Climate, conflict and forced migration

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November 2018

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Climate, conflict and forced migration

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Abstract

Despite the lack of robust empirical evidence, a growing number of media reports attempt to link climate change to the ongoing violent conflicts in Syria and other parts of the world, as well as to the migration crisis in Europe. Exploiting bilateral data on asylum seeking applications for 157 countries over the period 2006-2015, we assess the determinants of refugee flows using a gravity model which accounts for endogenous selection in order to examine the causal link between climate, conflict and forced migration. Our results indicate that climatic conditions, by affecting drought severity and the likelihood of armed conflict, played a significant role as an explanatory factor for asylum seeking in the period 2011-2015. The effect of climate on conflict occurrence is particularly relevant for countries in Western Asia in the period 2010-2012 during when many countries were undergoing political transformation. This finding suggests that the impact of climate on conflict and asylum seeking flows is limited to specific time period and contexts.

1   Introduction

The ongoing Syrian conflict, which began in March 2011, has drawn attention from both the scientific community and the media to the question of how climatic conditions can contribute to political unrest and civil war. Recent studies of the Syrian uprising have shown that growing water scarcity and frequent droughts, coupled with poor water management, led to multiyear crop failures, economic deterioration and consequently mass migration of rural families to urban areas (Gleick, 2014; Kelley et al., 2015). Rapid growing population, overcrowding, unemployment and increased inequality put pressure on urban centres and finally contributed to the breakout of political unrest. Should these mechanisms be in place, the effect of anthropogenic climate change on the frequency and intensity of extreme events is expected to affect the risk of violent conflicts by aggravating such drivers of conflicts as poverty, food insecurity and inequalities (IPCC, 2014).

Conflicts bring about a series of negative consequences including premature death, disability, psychological trauma, physical injury and malnutrition (Murray et al., 2002). Likewise, conflict can also be the cause of displacement. There is evidence that violence, in particular, serves as a main push factor in the case of forced migration (Moore and Shellman, 2004; Schmeidl, 1997). If climate change does induce conflict, then indirectly climate change also contributes to forced migration. Indeed, recent media headlines, especially those on Europe's refugee crisis, often cite climate change-induced conflict in the Middle East and Africa as a major driver of the surge of migrants to Europe in the past couple of years. The narrative behind these headlines tend to follow a similar path, claiming climate change reduces availability and alters the distribution of resources such as water, food and arable land which in turn trigger violent conflict and, as a consequence, migration. However, scientific literature linking climate, conflict and migration together is relatively scare. Extant literature on the impacts of climate change on conflict and migration commonly assess how environmental pressures instigate outmigration and consequently how climate change-induced migration promote conflict in migrant receiving areas. The arrival of climate migrants can put pressure on infrastructure, services and the economy of the receiving area leading to competition over resources, especially when the resources are scarce (Reuveny, 2007). However, whilst this narrative is common amongst scholars of peace and conflict studies (Homer-Dixon, 1999; Reuveny, 2008, 2007), there is little empirical evidence supporting this claim (Brzoska and Fröhlich, 2016; Raleigh and Urdal, 2007).(Reuveny, 2007). Generally, drivers of migration e.g. climate, political factors, economic conditions and conflict are considered simultaneously in the empirical specification without considering the pathway through which migration is determined. Typically, in macro-level studies at the country or regional level, migration flows are estimated using linear models controlling for relevant socioeconomic and political confounding variables. The specific impact of

climate on migration is then isolated, often using multivariate models (Piguet, 2010). Beine and Parsons (2015), for instance, include international violence along with climate-related variables and show that the increase in the incidence of international violence corresponds with higher migration flows. Likewise, using the occurrence of a civil war as a proxy for institutional quality, Drabo and Mbaye (2015) report a similar finding although this applies only to highly educated people. In any case, these models merely show the closed-formimpact of conflict on migration but do not make any links between climatic or environmental factors and conflict. These studies do not address the indirect pathway through which climate affects migration through conflict, as often claimed by the media.

To the best of our knowledge, there is no scientific study that has empirically established the links between climate change, conflict and migration and identified the causal pattern in a convincing manner, partly due to the inherent complexity of the task (Fröhlich, 2016) . As of now, both the empirical support and theoretical foundations of such relationship are scarce (Brzoska and Fröhlich, 2016). A recent article by Missirian and Schlenker (2017) addresses the relationship between asylum seeking and temperature fluctuations using asylum applications to the European Union between 2000 to 2014 as a proxy of conflict. Climate-induced conflict is thus not measured directly but through the assumption that asylum applications reflect distress-driven migration. Apart from employing a very limited approach and exclusively using temperature as a single climatic indicator, the study does not explicitly examine the causal link between climate and conflict. The lack of scientific rigour of the interpretations of the results offered has caused justifiable criticism by fellow scholars[1]. Another recently published article by Owain and Maslin (2018) explores how droughts and temperature variability are related to population displacement and conflict in East Africa. By including both conflict and displacement in the same empirical model , the study merely tests the relationships between climatic factors and conflict; and climatic factors and migration. In this research design, it is not possible to explicitly disentangle the pathways through which climate influences migration.

This paper aims to empirically establish the causal path from climate change to violent conflict and to cross-border migration and explore how climate and conflict interplay in influencing cross-border migration. Exploiting the bilateral refugee flows data for the years 2006-2015 for 157 countries, we employs the sample selection methods for gravity-type models to first estimate the impact of climate on conflict and secondly how conflict influences forced migration. To the best of our knowledge, the causal link between climate, conflict and migration is investigated for the first time at this level of statistical rigour. Our study unpacks conflict as a causal mediator between climate change on the one hand and asylum migration on the other. This study thus provides an empirical assessment of scientific evidence on the popular claim regarding the

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[1] See for example the discussion in http://wmbriggs.com/post/23581/.

role of climate change on conflict and migration. The remainder of the paper is organised as follows. Section 2 provides a review of empirical literature on climate, conflict and migration and discusses underlying mechanisms through which climate can influence migration. Section 3 describes estimation methods and data. Section 4 presents the main results and additional results from the robustness check. Section 5 discusses the main findings and concludes.

2   Review of literature on conflict, climate and migration

As previously mentioned, there is no study that empirically assesses the existing causal relationships between climate, conflict and migration simultaneously. Empirical studies on the subject tend to be organized along the triplet axes of climate change and migration; climate change and conflict; and conflict and migration. With respect to the first strand of literature, there is no empirical consensus on the relationship and the direction of association between climate change and migration – climatic shocks may induce, constrain or have no impact on migration depending on the particular characteristics of the climatic shock and the region of occurrence. Cross-national studies based on household surveys and micro-censuses report mixed evidence: whilst an increase temperature is associated with higher international migration in Uganda, outmigration decreases with temperature rise in Burkina Faso and Kenya, and no relationship is found between migration and temperature anomalies in Nigeria and Senegal (Gray and Wise, 2016; Nawrotzki and Bakhtsiyarava, 2016). Even a series of studies that focus on the same country do not find an identical pattern. Rainfall deficits suppress US-bound migration from rural Mexico according to some studies (Hunter et al., 2013; Nawrotzki et al., 2015) but increase migration according to another (Barrios Puente et al., 2016). Likewise, a set of macro level studies of bilateral migration between countries also report inconsistent findings with international migration increases with higher temperature on the one hand (Backhaus et al., 2015; Cai et al., 2016; Cattaneo and Peri, 2016) and no relationship is found in other pieces (Beine and Parsons, 2015).

Inconsistency in the existing empirical findings is largely due to heterogeneity in measurement, methods and data used (Beine and Jeusette, 2018). Climate variables include both slow onset and fast onset events. The former captures long-run climatic factors typically measured as levels, deviations, anomalies or variability of precipitation and temperature. Fast onset climatic factors generally capturing natural disaster events including temperature and precipitation extremes, floods, storms and droughts. Definitions of what is considered to be deviations from normality and extreme events, for instance, vary across studies. Likewise, migration encompasses different types of mobility including internal and international migration, forced and voluntary migration and is sometimes indirectly measured e.g. using the rate of urbanisation as a proxy for internal migration (Barrios et al., 2006). The choices of climate and migration definitions and measures thus

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can influence the direction and magnitude to which climate affects migration.

Furthermore, the lack of consensus of these findings is partly due to the complexity of migration processes; climatic impacts on migration might be indirectly mediated through social, demographic, economic, political and environmental factors (Black et al., 2011; Hugo, 2011). . The most widely used conceptual framework in the study of environmental migration is that of Black et al. (2011) which explains that in addition to direct influence, environmental change induces changes in other drivers of migration and thus indirectly affects migration decision. Indeed, some macro-level studies provide support of the indirect effect of climatic factors on international migration which run through reduction of crop yields (Cai et al., 2016), changes in GDP per capita (Cattaneo and Peri, 2016; Coniglio and Pesce, 2015) and wage differences between origin and destination (Beine and Parsons, 2015). Even considering only the indirect channel, the effect of climatic factors on the mediators is not homogenous. Cattaneo and Peri (2016), for instance, report increased migration for middle-income countries whilst migration is suppressed in low-income countries with higher temperature.

Climate change can potentially influence the drivers of migration through difference climatic hazards such as a rise in sea level, change in tropical storm and cyclone frequency and intensity, changes in rainfall patterns, increases in temperature and changes in atmospheric chemistry (Black et al., 2011). These changes directly affect the environmental drivers of migration such as reduction in water availability and crop and pasture productivity, as well asloss of ecosystem services. Climate change also indirectly influences other drivers of migration. For instance, economic drivers are affected through the reduction of household incomes due to a decline in crop, livestock or fisheries productivity. Similarly, climate change exacerbates the availability of limited resources and violence emerges over access to these resources (Raleigh, 2010). Indeed, a systematic review of 53 studies on environmental change and migration focusing on Africa by Borderon et al. (2018) reports that there is no evidence showing that environmental change is a sole driver of migration. Considering complex interactions between migration drivers thus is essential when examining the link between climate and migration. As for the second strand of literature on the relationship between climate and conflict, the evidence from large-scale studies is fairly robust. A recent meta-analysis of 60 quantitative studies confirms that the risk of conflict increases substantially with deviations from normal precipitation and mild temperatures (Hsiang et al., 2013). On average, one standard deviation change toward warmer temperatures or more extreme rainfall increases frequency of interpersonal violence by 4% and intergroup conflict by 14%. Another meta-analysis of 55 studies report a similar finding whilst emphasising that climate is unlikely to be the sole or even the primary driver of human conflict (Burke et al., 2015). Similar to how climate may affect migration, changes in the climate also influence conflict through multiple pathways

ranging from agriculture and economic productivity, demographic pressure to psychological mechanisms. However, quantitative research examining key causal pathways is still in its infancy and more evidence is called for.

Although there is no statistical evidence of the link between climate and conflict in Syria, the Syrian uprising provides a case study of how climate change and drought played a role in triggering conflict. During the period 2007-2010, Syria had experience the worst drought likely to be caused by anthropogenic climate change (Kelley et al., 2015). The three-year severe drought resulted in a dramatic reduction of the supply of groundwater. Severe droughts coupled with inadequate water management decisions, poor planning and policy errors led to large-scale multiyear crop failures. Dramatically rising food prices coupled with economic deterioration led to displacement and migration of rural farming families to urban areas (Gleick, 2014). The rapid increase in urban population from 8.9 million in 2002 to 13.8 million in 2010 put pressure on infrastructure, economic resources and social services in the urban areas which were key areas being neglected by the Assad government. The devastating consequences of drought due to poor governance and unsustainable agriculture and environmental policies consequently contributed to political unrest in Syria (Kelley et al., 2015). This narrative describes a pathway trough which climate change triggers conflict through interactions with other factors.

If climate does influence conflict, the next question is how conflict is linked with migration. The evidence from the third strand of literature on conflict and migration suggests countries experiencing different types of violent conflict have higher outmigration and refugee flows (Beine and Parsons, 2015; Drabo and Mbaye, 2015; Gröschl and Steinwachs, 2016; Hatton and Williamson, 2003). However, not all conflicts result in migration and push factors play a role in determining outmigration flows whilst the area of destination is determined by pull factors attracting migrants to a specific region. Similar to the relationship between climate and migration, it is unlikely that conflict alone is not a major driver of mobility and displacement but tradition push and pull factors such as differences in per capita income between origin and destination, population size and distance also play a role in determining outmigration (Czaika and Kis-Katos, 2009; Lozano-Gracia et al., 2010). However, when conflict involves violence as measured by e.g. the ratio of victims of massacres, migration outflows increase with violence at the origin and migration inflows decreases as violence intensifies at the destination (Lozano-Gracia et al., 2010).

It is also plausible that the influence of conflict on outmigration is indirect. Conflict affects many factors that may in turn induce migration, such as income loss, the breakdown of social relations and institutional failures. Some studies, for instance, do not find the direct effect of armed conflicts on migration but through the reduction in GDP per capita in origin countries (Coniglio and Pesce, 2015).

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Note that the relationship between conflict and migration can be reverse. Literature in peace and conflict studies, in particular, often perceive conflict as an outcome of environmental migration (Raleigh, 2010; Reuveny, 2008, 2007). It is hold that environmental degradation and resource scarcity lead to population movements in response to environmental pressure. The increase in the number of migrants can contribute to conflict in migrant receiving areas in many different ways. This ranges from competition over natural and economic resources, ethnic tensions, socioeconomic tensions and burden on infrastructure and services. Reuveny (2007) emphasises that in the context of neo-Malthusian resource scarcity, climate change-induced migration is particularly prone to creating conflict in the destination area because large and rapid migration flows prevent the receiving areas to smoothly incorporate the migrants. There is however not much empirical support for this theoretical model, especially because the evidence on climate-induced mass migration is weak (Brzoska and Fröhlich, 2016; Fröhlich, 2016) and there are many other factors (e.g. political stability, economic conditions and capacity of government to provide services) that are significant than migration (Burrows and Kinney, 2016) . The lack of evidence is supported by a recent study by Cattaneo and Bosetti (2017) using the two-stage least squares approach. The study finds no significant relationship between the presence of international climate migrants and conflict in destination countries. Therefore, a reverse causation of climate-induced migration leading to conflict is unlikely in our case.

Based on the empirical literature on the relationships between climate and conflict; and conflict and migration, the impact of climate change on migration can be thought of as being mediated through conflict as presented in Figure 1. The relationship between climate change, conflict and migration is likely to follow the sequence of climate change exacerbating human conflict due to competition over scarce resources. For instance, recurrent severe droughts due to climate change can lead to conflict and instability in a country with poor management of natural resources. Consequently, climate-induced conflict outbreak drives displacement and outmigration. Figure 1 also presents a possibility of the reverse causation depicted by grey arrows whereby climate change first drives outmigration and subsequently migrant pressure contributes to conflict. The latter relationship however is not the focus of this study.
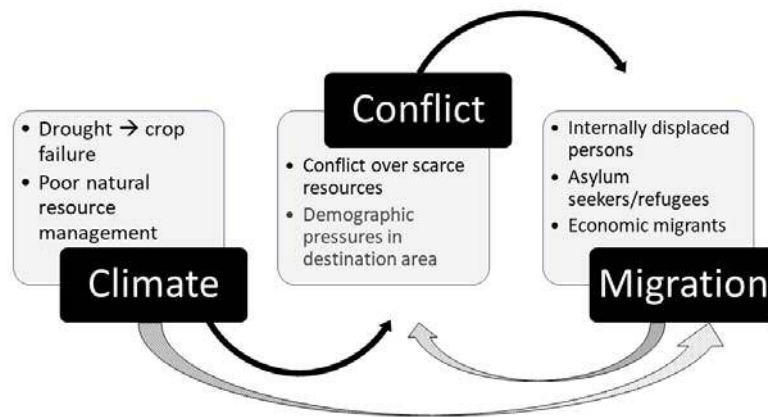
Figure 1: Conceptual model of climate, conflict and migration

To model for the sequences of the relationship between climate, conflict and migration, the analysis should be done in two steps by first looking at how climate influences conflict and secondly how conflict drives migration. Nevertheless, generally, drivers of migration (e.g. climate, political factors, economic conditions and conflict) are assessed simultaneously without considering the causal structure through which migration is determined. To this end, this study aims at empirically establishing the causal path from climate change to violent conflict and to cross-border migration, and to explore how climate and conflict interplay in influencing cross-border migration. Exploiting bilateral asylum seeking flow data for the years 2006-2015 for 157 countries, we employ a gravity-type model with endogenous selection to first estimate the impact of climate on conflict and secondly to assess how conflict influences forced migration. This study thus provides an empirical assessment of the popular claim regarding the role of climate change on conflict and migration.

3   Modelling global asylum-seeking flows and data

3.1   Model specification and estimation methods

Our modelling framework aims at assessing quantitatively the determinants of asylum seeking flows using a gravity equation setting similar to that proposed for bilateral migration data (Cohen et al., 2008) but addressing explicitly the statistical problems caused endogenous selection in origin-destination pairs and non-random treatments. In this sense, our statistical problem is similar to those often encountered in health care studies, where for example the enrollment in a healthcare maintenance organisation (treatment) affects

a person's decision on both whether to use healthcare at all (extensive margin) and how much to spend for healthcare (intensive margin), given a positive decision.

In our setting, however, conflict (treatment) itself is not randomly 'assigned' across our population of origin countries, that is, we have to consider the treatment itself to be endogenous as well. As with the healthcare example given above, this treatment (conflict) potentially affects the probability that we observe non-zero flows between some origin-destination country pairs (extensive margin). In other words, we have to account for a selection of countries in sending out migrants to a certain country of destination. Furthermore, conflict potentially affects the number of migrants seeking asylum in some destination country. These figures, however, are only observed in the case of actual flows and thus have to be considered as being potentially non-randomly censored.

This setting leaves us with three simultaneous equations, where two of them contain our common endogenous binary regressors (i.e. conflict onset). In order to estimate this framework of simultaneous equations, we apply a simple two-step estimation technique proposed by Kim (2006). Translated to our context, we are interested in the following sample selection model that contains a common endogenous dummy variable in the selection equation (1) and the censored equation (2).

$$c_i^* = Z_{c,i}^{'}\gamma_1 + \varepsilon_{c,i}, \qquad c_i = I(c_i^* > 0), \qquad (1)$$

$$s_{ij}^* = Z_{s,ij}^{'}\gamma_2 + c_i\beta_2 + \varepsilon_{s,ij}, \qquad s_{ij} = I(s_{ij}^* > 0), \quad (2)$$

$$a_{ij}^* = Z_{a,ij}^{'}\gamma_3 + c_i\beta_3 + \varepsilon_{a,ij}, \qquad a_{ij} = a_{ij}^* s_i, \qquad (3)$$

where equation (1) specifies the occurrence of conflict ($c_i = 1$) in country i, equation (2) address whether a non-zero flow of asylum seeking applications takes place from country i to country j ($s_{ij} = 1$) and equation (3) models the size of the flow of applications (in logs, $a_{ij} = 1$) from origin country i to destination country j for origin-destination pairs with non-trivial flows.. $I(x)$ is an indicator function taking value one if x is true and zero otherwise and the exogenous controls for each one of the equations in the model are summarized in the vectors $Z_{c,i}$, $Z_{s,ij}$ and $Z_{a,ij}$, respectively. The error terms, c_i, s_{ij} and a_{ij} are assumed jointly multivariate normal and potentially correlated, thus capturing the endogenous selection of origin countries that present non-zero asylum applications to endogenously selected destination countries.

Following Kim (2006), this sample selection model with a common endogenous regressor in the selection

equation and the censored outcome equation is estimated as a hybrid of the bivariate probit and the type-II Tobit model containing the common endogenous binary conflict indicator. This implies that we have to control for the endogeneity caused by c_i and the selection bias caused by the censoring indicator s_{ij} at the same time.

Instead of a simulation assisted Full Maximum Likelihood (FIML) approach we follow Kim (2006) and employ a simple two-step estimation technique by first estimating the bivariate probit model with structural shift (equations (1) and (2)) and further use the estimation results of this first stage as control functions for the censored outcome equation using a simple Generalized Method of Moments Estimator (GMM). This way we can interpret the Molde as a Type V-Tobit model with a bivariate selection and parameter restrictions. This approach bears the advantage of being numerically robust and easy to implement since it relaxes the strong normality assumptions imposed when using the FIML approach.

For the empirical identification we impose exclusion restrictions, that is, for each regression we include regression specific covariates that identify treatment and selection, respectively. These regression specific covariates affect the main dependent variable (i.e. number of asylum applicants) only through the instrumental variable (endogenous treatment or selection identifier in our case) and not directly. This statistical approach allows us to directly discuss potential climate related effects on conflict and thus - through the imposed statistical structure - on asylum seeker flows.

3.2   Data and measurement

3.2.1   Asylum-seeking flows data and patterns

Dyadic data on asylum applications are sourced from the United Nations High Commissioner for Human Rights (UNHCR) (UNHCR, 2018). The data are provided to UNHCR by a mixture of sources. In more developed countries, the host government are generally the sole data provider, whilst in developing countries UNHCR field offices and other NGOs play a more important role in data collection.

Asylum seekers are defined as individuals who have sought international protection and whose claims for refugee status have not yet been determined. The UNHCR data contains information about asylum applications by year and the progress of asylum-seekers through the refugee status determination process starting in the year 2000. We focus on asylum seeking applications for two reasons. First, asylum seeking can be linked to conflict more directly than regular migration which is driven by various other push and pull factors. Second, whilst refugee flows are also likely to be driven by conflict, they are endogenous to a host country's specific policy in granting a refugee status. We therefore use asylum application data since actual

stock and refugee figures are prone to be strongly affected by country-specific political actions.
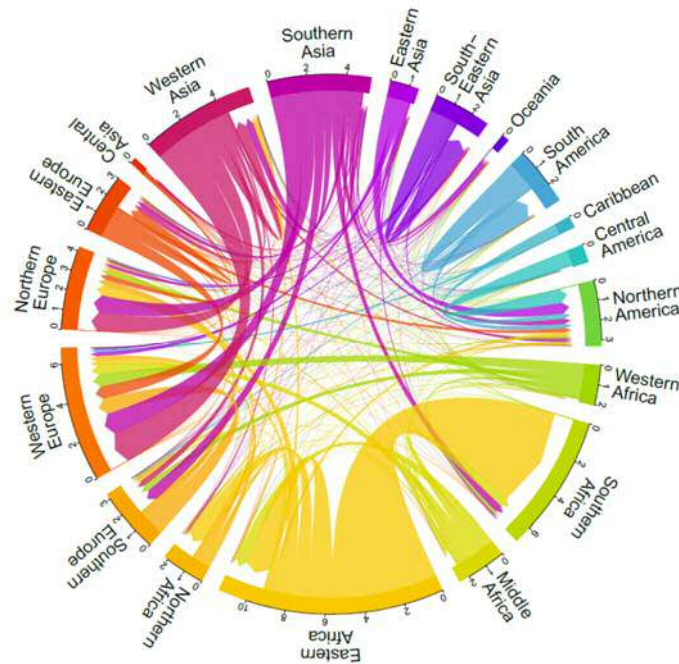
Figure 2: Asylum seeking flows by world region, 2006-2010 and 2011-2015

Figure 2 shows chord diagram plots depicting cumulative bilateral links for asylum seekers in the periods 2006-2010 and 2011-2015 based on data country of origin - country of applications data from the UNHCR. In the first period considered, the largest source of asylum seekers was from Sub-Saharan Africa with many making applications within the region. Additionally, Western Europe received a large volume of asylum applications, especially from Northern Africa and Western Asia, Sub-Saharan Africa and Southern Asia. In the period 2011-2015, the number of asylum applications in Sub-Saharan Africa remained large (about 1.8 million asylum seekers came from the region). However, the largest origin region of asylum seekers was from Northern Africa and Western Asia (over 2.4 million), predominantly in Syria and other countries affected by the Arab spring. Many of those seeking asylum from these countries made applications in Southern Europe and Western Europe.

3.2.2   Conflict data

Information on battle-related deaths are from the Uppsala Conflict Data Program (UCDP) Georeferenced Event Dataset (GED) Global version 17.1 (UCDP, 2018). The dataset contains 135181 events and the dataset covers the entirety of the Globe (excluding Syria), with information ranging from January 1989 to December 2016. The figures for Syria are obtained from the UCDP Battle Related Deaths Dataset 17.1, which contains

conflict-year and dyad-year information on the number of battle-related deaths in conflicts from 1989 to 2016. The most recent version is version 17.1. Conflict is defined in line with the UCDP GED as yearly battle-related deaths exceeding 25 casualties. Therefore, a country is considered to be in conflict if there are at least 25 casualties, both state-based and non-state-based, in a given calendar year.

3.2.3 Climate data

Climatic factor is measured using the Standardised Precipitation-Evapotranspiration Index (SPEI). SPEI is a multiscalar drought index based on climatic data and used for determining the onset, duration and magnitude of drought conditions with respect to normal conditions in a variety of natural and managed systems (e.g. crops, ecosystems, rivers). SPEI data are obtained from the Global SPEI database, offering long-time, robust information about drought conditions at the global scale, with a spatial resolution of 0.5 degrees and monthly periodicity (Beguería et al., 2010). The current version of the dataset covers the period between January 1901 and December 2015 based on Climatic Research Unit's TS 3.23 input data (monthly precipitation and potential evapotranspiration) (Harris et al., 2014).

SPEI measures the intensity and spatial distribution of droughts. It is considered superior to other drought indices, since it captures the effects of evaporation and transpiration caused by temperature, along with precipitation (Vicente-Serrano et al., 2010). SPEI is measured on an intensity scale with both negative values, indicating drought conditions, and positive values, indicating wet conditions. The index can be used to further categorise drought conditions into mild ($-1 < \text{SPEI} < 0$), moderate ($-1.5 < \text{SPEI} \leq -1$), severe ($-2 < \text{SPEI} \leq -1.5$), and extreme ($\text{SPEI} \leq -2$) (Mckee et al., 1993; Paulo and Pereira, 2006).

3.2.4 Socioeconomic and geographic data

The remaining covariates are derived from a variety of sources. Additional variables in Equations (1) and (2) include variables which are a standard battery of controls previously used in the literature when considering determinants of conflict (Collier and Hoeffler, 2002, 1998; Fearon and Laitin, 2003; Miguel et al., 2004). The variables such as ethnic polarization measurement, economic performance measured as log-transformed GDP per capita before the observational period and level of democratization are included to control for potential confounders of conflict.

For the estimation of asylum-seeking flows, we include standard control variables i.e. distance between country of origin and country of destination, whether countries share a common language, colonial relation, population size at the country of origin and destination and migrant networks based on the previous literature using the gravity-type model to estimate bilateral migration flows in the context of climate change (Backhaus

et al., 2015; Beine and Parsons, 2015). This set of control variables captures bilateral and country-specific push and pull factors different from conflict in the country of origin.

The data for the variables in the gravity model that builds the third stage of our empirical specification is partly sourced from Mayer and Zignago (2012), with data on the distance between countries based on capital cities. Note that the results are qualitatively unchanged when most populated areas or country centroids are used instead. The measurement of a country's political status is measured using the Polity IV index (Marshall et al., 2017)\, normalized between 0 (autocracy) and 1 (democracy). Our ethnic polarization measurement is obtained from the Geographical Research On War, Unified Platform (Bormann et al., 2015). When data are missing, the CIA Factbook is used as a source of information. For the calculation of the ethnic polarization index, we apply the Garcia-Montalvo (Montalvo and Reynal-Querol, 2005) and compute

$$4 \sum_{i=1}^{N} \pi_i^2 (1 - \pi_i)$$

Here, π_i is just the proportion of people that belong to the ethnic (religious) group i and N is the number of groups. We also estimated our model using conventional fractionalization indices $1 - \sum_{i=1}^{N} \pi_i^2$, yielding no qualitative changes to the results of our analysis.

Socioeconomic indicators such as GDP per capita and population figures are sourced from Feenstra et al. (2015) and missing information in this dataset is interpolated the International Monetary Fund's WEO Database (IMF, 2018).

4 Results

4.1 Main results

Tables 1 and 2 present the parameter estimates of equations (1), (2) and (3), obtained using the method described in (Kim, 2006) for cross-sectional data corresponding to different 5-year subperiods (2006-2010, 2011-2015), as well as three-year periods (2007-2009, 2010-2012 and 2013-2015). The parameter estimates for the equations modelling conflict and selection to asylum seeking are presented in Table 1. Our results indicate that armed conflict tends to be persistent, with countries that have experienced a large number of battle-related deaths prior to the period under study having a higher probability of conflict. Countries with levels of medium democracy, on the other hand, tend to present a higher probability of conflict when compared to their fully democratic or autocratic counterparts. Differences in the severity of drought episodes (related to lower values of the SPEI) are able to explain differences in the onset of conflict significantly in the period between 2011 and 2015, but not for 2006-2010. The predictive power of the variable is mostly

driven by its ability to explain conflicts occurring in the interval 2010-2012 and thus appear related to the emergence of armed conflict in the context of the Arab spring and the Syrian war, in addition to war episodes in Sub-Saharan Africa. As can be inferred from the significant positive parameter estimate of the conflict dummy in the asylum seeking selection equation, countries that experience war tend to be systematically more prone to present non-zero asylum seeking applications to the rest of the world. Countries with a history of asylum seeking linkages (be it as an origin or a destination) tend to have a higher probability of sending or receiving asylum seeking applications, and this probability is also higher for nations which are geographically close to each other.

The marginal effects of the SPEI variable on conflict and selection to asylum seeking for the 2010-2012 period are presented in Figure 2 for all countries in our dataset. The nonlinearity embodied in the link between climate, conflict occurrence and refugee flows implies that the quantitative effect of changes in drought probabilities on asylum seeking depends on the rest of the variables of the model. The model therefore allows for global and regional economic conditions to affect the probability of a given climatic shock creating asylum seeking flows and predicts different effects by country. Aggregating marginal effects by world region, our results indicate that the effect of changes in the SPEI index appears particularly large in Sub-Saharan African countries, some Central and South American nations, as well as in Asia. The combined average marginal effect for the SPEI variable in the period 2010-2012 implies that a one (within-country) standard deviation decrease in the SPEI leads on average to an increase of approximately 0.03 in the probability of asylum seeking flows from the country experiencing this change in climatic conditions. Such a link between changes in drought severity and asylum seeking flows is mediated by the increase in conflict probability caused by the change in the climatic variable, which can be very large in some world regions, as shown in the first panel of Figure 3.

	2006-2010	2011-2015	2007-2009	2010-2012	2013-2015
Conflict					
α_T	−1.92***	−1.66*	−1.26·	−1.79*	−0.87
	(0.58)	(0.75)	(0.65)	(0.75)	(0.63)
Battle Deaths$_{t-1}$	0.31***	0.34***	0.43***	0.31***	0.49***
	(0.05)	(0.05)	(0.09)	(0.05)	(0.12)
SPEI Index$^{12}_{t-1}$	−0.72	−1.01·	−0.19	−1.24*	−1.45·
	(0.57)	(0.52)	(0.55)	(0.51)	(0.86)
Democratization$^o_{t-1}$	3.41	3.68	2.02	6.78*	1.23
	(2.68)	(3.03)	(2.26)	(2.83)	(2.66)
(Democratization$^o_{t-1}$)^2	−3.22	−3.60	−2.25	−6.63**	−1.55
	(2.42)	(2.86)	(2.05)	(2.53)	(2.48)
Diaspora$^o_{t-1}$	−3.09	−3.15	−9.75**	−2.78	−3.00
	(2.77)	(3.55)	(3.76)	(2.55)	(2.77)
Ethnic Polarization$^o_{t-1}$	0.53	−0.15	1.01	−0.54	−0.37
	(0.62)	(0.75)	(0.72)	(0.57)	(0.57)
Selection					
α_S	−3.01***	−3.25***	−3.75***	−3.43***	−4.21***
	(0.18)	(0.20)	(0.19)	(0.20)	(0.22)
Distance	−0.26***	−0.24***	−0.27***	−0.24***	−0.19***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Distance^2	−0.03	−0.05*	−0.04*	−0.05*	−0.07**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Total Outmigration$^o_{t-1}$	0.19***	0.19***	0.22***	0.20***	0.23***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Total Inmigration$^d_{t-1}$	0.24***	0.27***	0.30***	0.28***	0.31***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Endogenous Treatment					
Conflict	0.53***	0.54***	0.45***	0.53***	0.49***
	(0.13)	(0.12)	(0.10)	(0.13)	(0.11)
Control Terms					
ρ_{120}	−0.29*	−0.39***	−0.29*	−0.33***	−0.41*
	(0.12)	(0.09)	(0.13)	(0.08)	(0.18)
ρ_{121}	−0.19*	−0.15	−0.15*	−0.30*	−0.16*
	(0.09)	(0.10)	(0.07)	(0.12)	(0.07)
LogLik	-18496.99	-17229.64	-15956.40	-17182.41	-15176.29
AIC	37023.98	34489.28	31942.80	34394.82	30382.58
BIC	37145.48	34610.78	32064.30	34516.32	30504.07
Num. obs. Full	24336.00	24336.00	24336.00	24336.00	24336.00

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, $^{cdot}p < 0.1$.
Standard Errors Clustered at Counrty of Origin and Country of Destination.
Natives in Destination measured as log-transformed stock of the respective origin natives in the destination country
Distance is measured as geodesic distance between origin and destination countries.
Colonial Relation indicates, whether there has ever been a colonial relationship between origin and destination ('Mother Country').
Democracy measures the democratic or autocratic tendency of a countries political rule from 0 (autocratic) to 1 (democratic).
GDP measures the Gross domestic production of country i measured in logs.
μ_{ij} are the respective auxiliary parameters used in the GMM second stage estimation. (See Kim (2006))

Table 1: Parameter estimates: Conflict and selection to asylum seeking equations

	2006-2010	2011-2015	2007-2009	2010-2012	2013-2015
Exogenous Variables					
α	1.41*	0.53	3.69***	1.28*	1.40˙
	(0.61)	(0.64)	(0.64)	(0.62)	(0.85)
Natives in Destination$_{t-1}$	0.21	0.19	0.18	0.19	0.18
	(0.53)	(0.50)	(0.60)	(0.55)	(0.62)
Distance	0.32˙	0.30˙	0.29	0.30˙	0.32˙
	(0.18)	(0.17)	(0.19)	(0.18)	(0.19)
Distance^2	-0.09	-0.12	-0.04	-0.09	-0.12
	(0.36)	(0.33)	(0.37)	(0.35)	(0.35)
Common Language	0.60***	0.34***	0.49***	0.39***	0.16˙
	(0.07)	(0.07)	(0.07)	(0.07)	(0.09)
Colonial Relation	0.02	0.26˙	0.16	0.22	0.13
	(0.14)	(0.15)	(0.14)	(0.14)	(0.17)
Democratization$^o_{t-1}$	-0.97***	-1.18***	-0.65***	-0.94***	-0.99***
	(0.10)	(0.10)	(0.10)	(0.10)	(0.12)
Population$^o_{t-1}$	-0.08	-0.09	-0.10	-0.07	-0.03
	(1.73)	(1.64)	(1.80)	(1.72)	(1.81)
GDP$^d_{t-1}$	0.19	0.18	0.08	0.15	0.06
	(1.02)	(0.97)	(1.07)	(1.02)	(1.09)
Democratization$^d_{t-1}$	0.36*	0.91***	0.41**	0.69***	0.37*
	(0.14)	(0.14)	(0.14)	(0.15)	(0.18)
Population$^d_{t-1}$	0.07	0.12	0.01	0.06	0.13
	(1.75)	(1.65)	(1.82)	(1.74)	(1.82)
Treatment					
Conflict	1.27***	1.46***	0.95***	1.30***	1.30***
	(0.13)	(0.13)	(0.13)	(0.13)	(0.16)
Control Terms					
μ_{11}	-0.24**	-0.17*	-0.45***	-0.33***	-0.11
	(0.09)	(0.08)	(0.07)	(0.10)	(0.08)
μ_{12}	-2.33***	-2.34***	-2.38***	-2.14***	-2.37***
	(0.11)	(0.11)	(0.10)	(0.11)	(0.12)
μ_{01}	-0.53***	-0.59***	-0.01	-0.42***	-0.65**
	(0.10)	(0.09)	(0.12)	(0.08)	(0.20)
μ_{02}	-1.72***	-1.68***	-1.94***	-1.62***	-1.62***
	(0.10)	(0.10)	(0.10)	(0.09)	(0.12)
AIC	63798.19	67187.72	57747.92	61042.74	63773.28
BIC	63927.78	67317.31	57877.52	61172.33	63902.88
Num. obs. Full	24336.00	24336.00	24336.00	24336.00	24336.00
Num. obs. Truncated	6140.00	6363.00	5271.00	5769.00	4745.00
Num. obs. Treated	6240.00	5928.00	7020.00	6708.00	6864.00

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, $^{cdot}p < 0.1$.
Standard Errors Clustered at Counrty of Origin and Country of Destination.
Natives in Destination measured as log-transformed stock of the respective origin natives in the destination country
Distance is measured as geodesic distance between origin and destination countries.
Colonial Relation indicates, whether there has ever been a colonial relationship between origin and destination ('Mother Country').
Democracy measures the democratic or autocratic tendency of a countries political rule from 0 (autocratic) to 1 (democratic).
GDP measures the Gross domestic production of country i measured in logs.
μ_{ij} are the respective auxiliary parameters used in the GMM second stage estimation. (See Kim (2006))
Baseline Specification uses $I(Battledeaths > 0)$ as treatment on the full distribution of origin-destination pairs.

Table 2: Parameter estimates: Asylum seeking flow size

The parameter estimates for equation (3), which have a direct specification as (semi-)elasticities are presented in Table 2. A significantly higher number of asylum seeking flows are found in destination countries where there is already a large number of migrant population from the corresponding origin nation, as well as between pairs of countries which share the same language. Asylum seeking applications tend to take place from countries with relatively low indicators of democracy to countries where civil liberties and political rights are well developed with higher standards of living as measured by GDP per capita, as well as from relatively small countries (in terms of population size) to relatively large countries. The parameter estimates for the distance variable and its squared term indicate that the flow of asylum seeking applications tends to be relatively smaller to countries which are very close to the origin country but that the effect of geographic separation becomes negative after reaching a maximum. In other words, asylum seeking applicants go to the destination country which is not too close and not too far from their country of origin. Depending on the subsample on which the estimation is carried out, the point estimates in Table 2 imply that existence of conflict in the origin country increases the flow of asylum seeking applications to a given destination by 84 to 133 percent.

Based on the experience of the current decade, our results lend support to the existence of a mechanism whose causality runs in a first stage from climate to conflict and in a second stage from conflict to sending out asylum seekers and subsequently the size of asylum seeking flows. This causal linkage, however, is mostly related to the experience of conflicts in the years 2010-2012, a sub-period that was dominated by the birth of military conflicts in Libya, Egypt, Syria and South Sudan.

4.2 Robustness check

The main results suggest that the influence of climate on conflict occurrence and subsequent asylum seeking flows applies to a specific geographical context and time period. We thus perform a robustness check using different model specifications including using the threshold of a positive number of battle-related deaths instead of 25 to identify conflict, as well as excluding Western Asia and Northern Africa in the sub-sample analyses.

Tables 3 and 4 present the parameter estimates for conflict and selection to asylum seeking equations (Equations 1 and 2) for the period 2011-2015 and 2010-2012, respectively. For the period 2011-2015, changing the definition of our conflict variable and the sample of countries employed in the estimation does not substantially modify the results. However, in Table 4, we find that the effect of SPEI on conflict occurrence is specific to countries in Western Asia in the period 2010-2012. In 2010-2012, violent conflicts

were concentrated in Western Asia and Northern Africa. The model which excludes Northern African countries but including Western Asian countries show the significant effect of SPEI on conflict suggesting that the effect of climate on conflict found in the years 2010-2012 is driven by the events in Syria and its neighbouring countries.
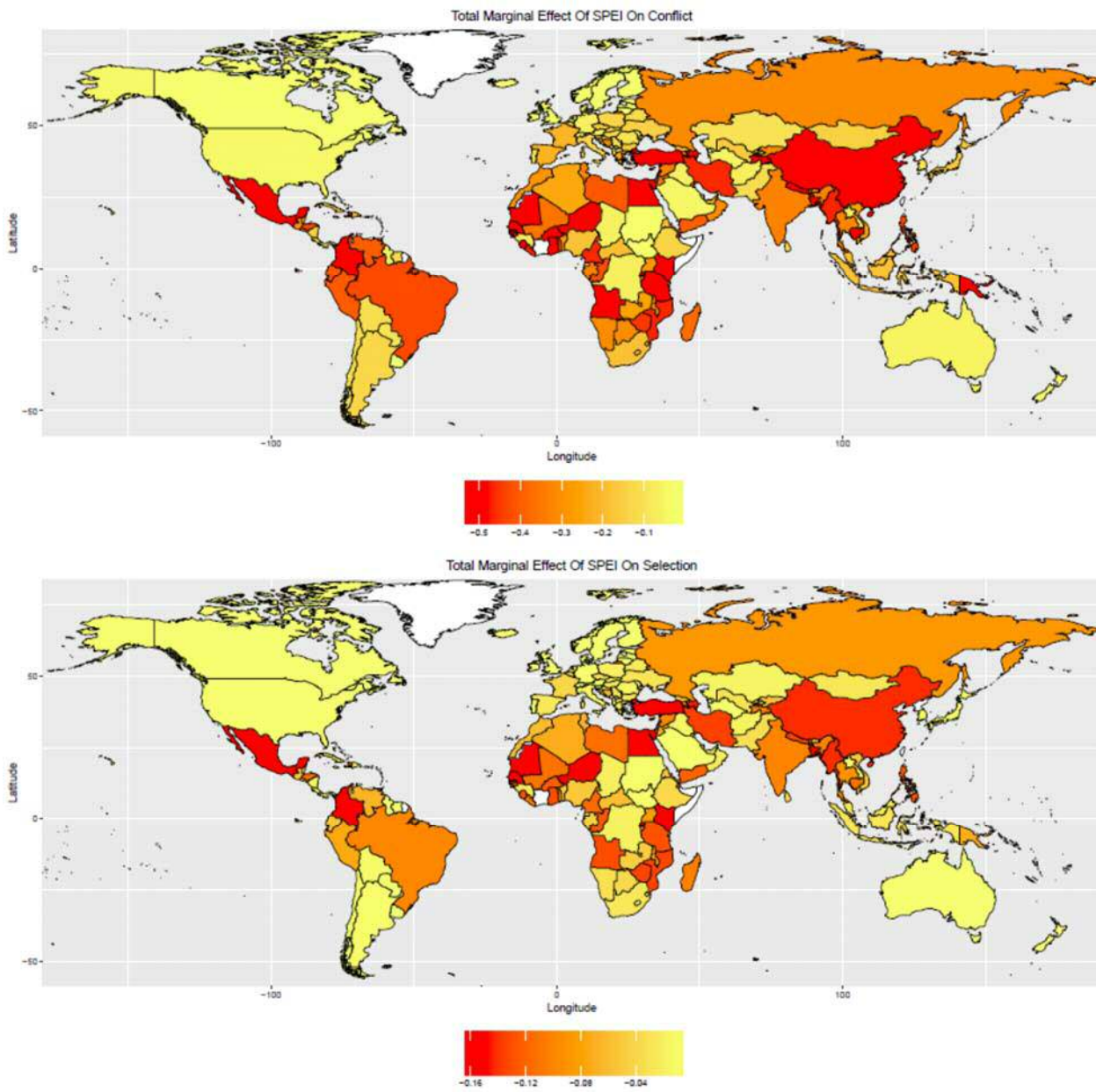
Figure 3: Marginal effects of SPEI on conflict and selection to asylum seeking for the 2010-2012 period.

5 Discussion and Conclusions

Existing frameworks for the study of migration drivers tend to define five categories of factors affecting migration flows (see (Lee, 1966) and the embedding of this framework in climate change research by (Black et al., 2011): economic drivers (differences in income and employment opportunities that act as determinants of migration flows), political drivers (with conflict being one of its most important materializations), demographic drivers (related to the size and composition of populations in origin regions, as well as health-related factors), social drivers (that include cultural practices) and environmental drivers (linked to ecosystem services). Our study concentrates on how environmental and political drivers interact with each other as determinants of forced migration as measured by asylum seeking applications. Our analysis assesses quantitatively the climate-conflict-migration association at a global level using an econometric model that aims at identifying these links explicitly. In contrast to the analysis carried out by Missirian and Schlenker (2017), our results indicate that there is no empirical evidence backing the existence of a robust link between climatic shocks, conflict and asylum seeking for the full period 2006-2015. The estimates of our model support this linkages only for the period 2010-2012, where global refugee flow dynamics were dominated by asylum seekers originating from Syria and countries affected by the Arab spring, as well as flows related to war episodes in Sub-Saharan Africa.

Excluding these regions from the analysis provides further statistical evidence, that the link between climate shocks, conflict and subsequent migration flows might rather be interpreted as local phenomena and therefore to be very specific to those regions. By analysing 41 African countries during 1981-99 Miguel et al. (2004) suggest that rainfall variation affect the probability of the onset of conflicts through its effects on GDP per capita. Thus, short-term drops in the opportunity costs (i.e. from forgone earnings because of drought periods) of being a rebel (or government) soldier significantly increases the incidence of civil conflict.

	Baseline	25 Battle Deaths	Without Western Asia	Without Northern Africa
Exogenous Variables				
α	1.28*	1.74**	1.57*	1.79**
	(0.62)	(0.62)	(0.68)	(0.66)
Natives in Destination$_{t-1}$	0.19	0.18	0.20	0.20
	(0.55)	(0.54)	(0.59)	(0.58)
Distance	0.30˙	0.31˙	0.32˙	0.30
	(0.18)	(0.17)	(0.19)	(0.19)
Distance^2	−0.09	−0.09	−0.10	−0.08
	(0.35)	(0.34)	(0.38)	(0.37)
Common Language	0.39***	0.43***	0.38***	0.37***
	(0.07)	(0.07)	(0.07)	(0.07)
Colonial Relation	0.22	0.22	0.20	0.20
	(0.14)	(0.14)	(0.16)	(0.15)
Democratization$^o_{t-1}$	−0.94***	−0.99***	−1.09***	−0.96***
	(0.10)	(0.10)	(0.11)	(0.11)
Population$^o_{t-1}$	−0.07	−0.08	−0.11	−0.08
	(1.72)	(1.68)	(1.81)	(1.78)
GDP$^d_{t-1}$	0.15	0.13	0.18	0.09
	(1.02)	(0.99)	(1.07)	(1.06)
Democratization$^d_{t-1}$	0.69***	0.69***	0.37*	0.76***
	(0.15)	(0.14)	(0.18)	(0.16)
Population$^d_{t-1}$	0.06	0.06	0.07	0.06
	(1.74)	(1.69)	(1.82)	(1.80)
Treatment				
Conflict	1.30***	1.43***	1.50***	1.43***
	(0.13)	(0.13)	(0.14)	(0.13)
Control Terms				
μ_{11}	−0.33***	−0.37***	−0.71***	−0.35***
	(0.10)	(0.08)	(0.11)	(0.10)
μ_{12}	−2.14***	−2.54***	−1.98***	−2.16***
	(0.11)	(0.11)	(0.12)	(0.11)
μ_{01}	−0.42***	−0.56***	−0.47***	−0.48***
	(0.08)	(0.09)	(0.09)	(0.08)
μ_{02}	−1.62***	−1.72***	−1.59***	−1.63***
	(0.09)	(0.10)	(0.10)	(0.10)
AIC	61042.74	61028.56	48640.19	55494.94
BIC	61172.33	61158.16	48766.09	55623.28
Num. obs. Full	24336.00	24336.00	19321.00	22500.00
Num. obs. Truncated	5769.00	5769.00	4674.00	5150.00
Num. obs. Treated	6708.00	4056.00	4865.00	5850.00

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{cdot}p < 0.1$.
Standard Errors Clustered at Counrty of Origin and Country of Destination.
Natives in Destination measured as log-transformed stock of the respective origin natives in the destination country
Distance is measured as geodesic distance between origin and destination countries.
Colonial Relation indicates, whether there has ever been a colonial relationship between origin and destination ('Mother Country').
Democracy measures the democratic or autocratic tendency of a countries political rule from 0 (autocratic) to 1 (democratic).
GDP measures the Gross domestic production of country i measured in logs.
μ_{ij} are the respective auxiliary parameters used in the GMM second stage estimation. (See Kim (2006))
Specification uses $I(Battledeaths > 25)$ as treatment on the full distribution of origin-destination pairs.

Table 3: Robustness check: Conflict and selection to asylum seeking equations for the period 2011-2015

	Baseline	25 Battle Deaths	Without Western Asia	Without Northern Africa
Conflict				
α_T	-1.79^*	-1.90^*	-1.65^{cdot}	-2.03^*
	(0.75)	(0.81)	(0.89)	(0.81)
Battle Deaths$_{t-1}$	0.31^{***}	0.38^{***}	0.28^{***}	0.31^{***}
	(0.05)	(0.07)	(0.05)	(0.05)
SPEI Index$^{12}_{t-1}$	-1.24^*	-1.00	-0.77	-1.04^{cdot}
	(0.51)	(0.70)	(0.59)	(0.53)
Democratization$^o_{t-1}$	6.78^*	2.46	7.08^*	7.26^*
	(2.83)	(3.19)	(3.40)	(2.97)
(Democratization$^o_{t-1}$)^2	-6.63^{**}	-2.56	-6.69^*	-6.91^{**}
	(2.53)	(3.20)	(2.91)	(2.63)
Diaspora$^o_{t-1}$	-2.78	-0.75	-11.37	-2.28
	(2.55)	(4.89)	(7.73)	(2.59)
Ethnic Polarization$^o_{t-1}$	-0.54	-0.61	-0.40	-0.51
	(0.57)	(0.87)	(0.69)	(0.57)
Selection				
α_S	-3.43^{***}	-3.46^{***}	-3.43^{***}	-3.52^{***}
	(0.20)	(0.19)	(0.21)	(0.20)
Distance	-0.24^{***}	-0.24^{***}	-0.22^{***}	-0.23^{***}
	(0.03)	(0.04)	(0.04)	(0.03)
Distance^2	-0.05^*	-0.05^*	-0.06^{**}	-0.05^*
	(0.02)	(0.02)	(0.02)	(0.02)
Total Outmigration$^o_{t-1}$	0.20^{***}	0.21^{***}	0.21^{***}	0.20^{***}
	(0.02)	(0.02)	(0.02)	(0.02)
Total Immigration$^d_{t-1}$	0.28^{***}	0.28^{***}	0.28^{***}	0.29^{***}
	(0.02)	(0.02)	(0.02)	(0.02)
Endogenous Treatment				
Conflict	0.53^{***}	0.40^{**}	0.44^{**}	0.47^{***}
	(0.13)	(0.13)	(0.14)	(0.13)
Control Terms				
ρ_{120}	-0.33^{***}	-0.36^{***}	-0.31^{***}	-0.31^{***}
	(0.08)	(0.11)	(0.08)	(0.08)
ρ_{121}	-0.30^*	-0.04	-0.27^*	-0.27^*
	(0.12)	(0.09)	(0.13)	(0.12)
LogLik	-17182.41	-14623.27	-13011.41	-15558.13
AIC	34394.82	29276.54	26052.81	31146.27
BIC	34516.32	29398.04	26170.85	31266.59
Num. obs. Full	24336.00	24336.00	19321.00	22500.00

$^{***}p < 0.001$, $^{**}p < 0.01$, $^*p < 0.05$, $^{cdot}p < 0.1$.
Standard Errors Clustered at Counrty of Origin and Country of Destination.
Natives in Destination measured as log-transformed stock of the respective origin natives in the destination country
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GDP measures the Gross domestic production of country i measured in logs.
μ_{ij} are the respective auxiliary parameters used in the GMM second stage estimation. (See Kim (2006))

Table 4: Robustness check: Conflict and selection to asylum seeking equations for the period 2010-2012

Indeed, our study shows that an increase in drought episodes can drive outmigration through exacerbating conflict in a country with some level of democracy. This is confirmed by the finding that climate contributes to conflict only in a specific period of 2010-2012 and specifically to certain countries, particularly those in Western Asia experiencing the Arab Spring. Climate change thus will not generate asylum seeking everywhere but likely in a country undergoing political transformation where conflict represents a form of population discontent towards inefficient response of the government to climate impacts.

In line with Miguel et al. (2004) the results of our study imply that policies to improve the adaptive capacity to deal with the effects of climate change in developing economies may have additional returns by reducing the likelihood of conflict and thus forced migration outflows. From a policy point of views, our empirical analysis provides empirical backing to some of the arguments put forward, among others, by Barnett (2003), who argues for conceptualizing global responses to climate change also in the framework of national security considerations and human security concerns. The integration of concerns related to conflict-driven forced migration in the current policy discourse concerning actions to combat climate change appears particularly urgent in the context of the targets defined by the Sustainable Development Goals (SDGs). The link between climate change and migration is not made explicit in the SDGs, which focus on adaptation measures and do not treat forced migration and climate change as interrelated phenomena which may be moderated by conflict onset. The results presented provide empirical backing to the connection of these two policy goals in the design of climate change responses at the global level, a proposal recently voiced also by Stapleton et al. (2017).

Gaining a deeper understanding of the characteristics of migration flows which are driven by climate shocks is a potentially promising path of further research. The availability of data for refugee populations (see (Buber-Ennser et al., 2016), for example) should enable future empirical studies which will shed light on the particular mechanisms through which climate change acts as a push factor through its role as a catalyst of conflict. While our analysis concentrates on asylum seeking flows due to data availability at the global level, case studies that would be able to quantify forced migration flows in a more detailed manner would also be important in order to advance our knowledge on the causalities underlying the climate-conflict-migration trinity.

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