (0.040) | (0.041) | (0.225) | (0.227) |
| Precipitation X Low Diaspora | -0.004 | -0.004 | -0.013 | -0.013 | 0.043 | 0.051 |
| | (0.006) | (0.006) | (0.009) | (0.009) | (0.073) | (0.077) |
| Observations | 4,161 | 4,161 | 4,143 | 4,143 | 414 | 414 |
| R-squared | 0.076 | 0.074 | 0.080 | 0.076 | 0.095 | 0.064 |
| Number of countries | 124 | 124 | 124 | 124 | 116 | 116 |
| First st. F-stat | 10.916 | 10.804 | 10.799 | 10.644 | 11.204 | 10.678 |
| Temperature effect in low diaspora c. | 0.073** | 0.078** | 0.076** | 0.083** | 0.376* | 0.437* |
| Temperature effect in poor countries | 0.065** | | 0.102*** | | 0.607*** | |
| Temperature effect in low diaspora and poor countries | 0.155*** | | 0.190*** | | 1.073*** | |

**Note:** The dependent variable in columns (1) to (4) is a dummy equal to 1 if the country has experienced a civil conflict in the year and 0 otherwise. In columns (5) and (6), where data are decennial, the dummy is one if the country has experienced one or more civil conflicts in the decade. The last three rows show the calculated effect of an increase in temperature by one degree Celsius on the probability of conflict in low-diaspora, in poor countries and in low-diaspora and poor countries. Standard errors are clustered by country. Country fixed effects, time fixed effects and Region by time fixed effects included. ***, **,* indicate significance at the 1, 5 and 10% level.

## Table A1: Number of conflicts in a decade

| Dependent variable: Civil Conflict indicator | Decade Specification | | | |
|---|---|---|---|---|
| | OLS | | 2SLS | |
| | (1) | (2) | (3) | (4) |
| Temperature | -0.084 | -0.539 | 0.076 | 0.081 |
| | (0.708) | (0.724) | (0.766) | (0.772) |
| Precipitation | -0.245 | -0.182 | -0.122 | -0.124 |
| | (0.157) | (0.157) | (0.148) | (0.148) |
| Temperature X Poor | 2.166* | 2.467* | 2.613** | 2.608** |
| | (1.289) | (1.304) | (1.161) | (1.159) |
| Precipitation X Poor | 0.185 | 0.179 | -0.050 | -0.050 |
| | (0.220) | (0.226) | (0.285) | (0.284) |
| Temperature X Low Diaspora | | 3.439** | | |
| | | (1.509) | | |
| Precipitation X Low Diaspora | | -0.250 | | |
| | | (0.313) | | |
| Ln (inflows) | | | -0.142 | |
| | | | (0.394) | |
| Ln (inflows per capita) | | | | -0.142 |
| | | | | (0.348) |
| Observations | 492 | 492 | 414 | 414 |
| R-squared | 0.088 | 0.110 | 0.107 | 0.107 |
| Number of countries | 126 | 126 | 116 | 116 |
| First st. F-stat | | | 11.570 | 15.421 |
| Country FE | Yes | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes | Yes |
| Region by time effects | Yes | Yes | Yes | Yes |
| Temperature effect in low diaspora countries | | 2.900* | | |
| Temperature effect in poor countries | 2.083 | 1.928 | 2.688** | 2.689** |
| Temperature effect in low diaspora and poor countries | | 5.367*** | | |

**Note:** The dependent variable is the number of conflicts in a decade. The last three rows show the calculated effect of an increase in temperature by one degree Celsius on the dependent variable in low-diaspora, in poor countries and in low-diaspora and poor countries. Standard errors are clustered by country. ***, **,* indicate significance at the 1, 5 and 10% level.

**Table A2: Temperature and Conflict. Squared terms for temperature**

| **Dependent variable: Civil Conflict indicator** | **Contemporaneous, yearly specification** | **Lagged, yearly Specification** | **Decade Specification** |
|---|---|---|---|
| | (1) | (2) | (3) |
| Temperature | 0.004 | 0.016 | -0.154 |
| | (0.017) | (0.019) | (0.176) |
| Precipitation | 0.002 | 0.008 | -0.042 |
| | (0.007) | (0.008) | (0.070) |
| Temperature squared | 0.000 | -0.000 | 0.007 |
| | (0.001) | (0.001) | (0.005) |
| Precipitation squared | -0.000 | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.002) |
| Observations | 4,942 | 4,816 | 492 |
| R-squared | 0.062 | 0.060 | 0.063 |
| Number of countries | 126 | 126 | 126 |
| Country FE | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes |
| Region by time effects | Yes | Yes | Yes |

**Note:** The dependent variable in columns (1) and (2) is a dummy equal to 1 if the country has experienced a civil conflict in the year and 0 otherwise. In column (3), where data are decennial, the dummy is one if the country has experienced one or more civil conflicts in the decade. Standard errors are clustered by country.

**Table A3: Summary Statistics, by low income and low diaspora**

| Variable | Number of Observations | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **Yearly measures** | | | | | |
| Conflict incidence in poor and low diaspora | 234 | 0.57265 | 0.495754 | 0 | 0 |
| Conflict incidence in poor and high diaspora | 931 | 0.179377 | 0.383874 | 0 | 1 |
| Conflict incidence in non-poor and low diaspora | 805 | 0.229814 | 0.420975 | 0 | 1 |
| Conflict incidence in non-poor and high diaspora | 2972 | 0.143674 | 0.350818 | 0 | 1 |

**Table A4: Temperature, Conflict and Low Diaspora. Fixed effects logit estimator**

| Dependent variable: Civil Conflict indicator | Contemporaneous, yearly specification | Lagged, yearly Specification | Decade Specification |
|---|---|---|---|
| | (1) | (2) | (3) |
| Temperature | -0.454** | -0.517** | -0.738 |
| | (0.204) | (0.229) | (1.026) |
| | [-0.113] | [-0.129] | [-0.201] |
| Precipitation | -0.065 | -0.072* | -0.481 |
| | (0.045) | (0.040) | (0.325) |
| | [-0.016] | [-0.018] | [-0.119] |
| Temperature X Poor | 0.769* | 1.004** | 3.604** |
| | (0.423) | (0.478) | (1.676) |
| | [0.192] | [0.251] | [0.892] |
| Precipitation X Poor | 0.085 | 0.186*** | -0.061 |
| | (0.069) | (0.063) | (0.505) |
| | [0.021] | [0.046] | [-0.015] |
| Temperature X Low Diaspora | 0.747** | 0.835** | 4.517 |
| | (0.365) | (0.403) | (2.846) |
| | [0.187] | [0.209] | [1.118] |
| Precipitation X Low Diaspora | 0.018 | -0.020 | 0.360 |
| | (0.058) | (0.062) | (0.744) |
| | [0.004] | [-0.005] | [0.089] |
| Observations | 2,993 | 2,917 | 244 |
| Number of countries | 76 | 76 | 62 |
| Country FE | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes |

**Note:** The dependent variable in columns (1) and (2) is a dummy equal to 1 if the country has experienced a civil conflict in the year and 0 otherwise. In column (3), where data are decennial, the dummy is one if the country has experienced one or more civil conflicts in the decade. Standard errors in parentheses are clustered by country. Marginal effects are in brackets. The sample size drops with the logit estimator compared with the linear probability model, as countries with no variation in the dependent variable (countries being in all years in peace) are removed when country fixed effects are included. ***, **,* indicate significance at the 1, 5 and 10% level.

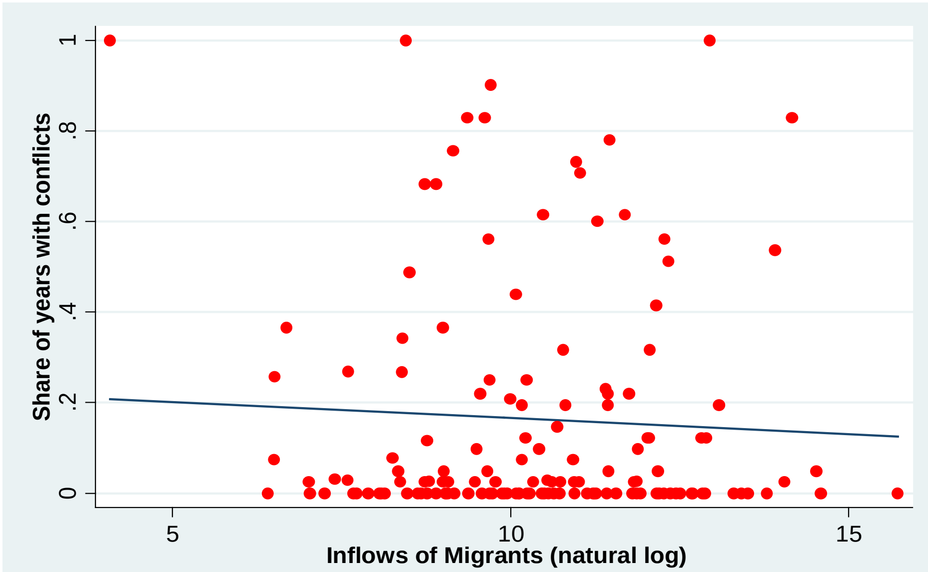
**Table A5: 2SLS- First Stage for the inflows of migrant. Gravity-based immigration instrument**

| **Dependent variable: natural logarithm of the inflows of migrants** | **Contemporaneous, yearly specification** | | **Lagged, yearly Specification** | | **Decade Specification** | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Ln (OLS-predicted inflows) | 0.413*** | | 0.411*** | | 0.427*** | |
| | 0.125 | | 0.125 | | 0.126 | |
| Ln (OLS-predicted inflows per capita) | | 0.465*** | | 0.462*** | | 0.481*** |
| | | [0.122] | | 0.122 | | 0.123 |
| Temperature | -0.030 | -0.026 | -0.058 | -0.056 | -0.381 | -0.367 |
| | 0.046 | 0.045 | 0.043 | 0.044 | 0.263 | 0.267 |
| Precipitation | -0.008 | -0.008 | -0.004 | -0.005 | -0.084 | -0.090 |
| | 0.009 | 0.010 | 0.009 | 0.010 | 0.090 | 0.092 |
| Temperature X Poor | 0.139 | 0.138 | 0.169 | 0.169 | 0.605 | 0.598 |
| | 0.146 | 0.143 | 0.146 | 0.144 | 0.514 | 0.509 |
| Precipitation X Poor | -0.016 | -0.017 | -0.022 | -0.024 | -0.130 | -0.136 |
| | 0.022 | 0.023 | 0.026 | 0.027 | 0.159 | 0.163 |
| Observations | 4161 | 4161 | 4143 | 4143 | 414 | 414 |
| R-squared | 0.3271 | 0.2271 | 0.3279 | 0.2267 | 0.3364 | 0.2426 |
| Number of countries | 124 | 124 | 124 | 124 | 116 | 116 |
| First st. F-stat | 10.92 | 14.66 | 10.83 | 14.42 | 11.57 | 15.4 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Region by time effects | Yes | Yes | Yes | Yes | Yes | Yes |

**Note:** The dependent variable is the natural logarithm of the inflows of migrants in columns (1), (3) and (5) and the natural logarithm of the inflows of migrants relative to destination country's population in columns (2), (4) and (6). Standard errors are clustered by country. ***, **,* indicate significance at the 1, 5 and 10% level.

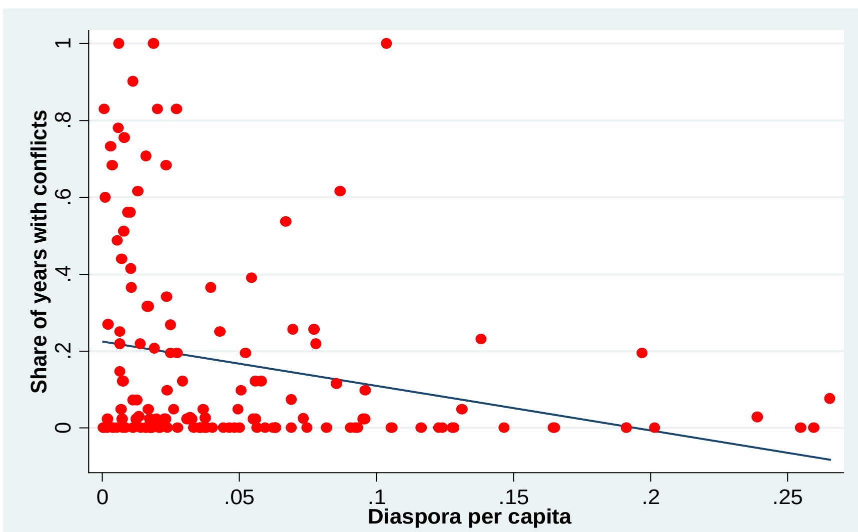
## Figures

**Figure 1: Correlation between immigration and conflict, 1960-2000**



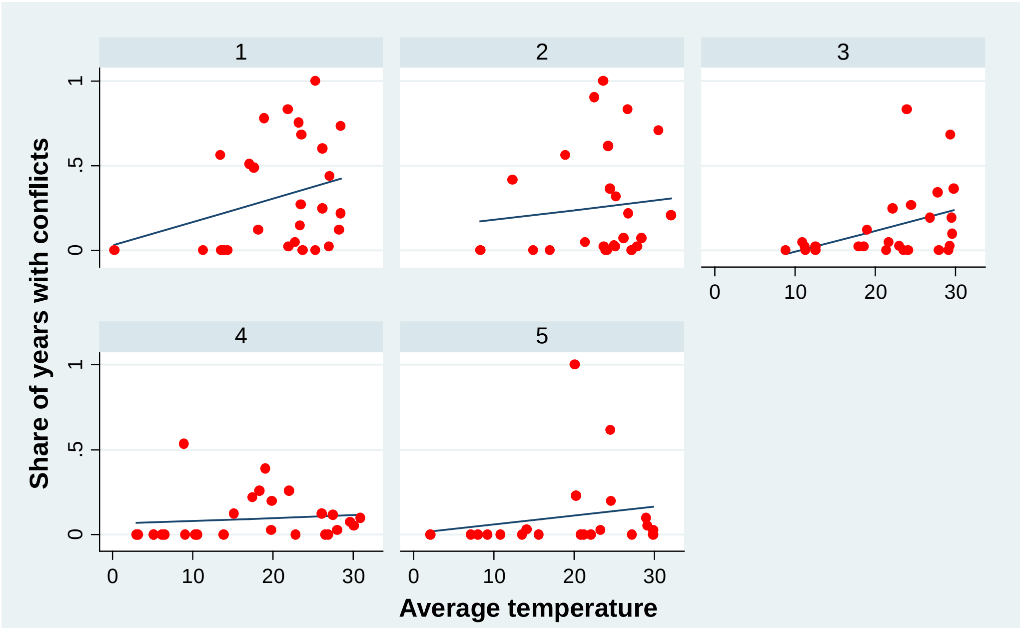

**Note:** Each point in the scatterplot represents a country. The vertical axis shows the share of years between 1960 and 2000 during which the country experienced a civil conflict. The horizontal axis shows the (natural logarithm of) average inflows of migrants in the country between 1960 and 2000. The regression line has a slope of -0.007 and a standard error of 0.01.

**Figure 2: Correlation between diaspora in 1960 and conflict 1960-2000**



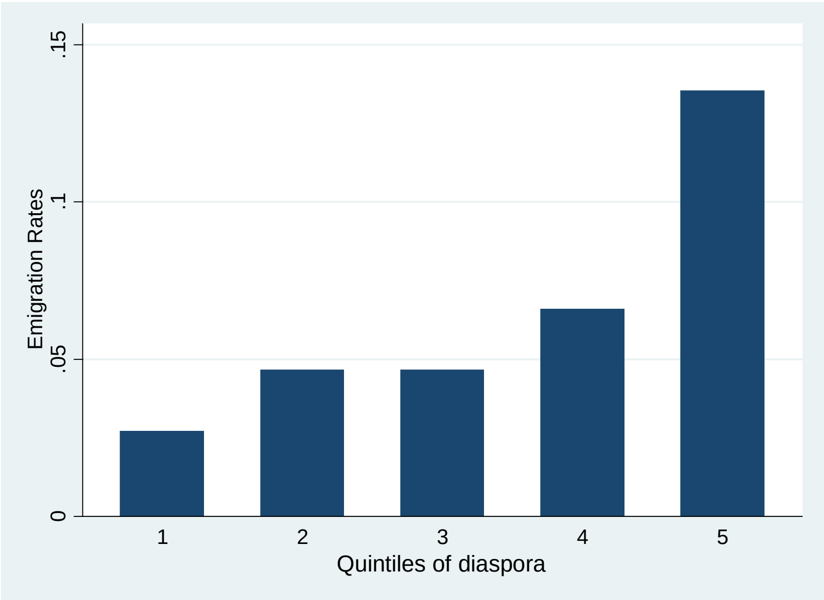

**Note:** Each point in the scatterplot represents a country. The vertical axis shows the share of years between 1960 and 2000 during which the country experienced a civil conflict. The horizontal axis shows the people from a country residing abroad as share of the total resident population of the country. The regression line has a slope of -1.15 and a standard error of 0.22.

**Figure 3: correlation between temperature and conflict, by intensity of Diaspora**



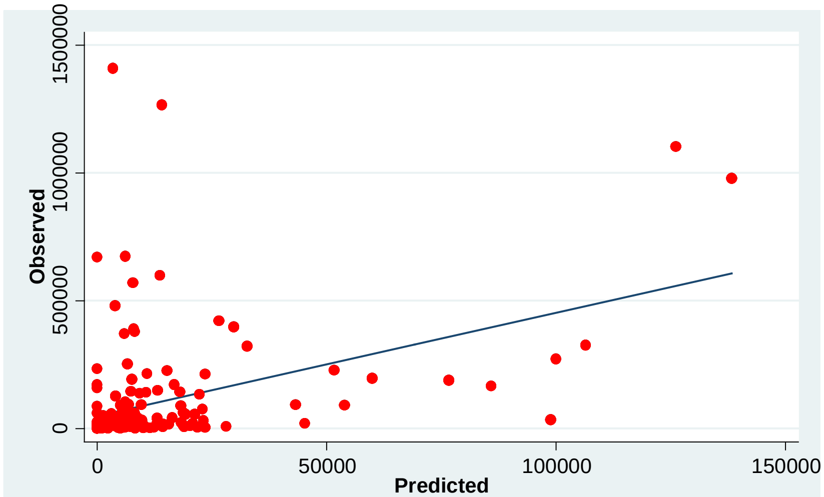

**Note:** Each point in the scatterplot represents a country. Each panel includes only one quintile of countries, ranked by the intensity of the diaspora, from the lowest quintile (1) represented in the top-left panel, to the highest quintile (5) in bottom-right panel. The vertical axis in each graph shows the share of years between 1960 and 2000 during which the country experienced a civil conflict. The horizontal axis in each panel shows the average temperature in the country between 1960 and 2000. The regression lines show a positive and more significant relation in the top three panels relative to the bottom two.

**Figure 4: Diaspora and emigration rates 1960-2000**




**Note:** The vertical axis shows the average emigration rates of the countries between 1960 and 200 for the different quintiles of the diaspora (horizontal axis).

**Figure 5: Observed and predicted migrant inflows**




**Note:** Each point in the scatterplot represents a country. The vertical axis shows the average observed inflows of migrants between 1960 and 2000. The horizontal axis shows the average OLS-predicted inflows of migrants between 1960 and 2000.

## List of countries in the sample

**Low diaspora and poor**

Bangladesh, Cambodia, Etiopia, Madagascar, Myanmar, Sierra Leone

**Low diaspora and non-poor**

Argentina, Bhutan, Brazil, China, Egypt, Gabon, Guatemala, Indonesia, Iran, Japan, Mongolia, Nigeria, Papua New Guinea, Peru, Philippines, Sri Lanka, Thailand, United States, Venezuela, Vietnam

**Non-low diaspora and poor**

Afghanistan, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Gambia, Guinea, Guinea-Bissau, Haiti, Kenya, Liberia, Malawi, Mali, Mozambique, North Korea, Nepal, Niger, Rwanda, Somalia, Tanzania, Togo, Uganda, Zimbabwe

**Non-low diaspora and non-poor**

Albania, Algeria, Angola, Australia, Austria, Belize, Bolivia, Botswana, Brunei Darussalam, Bulgaria, Cameroon, Canada, Chile, Colombia, Congo, Costa Rica, Cuba, Denmark, Djibouti, Dominican Republic, Ecuador, El Salvador, Equatorial Guinea, Finland, France, Germany, Ghana, Greece, Guyana, Honduras, Hungary, Iceland, India, Iraq, Ireland, Israel, Italy, Ivory Coast, Jordan, Korea, Rep., Kuwait, Laos, Lebanon, Lesotho, Libya, Malaysia, Mauritania, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Norway, Oman, Pakistan, Panama, Paraguay, Poland, Portugal, Saudi Arabia, Senegal, South Africa, Spain, Sudan, Suriname, Swaziland, Sweden, Switzerland, Syria, Tunisia, Turkey, United Arab Emirates, United Kingdom, Uruguay, Yemen, Zambia