Climate migration in Asia

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Abstract

This paper investigates the role of climatic factors in the migration decision. We use international migration flows between 198 origin countries and 16 OECD countries. We focus on the difference in the effect of climatic factors by region. Asia is an interesting region to study this relationship, because it is the most populated region in the world and the most affected one by climate change. Temperature has a smaller effect on migration towards OECD countries in Asia compared to Europe, Africa, and North America. For disasters, we only find a stronger effect on migration in Asia compared to Africa. Temperature matters in most regions while disasters do not. Generally, higher temperatures increase migration flows except in Asia, South America, and the Pacific.

1 Introduction

The last couple of decades have seen a large increase in mobility in Asia (Asian Development Bank, 2012). This holds for movements within and across borders and is focused towards urban areas. Asia is the region with the largest number of international migrants (41 percent of total international migrants, see UN, 2017a) and has seen the largest increase in international migrants across all regions of the world from 2000 to 2017 (about 62 percent, see UN, 2017a). Among the top 5 origin countries of international migrants are four Asian countries: India, Russia, China, and Bangladesh. The increase in migration has almost been exponential. Figure 1 presents the annual total migration flows from all Asian countries towards 16 OECD countries included in our data set. We observe a strong upward trend with drops around the 1997 Asian Financial Crisis and the Global Financial Crisis. Over our

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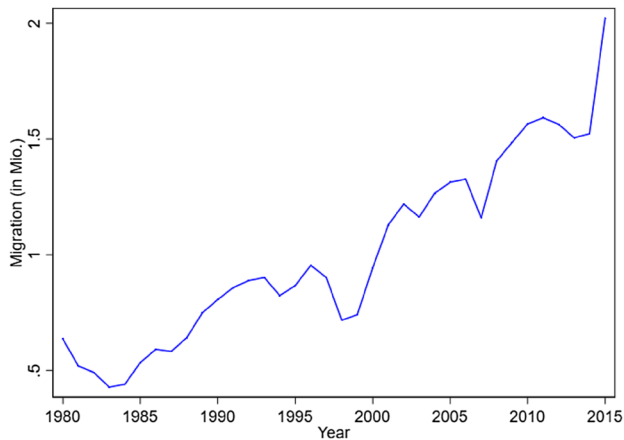
Fig. 1 Total Migration Flows. *Notes*: Total international migration flows (in million) out of Asia over time (1980–2015)

observed time period (1980–2015) we see that migration flows in our sample almost quadrupled.

At the same time, this region will be heavily affected by the impacts of climate change in the future (Asian Development Bank, 2012). Research has shown that climate change symptoms include an increase in the frequency, severity, and likelihood of weather-related disaster and increases global temperatures (IPCC, 2012). In fact, Asia is already the region most prone to disasters (UN, 2017b) and people are already displaced by disasters (Asian Development Bank, 2012). Its topography, with islands, deltas, mountains, and deserts makes it prone to different kinds of climate change impacts. These include, for example, weather-related disasters (storms, floods, droughts, and extreme temperature events), sea-level rise, water scarcity, food insecurity, health impacts due to climate-sensitive diseases, and ocean acidification (UN, 2017b).

The combination of being the most populous region in the world and the most affected region by impacts of climate change makes Asia an interesting region to study the effects of climatic factors on migration. In this paper, we investigate whether climatic factors such as temperature and weather-related disasters are drivers of international migration out of all Asian countries. While country-specific studies in Asia exist (e.g. Bardsley and Hugo 2010 and Bohra-Mishra et al. 2014), this is the first panel data study that uses migration flows out of all Asian countries over a long period of time (36 years). To be precise, we use data for migration flows from 1980 to 2015 out of all Asian countries towards 16 OECD destination countries.

Several interesting results stand out. First, we find that temperature, but not weather-related disasters, have a significant direct effect on migration in our sample. Temperature has a smaller effect on migration towards OECD countries in Asia compared to Europe, Africa, and North America. For disasters, we only find a stronger effect on migration in Asia compared to Africa. Temperature matters

in most regions while disasters do not. Generally, higher temperatures increase migration flows except in Asia, South America, and the Pacific. This result contradicts studies done on larger data sets by, for example, Aburn and Wesselbaum (2019) who use flows out of 198 origin countries and find a significant positive direct effect of temperature on migration. This result does relate to the discussion about whether climatic shocks can trap populations. Papers such as Gray and Mueller (2012) or Noy (2017) argue that climatic shocks can reduce mobility, which is what we find in our sample. Finally, we find evidence of non-linear effects of temperature on migration with more migration out of countries that origin relatively small, large increase in temperature anomalies respectively. In contrast, we do only find a significant linear effect of weather-related disaster in our sample.

The paper extends the the existing literature on the climate-migration relationship in Asia. Alam (2003) shows that changes in rainfall patterns, via affecting droughts and agricultural productivity, have affected migration in Bangladesh. Further, Gray and Mueller (2012), again for Bangladesh, find that crop failure has an effect on migration in a sample of 1,700 households between 1990 and 2004. Using cell phone operator data to measure mobility, Lu et al. (2016), study the displacement and migration after Cyclone Mahasen affected Bangladesh in 2013. They do not find permanent displacement effects. Dun (2011) documents emigration out of flood-prone eras in the Mekong Delta in Vietnam.

2 Data and methodology

2.1 Data

In this paper, we combine data on international migration flows between 198 origin countries and 16 OECD countries with data on temperature and weather-related disasters. Migration data is taken from the paper by Aburn and Wesselbaum (2019). They compile a panel data set of migration from 198 origin countries to 16 OECD destination countries from 1980 to 2015 on an annual basis. The data is taken from the 2015 Revision of the United Nations' Population Division and has been merged with data from the OECD and Ortega and Peri (2013). This migration data set covers only regular, permanent migration, but excludes undocumented immigration. In addition, it will also include people who have already entered a destination country and have changed their visa status (e.g. from temporary to permanent). The choice of destination countries is dictated by data availability. Our destination countries include countries belonging to the 20 countries in the world that have (i) the largest immigrant stock and (ii) the largest number of international migrants in 2015. Our data set covers a sizable amount of migrants with almost five million migrants per year towards the end of our sample.

We are interested whether climate variables affect the decision to migrate and whether these effects are different in Asia compared to other continents. We use two different variables to measure changes in climatic conditions. We use temperature as a measure of slow-moving changes and weather-related disasters as a measure of sudden events. Temperature is measured as temperature anomalies (in degrees

Table 1 Descriptive statistics

	Obs.	Mean	Std. Dev.	Min	Max
Log (migration)	83,623	3.926	2.789	0	13.760
Temperature	106,080	0.518	0.512	−1.9	3.030
Weather-related Disaster	109,152	1.165	2.562	0	33
Log (GDP)	96,992	8.264	1.510	4.749	11.886
Log (Population)	111,296	15.289	2.216	8.921	21.039
Policy	87,696	2.007	7.138	−10	10
Life expectancy	106,064	66.406	10.076	27.079	84.278
Agricultural Land	102,576	38.685	21.912	0.442	86.167

Celsius) relative to the monthly average from 1951 to 1980. The data is taken from the Berkeley Earth database. They compute a regional temperature field from weather stations. This temperature field is then averaged to obtain a country-by-year measure of temperature. Weather-related disasters include storms, droughts, floods, and extreme temperature events. Data is taken from the EM-DAT database from the Centre for Research on the Epidemiology of Disasters (CRED). An event is classified as a disaster if at least one of the following criteria holds: (i) ten or more people killed, (ii) hundred or more people affected, (iii) a state of emergency is declared, *or* (iv) a call for international assistance is issued.

Finally, we also control for the effect of income on the migration decision, as income is usually found to be a driver of migration. We use data for per capita Gross Domestic Product (GDP, for short) as a proxy variable for income. Data is taken from the World Bank database and is GDP per capita at constant 2010 U.S. Dollar. Other control variables are population, political freedom, and life expectancy. The population variable is total population taken from the World Bank database. The measure of the political freedom is the polity2 variable from the PolityTM IV project (Center for Systemic Peace). This variable varies between 10 (strongly democratic) and -10 (strongly autocratic). Life expectancy (average life expectancy, in years) is also taken from the World Bank database. Finally, the share of agricultural land measure the share of total land area used as arable land, permanent cropland, and permanent pastures.

Table 1 provides summary statistics for all our variables.

Temperature anomalies vary between −1.9 to 3.03 degrees Celsius with an average of 0.52 degrees Celsius. The results also show a high degree of heterogeneity in the increase of temperature across countries. Figure 2 in the appendix plots the average temperature anomaly across our sample. We observe a clear upward trend over the entire sample period. In Asia, the countries with the lowest average temperature anomaly in our sample are Hong Kong, Bangladesh, and Laos.[1] The countries with

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[1] Notice that temperature anomalies are country-specific, such that they are deviations from country-specific trends.

the largest average temperature anomaly in Asia are Russia, Turkmenistan, and Mongolia. Weather-related disaster (see Fig. 3 in the appendix) have almost tripled since the beginning of our sample in 1980. The countries with the lowest number of disasters in Asia are the United Arab Emirates, Qatar, and Singapore, while China, India, and the Philippines have the highest number of weather-related disasters in our sample. We find that countries have different exposures to disasters ranging from 0 to 33 per year.

2.2 Econometric approach

We estimate the following fixed-effects regression model[2]

$$\log \left(Migration_{ij,t} \right) = \alpha + \beta_i \mathbf{X}_{i,t} + \varsigma_j + \nu_t + \varepsilon_{ij,t}, \tag{1}$$

where our dependent variable is the current migration flow, $Migration_{ij,t}$, between origin country i and destination country j at time t.[3] These flows are explained by the set of variables in $\mathbf{X}_{i,t}$ such as temperature, weather-related disaster, and income. We are interested in the effects of our independent variables captured by the vector β_i. Then, $\varepsilon_{ij,t}$ are i.i.d. error terms with mean 0 and variance σ^2. All regressions use clustered standard errors at the country-pair level (Mayda 2010 and Ortega and Peri 2013). By doing so, we address the problem that there are likely common unobserved random shocks at the country-pair level. As a consequence, all observations with in each country-pair would be correlated. All regressions, use destination country fixed effects, ς_j, and time (year) fixed effects, ν_t. Since we interact the climate variables with a continent dummy, we cannot include a origin country fixed effects (due to collinearity), but the continent dummy will capture factors such as culture.

We want to stress that we—explicitly—do not control for other socioeconomic variables such as unemployment, conflict, or immigration laws. Most importantly, including these and other variables would lead to the typical "bad control" problem, where control variables are themselves endogenous (Hsiang et al. 2013). This would lead to biased estimates. Further, we want to investigate the direct (or total) effects of climate variables on migration and, therefore, have to exclude control variables that would change the interpretation to partial effects.

Finally, it should be highlighted that a key advantage of this regression is that our independent climatic variables are plausibly exogenous and reverse causality (migration drives temperature) is not a concern. At the same time, a limitation of this reduced-form approach is that it prevents us from understanding how exactly climatic variables affect migration. Nevertheless, causal inference is obtained by the random variation in climatic variables within each country over time. Another

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[2] This specification can be obtained from the standard model of migration due to Borjas (1987) and resembles an augmented gravity equation (Mayda 2010; Ortega and Peri 2013, and Aburn and Wesselbaum, 2017).

[3] Writing the dependent variable, migration, in logarithmic terms results in a problem, because we observe zero flows. We solve this problem by adding one to all flows (cf. Alexeev et al. 2011; Ortega and Peri 2013, and Cai et al. 2016).

Table 2 Main results

Variable	1	2	3
Temperature	−0.397***	−0.103	−0.227***
	(0.075)	(0.066)	(0.053)
Temperature * Europe	0.486***	0.032	0.356***
	(0.086)	(0.077)	(0.065)
Temperature * Africa	0.822***	0.840***	0.416***
	(0.106)	(0.100)	(0.080)
Temperature * North America	0.667***	0.316**	0.324***
	(0.155)	(0.146)	(0.090)
Temperature * South America	0.012	−0.019	0.006
	(0.150)	(0.121)	(0.100)
Temperature * Pacific	−0.461*	−0.547**	−0.456**
	(0.262)	(0.213)	(0.217)
Disaster		0.285***	0.019
		(0.013)	(0.012)
Disaster * Europe		0.308***	0.010
		(0.038)	(0.027)
Disaster * Africa		0.071**	−0.082***
		(0.034)	(0.027)
Disaster * North America		−0.022	−0.006
		(0.018)	(0.015)
Disaster * South America		0.240***	−0.065
		(0.054)	(0.042)
Disaster * Pacific		0.523***	0.093
		(0.068)	(0.082)
Controls	No	No	Yes
Obs.	78,474	76,661	61,553
R^2_{adj}	0.31	0.42	0.62

Notes: Dependent variable: log migration flow. Controls are: log GDP, log population, policy, life expectancy, agricultural land. Standard errors are clustered at the country-pair level and shown in parenthesis. All regressions use year and destination country fixed effects. Constant and continent dummies not shown. Significance levels: ***$p < 0.01$, ** $p < 0.05$, * $p < 0.10$

limitation is that we cannot control for the stock of migrants, as we do not have data on this variable (over time and space).

3 Main results

Our estimation results are presented in Table 2.

Model 1 estimates the direct effect of temperature on migration. We find that this effect is significantly negative ($p < 0.01$). However, we have to consider the joint

effect taking into account the interaction effect by continent to understand the total effect. We find that the joint effect of temperature is significantly positive in Europe, Africa, and North America but negative in the Pacific. Notice that this is relative to the base continent, which is Asia. Therefore, migration from Asian countries are less affect by temperature relative to Europe, Africa, and North America but more strongly compared to the Pacific. We do not find a significant difference in the effect between Asia and South America.

In Model 2, we add weather-related disasters and their interaction by continent. The above mentioned results hold, except that the difference to Europe is now insignificant. For disasters, we find that the effect on migration is larger compared to Asia in Europe, Africa, South America, and the Pacific but identical to North America.

Finally, Model 3 includes control variables: log GDP, log population, policy, life expectancy, and the share of agricultural land. This again confirms our findings for the effect of temperature discussed for Model 1. However, adding controls affect the results for disasters. We find that the only significant difference for the effect of disasters on migration is between Asia and Africa. The results show that there is a larger effect of disasters on migration in Asia relative to Africa. We do not find significant differences between Asia and the other continents. Temperature has a significant negative marginal effect in Asia (-0.227, $p = 0.000$), while it has positive marginal effects in Europe (0.129, $p = 0.000$), North America (0.188, $p = 0.004$), and negative effects in South America (-0.221, $p = 0.010$) and the Pacific (-0.683, $p = 0.001$). Disasters have an insignificant effect on migration in Asia (0.019, $p = 0.107$), Europe (0.029, $p = 0.256$), North America (0.013, $p = 0.261$), South America (-0.046, $p = 0.250$), and the Pacific (0.112, $p = 0.172$) but a negative significant effect for Africa (-0.063, $p = 0.012$).

Overall, we can draw the following conclusions. Temperature has a smaller effect on migration towards OECD countries in Asia compared to Europe, Africa, and North America. For disasters, we only find a stronger effect on migration in Asia compared to Africa. Temperature matters in most regions while disasters do not. Generally, higher temperatures increase migration flows except in Asia, South America, and the Pacific.

The negative effect is surprising as it contradicts findings in larger samples by Backhaus et al. (2015), Cattaneo and Peri (2016), Cai et al. (2016), or Aburn and Wesselbaum (2019). This negative sign implies that higher temperatures decrease migration flows. This result relates to the discussion about whether climatic shocks are drivers or inhibitors of migration. Studies such as Feng and Oppenheimer (2012), Hunter et al. (2013), and Aburn and Wesselbaum (2019) support the driver hypothesis. Other studies, e.g. Henry et al. (2004), Gray and Mueller (2012), Black et al. (2013), and Noy (2017) find that climate shocks can reduce mobility. The idea is that climatic conditions can trap people, for example, because households use asset holdings to smooth consumption over negative (climatic) shocks or because the spatial insurance channel becomes less efficient (see Dillon et al. 2011).

While our aggregate data does not allow us to look inside the Black Box and investigate why migration reacts differently across regions, some mechanisms are plausible. Table 3 presents the means of the variables in our analysis by

Table 3 Continent means

Means	Europe	Asia	Africa	North America	South America	Pacific	Dunn test
Log migration	5.031	4.378	3.074	3.322	4.311	2.510	0.000
Temperature	0.661	0.492	0.531	0.447	0.398	0.406	0.000
Disaster	0.802	1.879	0.672	1.649	1.267	0.606	0.000
Log GDP	9.780	8.273	6.947	8.680	8.563	8.318	0.000
Log population	15.239	16.333	15.505	14.427	16.092	12.220	0.000
Policy	8.102	−1.409	−1.116	5.717	5.510	6.838	0.000
Life expectancy	75.192	68.368	54.987	71.017	69.400	68.465	0.000
Agriculture	45.254	33.327	45.789	34.846	32.309	27.218	0.000

Notes: The Dunn test tests for stochastic dominance among multiple pairwise comparisons

continent. Some factors that could explain the different effects of temperature across continents are cultural differences (e.g. the role of families and social networks), different policy regimes (Asia is the most autocratic region in the sample) which could affect immigration laws and regulations around remittances, the role of agriculture in the generation of income, and a very high population and population density.

4 Conclusion

In this paper, we investigate the role of climatic factors for international migration decision in Asia. Asia is an interesting region to study this relationship because it is the most populous region in the world and the most affected region by climate change. Our contribution is to offer a panel data study that uses migration flows out of all Asian countries over a long period of time (36 years) in contrast to the existing country-specific studies in Asia, for example, Bardsley and Hugo (2010) and Bohra-Mishra et al. (2014).

In contrast to studies in larger panel data sets (Cattaneo and Peri 2016, or Aburn and Wesselbaum 2019) we find that temperature has a negative significant effect on international migration flows in Asia. Surprisingly, this effect is negative while other papers (e.g. Feng and Oppenheimer 2012 or Hunter et al. 2013) find a positive effect. This result supports the viewpoint that climatic shocks can trap populations. Papers such as Gray and Mueller (2012) or Noy (2017) argue that climatic shocks can reduce mobility, which is what we find in our sample. We do not find a significant effect of weather-related disaster in our sample.

Several limitations of our paper should be noted. Our findings hold for international migration but do not allow to draw conclusions about other

interesting and relevant migration processes, such as internal or rural to urban migration flows. Further, due to data limitations we cannot account for undocumented migration flows.
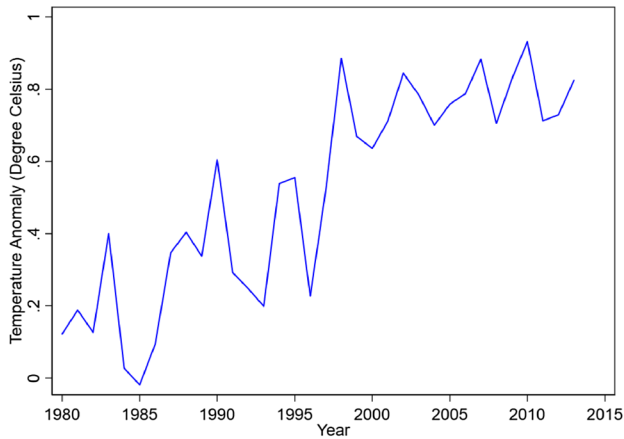
Appendix

See Figs. 2 and 3.

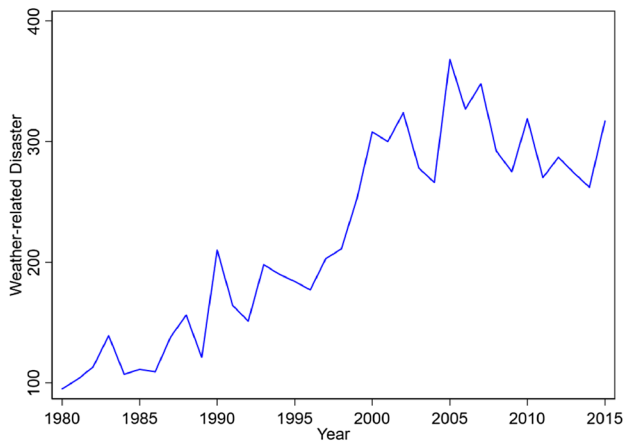**Fig. 2** Average temperature anomaly across all countries in our sample

Fig. 3 Total number of weather-related disasters in all countries over time

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