

CAF - WORKING PAPER #2022/23

First version: Decemeber 28, 2022

This version: January 13, 2023

Illegal Migration and Weather Shocks: Evidence from Rural Mexico

Facundo Danza¹ | Eungik Lee²

¹New York University.
fd800@nyu.edu

²New York University.
e12725@nyu.edu

We study the effect of weather shocks on legal and illegal migration from rural Mexico to the US. First, we find that shocks in the wet season on precipitation and temperature increase migration. The increment is entirely driven by illegal migrants. Second, we propose a mechanism to explain this result: the effect of weather on agricultural production. We find that shocks on precipitation and temperature decrease total harvested land and corn production. Third, we show that young and unwealthy workers are more sensitive to weather shocks. Lastly, we use climate projections to have a first glance on the impact that climate change will have on migration. We find that a shift of the size of climate change would double the number of illegal migrants. Since climate change will increase the frequency and intensity of weather shocks, our findings are increasingly relevant.

KEYWORDS

Illegal Migration, Weather Shocks, Agriculture, Climate Change

Small sections of text that are less than two paragraphs may be quoted without explicit permission as long as this document is acknowledged. Findings, interpretations and conclusions expressed in this publication are the sole responsibility of its author(s) and cannot be, in any way, attributed to CAF, its Executive Directors or the countries they represent. CAF does not guarantee the accuracy of the data included in this publication and is not, in any way, responsible for any consequences resulting from its use.

CAF - DOCUMENTO DE TRABAJO #2022/23

Primera versión: 28 de diciembre de 2022

Migración ilegal y shocks en el clima: evidencia de municipalidades rurales en México

Facundo Danza¹ | Eungik Lee²

¹New York University.
fd800@nyu.edu

²New York University.
e12725@nyu.edu

Este estudio investiga el efecto de shocks en el clima en la migración legal e ilegal desde regiones rurales de México hacia Estados Unidos. En primer lugar, se encuentra que los shocks en precipitaciones en la estación húmeda incrementa la migración. Esta migración se encuentra explicada casi en su totalidad por migrantes ilegales. En segundo lugar, se propone un mecanismo para explicar el efecto del clima en la producción agrícola. Se encuentra que los shocks en precipitaciones y temperaturas disminuyen el área total cosechada y la producción de maíz. En tercer lugar, se muestra que trabajadores jóvenes y de menor riqueza son más sensibles a shocks en el clima. Finalmente, se utilizan proyecciones de clima para obtener una primera estimación del impacto que el cambio climático tendría en migración. Se estima que un cambio del tamaño del cambio climático duplicaría el número de migrantes ilegales. Dado que el cambio climático incrementaría la frecuencia e intensidad de shocks climáticos, los hallazgos de este estudio son cada vez más relevantes.

KEYWORDS

Migración ilegal, shocks climáticos, agricultura, cambio climático

Pequeñas secciones del texto, menores a dos párrafos, pueden ser citadas sin autorización explícita siempre que se cite el presente documento. Los resultados, interpretaciones y conclusiones expresados en esta publicación son de exclusiva responsabilidad de su(s) autor(es), y de ninguna manera pueden ser atribuidos a CAF, a los miembros de su Directorio Ejecutivo o a los países que ellos representan. CAF no garantiza la exactitud de los datos incluidos en esta publicación y no se hace responsable en ningún aspecto de las consecuencias que resulten de su utilización.

1 | INTRODUCTION

Migration has been an important social phenomenon through history. It has been motivated and influenced by many factors: from societal collapse and conflict to the search for better environments and economic conditions. In this paper, we focus on one of such factors: weather shocks. In developing countries, weather shocks pose many challenges for agricultural (and non-agricultural) workers. International migration can work as a coping mechanism (Feng et al., 2010; Jessoe et al., 2018; Ibáñez et al., 2021). The legal status of the weather-induced migrants, however, has been scarcely investigated (Chort and De La Rupelle, 2022). The latter is thus the focus of our work.

We focus on rural Mexico, which has a long tradition of illegal migration; every year, 3 million agricultural workers try to migrate illegally to the US.¹ Moreover, 20 million agricultural workers are exposed to weather shocks (Dalby, 2013). Dalby (2013) estimates that Mexico is losing 400 square miles of farmland each year due to droughts and irregularities in the rainy season. Thus, the impact of weather shocks on illegal migration is of increasing relevance.

Our research questions are: (i) what is the effect of weather shocks on legal and illegal migration? (ii) which mechanism explains this effect? (iii) what will be the effect of climate change on migration?

Our paper can be summarized as follows. First, we estimate the effect of weather shocks on migration using individual level data from rural Mexico. We define weather shocks as deviations from the historical mean of the weather variables. In order to recover the causal effect, we use a two-way fixed-effects model. We find that shocks in the wet season on precipitation, average temperature, maximum temperature, and minimum temperature have a significant effect on migration at a 5% level. The effect is entirely driven by illegal migrants. Furthermore, the effect is substantial; for example, an increase of 1°C in maximum temperature increase migration in 27% with respect to the baseline.

Second, we propose an underlying mechanism: the effect of weather on agricultural production. Using the same econometrics approach, at municipality level, we find that shocks on precipitation, maximum temperature, and minimum temperature have a significant effect on total harvested land and corn production at a 5% level.²

Lastly, we interpret our results in the lens of climate change. For the climate scenario in which global temperature increases by 2°C, we show that a shift of the size of climate change would double the number of illegal migrants.

We contribute to the understanding of the effect of weather shocks on international migration. We combine individual-level data on migration with community-level data on weather.³ Since we have explicit information on the legal status of migrants, we can delve in the effect of weather on legal and illegal migration separately. We also study the heterogeneous effects of weather shocks and use our causal estimates to have a first glance of the impacts of climate change on migration. We expand the literature in several ways. First, we

¹PEW Research Centre, 'Mexican Immigrants: How Many Come? How Many Leave?', 2009.

²Unfortunately, we do not have data on average temperature at municipality level.

³"Communities" go from small towns, which have a population of less than 2,500 people, to middle-size cities, with less than 500,000 people.

add further detail in the migration decision, namely the legal status of the weather-induced migrants. Second, we use more precise data on weather variables; while most of the literature uses state or municipality level data, we use community level data. Lastly, we provide a direct link between weather shocks and migration: the effect of weather on agricultural production. We use data from 1,960 municipalities from 2003 to 2019, also improving the state of the art.

The rest of the paper is organized as follows. Section 2 discusses the literature in the topic. Section 3 describes the data. Section 4 discusses our econometrics analysis and results. Section 5 provides robustness checks. Section 6 concludes.

2 | LITERATURE REVIEW

Our paper contributes to three lines of research. First, we contribute to the literature on illegal migration, especially from Mexico to the US. Approximately 11 million Mexican immigrants live in the US illegally (Krogstad et al., 5). Hanson and Spilimbergo (1999) show that an increase in US wages relative to Mexican wages is positively correlated with illegal migration. Rendon and Cuecuecha (2010) develop a search model which rationalize this correlation. Reinhold and Thom (2013) discuss the life cycle of illegal migrants: Mexican workers try to migrate illegally when young and come back to Mexico when old. Munshi (2003) investigates the role of networks in local communities in Mexico, which help workers to find non-agricultural (illegal) jobs in the US. He also finds a negative relation between rainfall and migration. We highlight the importance of weather shocks as a “push” factor for illegal migration.

Second, we expand the literature on the effect of weather on agricultural production. In developing countries, weather shocks are a major risk for production. This is particular prevalent for rural Mexico. Corn, Mexico’s main crop, is heavily dependent on weather (Schlenker and Roberts, 2009). For example, Skoufias and Vinha (2013) show that a 2°C increase in average temperature generates a 24% decrease in corn production in Mexico. Skoufias (2007) reports that 65% of its land is rain-fed and that agricultural workers do not have a strategy to deal with weather change. We provide further evidence on this line; our results confirm the relevance of weather shocks on agricultural production.

Third, we contribute to the discussion on international migration as a coping mechanism to weather shocks. Workers respond to weather risk in many ways. In developed countries, farmers and firms adopt new technologies (Lee and Ji, 2021) and invest in R&D (Lobell et al., 2011). In developing countries, however, such strategies may not be available. Hence, international migration works as an important coping mechanism. Feng et al. (2010) show that drought-induced productivity-reductions in corn increase migration from Mexico to the US. Jessoe et al. (2018) find that weather fluctuations affect income and migration, both within Mexico and to the US. Ibáñez et al. (2021) show that temperature shocks increase migration from El Salvador to the US. We add to this literature further detail on the migration decision, namely the legal status of the weather-induced migrants.

Lastly, our paper is closely related to Chort and De La Rupelle (2022). They construct state level flows of illegal migrants from Mexico to the US and study the influence of extreme weather events such as hurricanes. Our research differs with theirs in several ways. First, we use individual level data on migration and community level data on weather. Both

allow us to study the effect of weather on migration more directly and accurately. It also allows us to delve in the heterogeneous effects of weather shocks. Second, we use data on *potential* migrants, while [Chort and De La Rupelle \(2022\)](#) have data on people who *actually* try to migrate. Lastly, we investigate the role of temperature and precipitation in a broad sense; [Chort and De La Rupelle \(2022\)](#) focus on extreme events only.

3 | DATA

For migration, we use data from the Mexican Migration Project (MMP). As described in their [web-page](#), "The MMP is a unique source of data that enables researchers to track patterns and processes of contemporary Mexican migration to the United States." It interviews potential Mexican migrants from 1982 to 2019. Specifically, MMP chooses communities within Mexico and obtains representative samples of those communities. Communities are of three types: "ranchos," which have a population of less than 2,500 people; towns, with 2,500 to 10,000 people; mid-sized cities, with 10,000 to 100,000 people; and metropolitan areas, usually a specific neighborhood within a large city. The interviews take place during winter, when seasonal migrants are more likely to return. Although the survey is not created to be representative of all migrants, it represents them closely ([Massey and Zenteno, 2000](#); [Massey and Capoferro, 2004](#); [Nawrotzki and DeWaard, 2016](#)).

MMP offers a variety of datasets. We focus on one of them, "LIFE." "LIFE" collects information on the whole history of the head of household in a retrospective fashion. In every survey wave, the head of the household is asked about her location, employment status, and demographic characteristics from her birth until the survey year. The main advantage of this data is that it has explicit information of the legal status of migrants. Moreover, it is conducted in many locations (more than 200), which allows us to exploit local-wise variations on weather. Its main disadvantage is that it does not include households whose members are in the US in the survey year; in particular, it does not include households that decided to move to the US once and forever.

We use the surveys from 2000 to 2019 and focus on the period 1990-2010. Since "LIFE" is constructed in a retrospective fashion, this means that we have an (unbalanced) panel of 21 years for all head of households interviewed from 2000 to 2019. We only keep people in their working years, from 18 to 65 years old. To minimize measurement error, we run our main analysis using 10-years-backward windows. Lastly, we focus on communities with less than 500,000 people, which are more likely to depend on agricultural production. In summary, we have data on 12,681 individuals from 88 communities for 11-year periods.

Table 1 provides summary statistics of our sample. Figure 1 illustrates the geographical location of our sample.⁴

For weather at the community level, we use data from Meteoblue. Meteoblue is a professional weather-forecast company that offers, from 1979 onward, hourly-simulated weather worldwide. This is a 2km-2km dataset that covers numerous weather variables such as precipitation, temperature, and evaporation.⁵ Meteoblue provides us daily data on precipitation, average temperature, maximum temperature, and minimum temperature for

⁴For confidentiality reasons, we cannot share the exact location the communities of this study. We share a (slightly) disturbed location of the municipality centroids in which these communities belong instead.

⁵The company validates its data comparing historical simulated data with realized historical weather in their website. You can check it out here: <https://www.meteoblue.com/en/historyplus>.

Variable	Mean	SD	Min	Max
Age	41.612	12.166	18	65
Male	0.873	0.334	0	1
Educ. Level (Yr)	7.116	4.409	0	23
Agricultural Worker	0.524	0.499	0	1
Land Owner	0.170	0.375	0	1
Business Owner	0.248	0.432	0	1
Owner	0.368	0.482	0	1
Migrate*	0.015	0.120	0	1
Legally Migrate*	0.004	0.063	0	1
Illegally Migrate*	0.011	0.102	0	1
Length Stayed** (Mh)	28.645	26.383	1	132
Individuals	12,681	12,681	12,681	12,681
Observations	129,343	129,343	129,343	129,343

TABLE 1 Summary Statistics

Notes: *Migrate refers to a indicative variable equal to one if the worker migrate to the US in a specific period. Since the worker has to be in Mexico to be able to migrate, the total number of observations in that variables is lower, 121,299. **Length of Stayed refers to the number of months migrants stay in the US; thus, it is calculated only for those how did migrate to the US at some point in our data. The number of observations in this case is 6,891.

each one of the communities in our sample from 1985 to 2020. Since we study weather shocks, it is vital that we count with precise estimations of location-specific weather. This poses a challenge for the weather data we use. Furthermore, MMP surveys mostly small communities; another challenge to our data. Meteoblue can respond to both challenges. Table 2 describes our weather data.

Variable	Mean	SD	Min	Max	SD within	SD across
Precipitation (cl)	63.48	55.17	4.72	345.15	18.26	49.28
Avg Temperature (°C)	21.34	3.49	14.13	29.56	0.55	3.21
Max Temperature (°C)	26.77	3.51	18.56	34.50	0.83	3.27
Min Temperature (°C)	15.88	3.76	8.76	24.52	0.54	3.33
Communities	88	88	88	88	88	88
Observations	968	968	968	968	968	968

TABLE 2 Summary Statistics - Weather

Notes: "SD" refers to the standard deviation of the correspondent variable across communities and time. "SD within" is calculated as the average standard deviation of the correspondent variable of each community across time. "SD across" is calculated as the average standard deviation of each year across communities.

For agricultural production, we use data from the "Servicio de Información Agroalimentaria y Pesquera" (SIAP) at the "Secretaría de Agricultura y Desarrollo Rural" from the Mexican government.⁶ We download total harvested land and corn grown for grain in the wet season from 2003 to 2019. Corn is the main crop of Mexico. In our study period, 70.86% of the total

⁶You can download the data directly from <https://nube.siap.gob.mx/cierreagricola/>

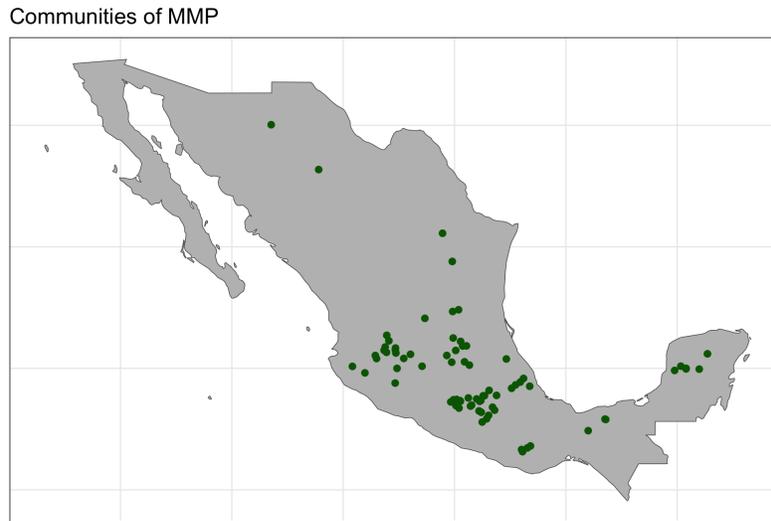


FIGURE 1 MMP: Communities Location - 2000-2019

harvested land corresponds to corn. As discussed in Section 2, corn production is highly dependant on weather.

On the one hand, the agricultural data is open-access. On the other hand, it is only available at municipality level. Thus, we need weather data at such level. We use another open-access dataset, "Daymet," from the Environmental Sciences Division at Oak Ridge National Laboratory (Thornton et al., 2020). Daymet offers monthly data on total precipitation, maximum and minimum temperature for all North America at 1km-1km level from 1980 to 2021. We aggregate this data at municipality level using municipality maps from the "Humanitarian Data Exchange" (HDX).⁷ The process can be entirely replicated in our [GitHub Repository](#).

Lastly, we use climate projections from TerraClimate, which offers worldwide estimates of future climate at 4km-4km level (Abatzoglou et al., 2018). As before, we aggregate this data at municipality level using municipality maps from the HDX.

4 | EMPIRICAL ANALYSIS

In this section, we show the relation between weather shocks and migration. Figure 2 illustrates our main point. On the x-axis, we plot deviations for the historical mean of the weather variables; for example, a "1°C" in the temperature plot means a 1°C deviation from historical maximum-temperature mean. On the y-axis, we plot the proportion of migrants in the population; that is, the number of migrants divided by the total number of workers. The dots reflect the proportion of migrants for decile-deviations of the weather variable. As expected, the higher (lower) the temperature (precipitation), the higher the migration. Moreover, the effect is entirely driven by illegal migrants.

We add similar plots for average and minimum temperature in the appendix (Figure A.1). The results are in the same line: the higher the temperature, the higher the migration. The formal econometrics specification is discussed in the next section.

⁷You can download the maps directly from <https://data.humdata.org/dataset/cod-ab-mex?>

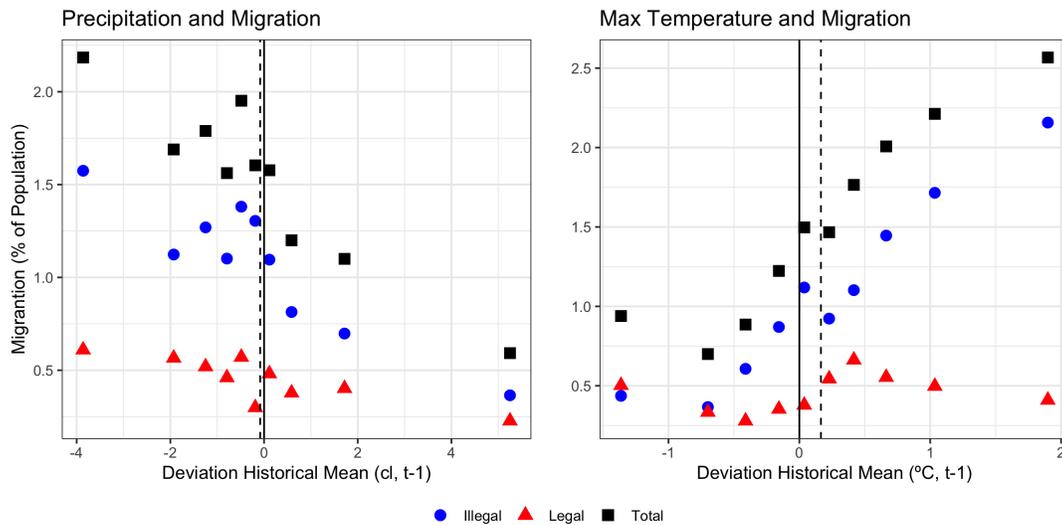


FIGURE 2 Weather Shocks and Migration

Notes: The dots reflect the proportion of migrants in the population for precipitation and maximum-temperature deviations from the historical mean in the wet season. Specifically, each dot groups observations in deciles of the deviation-from-the-historical-mean distribution and calculates the proportion of migrants for such deciles. The dotted vertical line reflects the average deviation from the historical mean in our period of study. The weather deviation is taken a period before the migration decision. The historical mean is taken over the period 1985-2014.

4.1 | Econometric Specification

In order to identify the effect of weather shocks on migration, we use a two-way fixed-effects model. Specifically, we run the following regression:

$$y_{ijt} = \alpha_i + \gamma_t + \beta_w w_{j,t-1} + \epsilon_{ijt} \quad (1)$$

where y_{ijt} is the variable of interest for a person i from community j at time t , e.g., did she migrate to the US in that specific period;⁸ $w_{j,t-1}$ is the weather “shock,” e.g., the deviation of the maximum temperature with respect to its historical mean in the wet season;^{9 10} α_i is the person fixed effect; γ_t is the year fixed effect; and ϵ_{ijt} is the error term. We cluster the errors at community level.

4.2 | Results

Table 3 shows our main results. Weather shocks in the wet season have a significant effect on migration at a 5% level. Specifically, a decrease of 1 centiliter (cl) on precipitation with respect to its historical mean generates a 0.04 percentage-points (p.p) increase in the probability of migrating to the US. Similarly, an increase of 1°C on average, maximum, and minimum temperature with respect to their historically mean generates a 0.63, 0.41, and

⁸Due to the very definition of our migration variable, we only consider individuals that are in Mexico at time $t - 1$.

⁹The wet season in Mexico goes from April to September, as discussed in Skoufias et al. (2011). This choice is thus in line with our proposed mechanism. Moreover, this is in line with Schlenker and Roberts (2009) (albeit with a month difference), who find that precipitation and temperature during March to August is highly correlated with US crop production.

¹⁰The historical mean is calculated for the period 1985-2014.

Dependent Variable:	Migrant			
Model:	(1)	(2)	(3)	(4)
<i>Variables</i>				
Dev Precipitation (cl, t-1)	-0.0004** (0.0002)			
Dev Avg Temp (°C, t-1)		0.0063*** (0.0009)		
Dev Max Temp (°C, t-1)			0.0041*** (0.0006)	
Dev Min Temp (°C, t-1)				0.0044*** (0.0009)
<i>Fixed-effects</i>				
id	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
<i>Fit statistics</i>				
Observations	121,299	121,299	121,299	121,299
Adjusted R ²	0.24955	0.25006	0.24996	0.24976

Clustered (commun) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

TABLE 3 Weather Shocks and Migration

Notes: The dependent variable is an indicator variable equal to one if the agent migrates to the US in that period. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1985-2014.

0.44 p.p increase, respectively.

The effects are substantial. The average proportion of migrants in the population on a given year is 1.52%. Thus, a decrease of 1cl on precipitation implies a 2.63% increase in the probability of migrating with respect to such a proportion; and an increase of 1°C on average, maximum, and minimum temperature implies a 41.16%, 27.08%, and 29.00% increase, respectively.

Interestingly, the effect is entirely driven by illegal migrants, as reflected in Table 4. A decrease of 1cl on precipitation generates a 0.03 p.p increase in illegal migration; and an increase of 1°C on average, maximum, and minimum temperature generates a 0.66, 0.43, and 0.47 p.p increase, respectively.

Dependent Variables:	Illegal Migrant				Legal Migrant			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Variables</i>								
Dev Precipitation (cl, t-1)	-0.0003*				-0.00009			
	(0.0002)				(0.00006)			
Dev Avg Temp (°C, t-1)		0.0066***				-0.0003		
		(0.0008)				(0.0004)		
Dev Max Temp (°C, t-1)			0.0043***				-0.0001	
			(0.0006)				(0.0003)	
Dev Min Temp (°C, t-1)				0.0047***				-0.0003
				(0.0008)				(0.0004)
<i>Fixed-effects</i>								
id	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>								
Observations	121,298	121,298	121,298	121,298	121,298	121,298	121,298	121,298
Adjusted R ²	0.18052	0.18135	0.18117	0.18089	0.40720	0.40720	0.40719	0.40720

Clustered (commun) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

TABLE 4 Weather Shocks and Migration by Legal Status

Notes: The dependent variable, for the first (last) 4 columns, is an indicator variables equal to one if the agent migrates illegally (legally) to the US in that period. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1985-2014.

4.3 | Mechanism

Ideally, we would observe income. We would then show that weather shocks affect income which in turn affects migration. Since we do not observe income, we study one of its main sources in rural Mexico: agricultural production. As discussed in Section 3, we have agricultural data at municipality rather than community level.

Following our main specification, we focus on the wet season in Mexico. Since our sample only includes 76 municipalities, we expand our data to all the municipalities within the 17 states which have at least one community in our sample. We end up with 1,960 municipalities.

Figure 3 illustrates our main point. Specifically, it plots harvested-land deviations against precipitation and maximum-temperature deviations from their historical means; the dots reflect the average harvested-land-deviations for the decile-deviations in weather. As expected, the higher (lower) the temperature (precipitation), the lower the harvested area. We add a similar plot for minimum temperature in the appendix (Figure A.2).

4.3.1 | Econometric Specification

In order to identify the effect of weather shocks on agricultural production, we use a two-way fixed-effects model, too. Specifically, we run the following regression:

$$y_{jt} = \alpha_j + \gamma_t + \beta_w w_{jt} + \epsilon_{jt} \quad (2)$$

where y_{jt} is the variable of interest for municipality j at time t , e.g., logarithm of total harvested area; w_{jt} is the weather "shock," e.g., the deviation of the maximum temperature with respect to its historical mean in the wet season; α_j is the municipality fixed effect; γ_t is the year fixed effect; and ϵ_{jt} is the error term. We cluster the errors at municipality level.

4.3.2 | Results

Table 5 shows our results. Weather shocks have a significant effect on total harvested area and corn-for-grain production at a 5% level. Specifically, an increase of 1cl on precipitation with respect to the historical mean generates an increase of 0.6% on total harvested area and 0.75% on corn production. Similarly, an increase of 1°C in maximum and minimum temperature with respect to their historical mean generates a decrease of 1.16% and 1.26% on total harvested area, and a decrease in 1.14% and 1.52% on corn production.

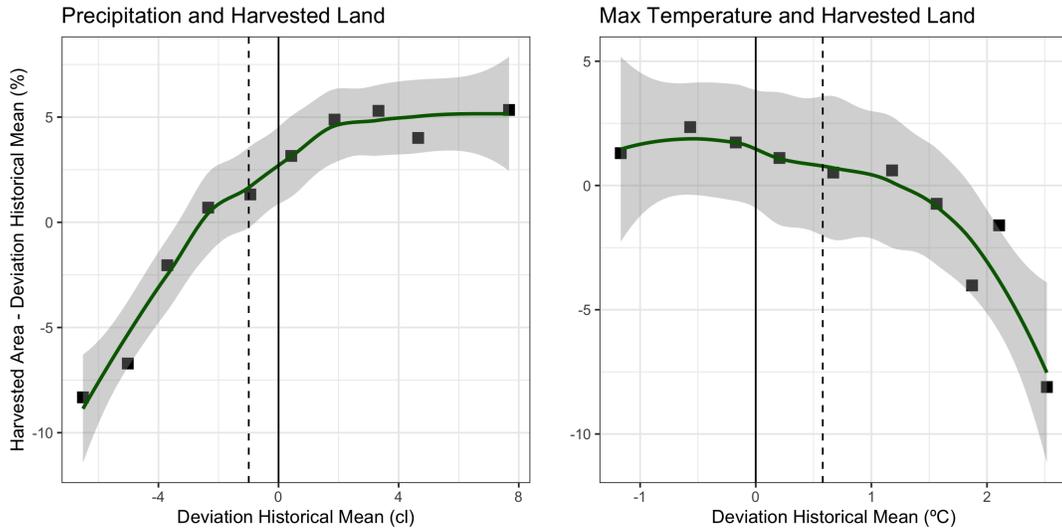


FIGURE 3 Weather Shocks and Harvested Land
Notes: The dots reflects the harvested-land deviations from its historical mean for precipitation and maximum-temperature deviations from its historical mean in the wet season. Specifically, each dot groups the observations in deciles of the deviation-from-the-historical-mean distribution and calculates the average deviation from the harvested land for such deciles. The historical mean is taken over the period 1985-2014.

Dependent Variables: Model:	Log (Harv Area) - Ha			Log (Corn Prod) - Gr, Ton		
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Variables</i>						
Dev Precipitation (cl)	0.0060*** (0.0008)			0.0075*** (0.0011)		
Dev Max Temp (°C)		-0.0116*** (0.0033)			-0.0114** (0.0047)	
Dev Min Temp (°C)			-0.0126*** (0.0039)			-0.0152** (0.0062)
<i>Fixed-effects</i>						
id	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>						
Observations	32,847	32,847	32,847	31,998	31,998	31,998
Adjusted R ²	0.90471	0.90454	0.90453	0.89528	0.89507	0.89508

Clustered (id) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

TABLE 5 Weather Shocks and Agricultural Production

Notes: The dependent variable, for the first (last) 4 columns, is the log of the harvested area (tons of corn-for-grain production) in the wet season. The independent variables are calculated as deviations from the historical mean on the same year and season. The historical mean is taken over the period 1985-2014.

4.4 | Extrapolation

In order to estimate the effect that climate change will have on illegal migration we would need a structural model.¹¹ We can, however, do back-of-the-envelope calculations to read our results in the lens of climate change.

Specifically, we can illustrate our results in shifts of the size of climate change. Unfortunately, we can only construct climate projections at municipality level. Thus, we assume the climate will change uniformly within municipalities. We can then calculate the expected change in precipitation, maximum and minimum temperature for every community, and ask: for a shift of the size of climate change, what would be the implied change in illegal migration?

Table 6 summarise our results. As expected, illegal migration would increase; the higher the increase in global temperature, the higher the increase in migration. For the climate model in which global temperature would increase in 2°C, the shift on precipitation would imply a 0.04 p.p increase on illegal migration - a 3.74% increase with respect to the baseline. For the same model, the shift on maximum and minimum temperature would imply a 0.81 and 0.97 p.p increase on illegal migration, respectively - a 75.70% and 90.06% increase with respect to the baseline.

Variable	2°C		4°C	
	Deviation	Migration (p.p)	Deviation	Migration (p.p)
Precipitation (cl)	-1.11 (1.509)	0.04 (0.02)	-2.38 (1.822)	0.10 (0.043)
Max Temp (°C)	1.96 (1.059)	0.81 (0.169)	4.45 (1.147)	1.84 (0.383)
Min Temp (°C)	2.19 (0.774)	0.97 (0.138)	4.30 (0.77)	1.90 (0.271)

TABLE 6 Projected Illegal Migration

Notes: The headlines "2°C" and "4°C" refer to increase on global temperatures for possible climate scenarios. The columns "Deviation" calculate the expected deviation for each variable for such scenarios in the wet season. The columns "Migration" refer to projected illegal migration for such deviations in p.p. Standard deviations are added in parenthesis. The historical period of reference is 1985-2014.

4.5 | Heterogeneity

In this section, we investigate the heterogeneous effects of weather shocks. Specifically, we study the role of wealth and age.

Figure 4 illustrates the results for wealth. It divides the sample in two: "non-owners," workers without land or business; and "owners," workers with land or business. Clearly, non-owners have a higher level of (illegal) migration. Furthermore, the effect of maximum temperature is more steep for this group.

Figure 5 illustrates our results for age. It divides the sample in two: " ≤ 41 ," workers

¹¹We are currently working in such a model.

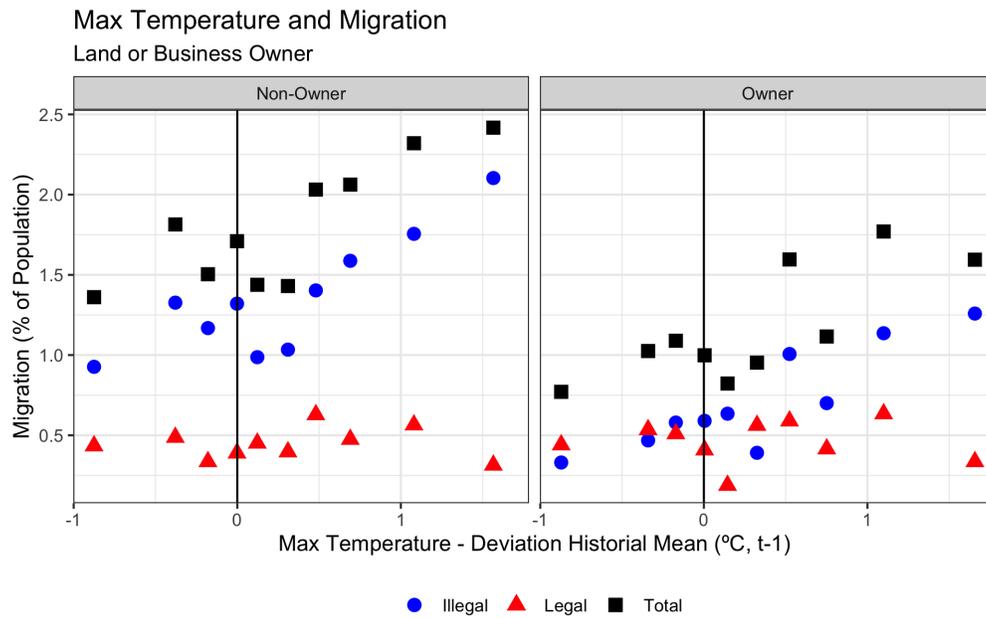


FIGURE 4 Weather Shocks and Migration by Wealth

Notes: The dots reflects the proportion of Mexican migrants in the population for maximum-temperature deviations from the historical mean in the wet season. Specifically, each dot groups observations in deciles of the deviation-from-the-historical-mean distribution and calculates the proportion of migrants for such deciles. The temperature deviation is taken the period before the migration decision. The historical mean is taken over the period 1985-2014.

younger than 41 years old; and “> 41,” workers older than 41 years old.¹² Clearly, the younger group has higher the proportion of (illegal) migrants. Furthermore, this group is much more sensitive to temperature shocks.

The formal econometrics analysis is added in Table 7 and 8; the effect of weather on illegal migration is more pronounced for non-owners and for young workers.

¹²We chose 41 years old just to divide the age range in two (almost) symmetric groups.

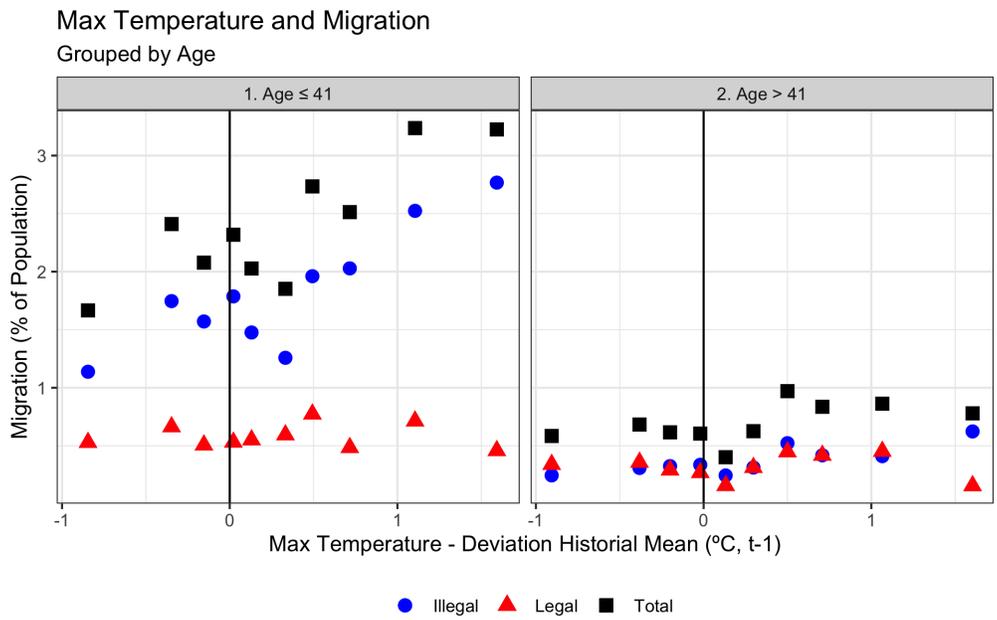


FIGURE 5 Weather shocks and Migration by Age
Notes: The dots reflects the proportion of Mexican migrants in the population for maximum-temperature deviations from the historical mean in the wet season. Specifically, each dot groups observations in deciles of the deviation-from-the-historical-mean distribution and calculates the proportion of migrants for such deciles. The weather deviation is taken the period before the migration decision. The historical mean is taken over the period 1985-2014.

Dependent Variables: Model:	Non-Owner Illegal Migrant				Owner Illegal Migrant			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Variables</i>								
Dev Precipitation (cl, t-1)	-0.0005** (0.0002)				-0.0001 (0.0002)			
Dev Avg Temp (°C, t-1)		0.0072*** (0.0010)				0.0052*** (0.0010)		
Dev Max Temp (°C, t-1)			0.0046*** (0.0007)				0.0039*** (0.0007)	
Dev Min Temp (°C, t-1)				0.0053*** (0.0011)				0.0029*** (0.0009)
<i>Fixed-effects</i>								
id	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>								
Observations	76,283	76,283	76,283	76,283	45,015	45,015	45,015	45,015
Adjusted R ²	0.21623	0.21704	0.21682	0.21659	0.20065	0.20147	0.20156	0.20087

Clustered (commun) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

TABLE 7 Illegal Migration and Weather Shocks by Wealth

Notes: The dependent variable, for the last (first) 4 columns, is an indicator variable equal to one if the agent migrates to the US illegally in that period and is (not) a land or business owner. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1985-2014.

Dependent Variables:	Illegal Migrant \leq 41				Illegal Migrant $>$ 41			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Variables</i>								
Dev Precipitation (cl, t-1)	-0.0007** (0.0003)				0.00003 (0.00008)			
Dev Avg Temp ($^{\circ}$ C, t-1)		0.0113*** (0.0013)				0.0014*** (0.0005)		
Dev Max Temp ($^{\circ}$ C, t-1)			0.0072*** (0.0010)				0.0009** (0.0004)	
Dev Min Temp ($^{\circ}$ C, t-1)				0.0088*** (0.0014)				0.0008 (0.0005)
<i>Fixed-effects</i>								
id	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>								
Observations	61,860	61,860	61,860	61,860	59,438	59,438	59,438	59,438
Adjusted R ²	0.17914	0.18062	0.18023	0.17989	0.25243	0.25255	0.25252	0.25246

Clustered (commun) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

TABLE 8 Illegal Migration and Weather Shocks by Age

Notes: The dependent variable, for the first (last) 4 columns, is an indicator variable equal to one if the agent migrates to the US illegally in that period and younger (older) than 41 years old. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1985-2014.

5 | ROBUSTNESS CHECKS

In this section, we do robustness checks to our main analysis. First, we define temperature shocks differently. Since our propose mechanism is agricultural production with emphasis on corn, we define “days of excess heat” as days with an average temperature above 29°C following [Schlenker and Roberts \(2009\)](#). Our results are in line with our main specification and can be found in [A.1](#). Specifically, an increase of one excess-heat-day increase migration in 0.02 p.p. The increment is entirely driven by illegal migrants.

Second, we take 8 years-backward windows and 12-years-backward windows. The results are rather similar, and can be found on Tables [A.2](#), [A.3](#), [A.4](#), and [A.5](#) in the appendix.

Third, we consider a different period for the historical mean. In our main analysis we used the period 1985-2014; in this robustness check we use the period 1990-2010. The results are also similar, and can be found in Tables [A.6](#) and [A.7](#) in the appendix.

Forth, we keep only the communities with less than 100,000 people. The results are virtually unchanged, and can be found in Tables [A.8](#) and [A.9](#) in the appendix.

Lastly, we add forage corn to the corn regression. We only missed significance for the minimum temperature coefficient; the results can be found on Table [A.10](#).

6 | CONCLUSION

We study the effect of weather shocks on migration from rural Mexico to the US. First, we find that shocks in the wet season on precipitation and temperature increase migration. The increment is entirely driven by illegal migrants. Second, we propose an underlying mechanism: the effect of weather on agricultural production. We find that shocks on precipitation and temperature decrease total harvested land and corn production. Third, we show that young and less wealthy workers are more sensitive to weather shocks. Lastly, we extrapolate our results using climate-projection models. We find that a shift of the size of climate change would double the number of illegal migrants.

We see some venues in which our work can be expanded. First, the effect that climate change will have on illegal migration remains as an open question. For instance, our approach does not account for adaptation, which will likely be substantial. Second, it would be interesting to investigate the “delayed” effect of weather shocks. Specifically, we show that weather shocks generate an immediate increase in illegal migration; it might also generate a delayed increase in legal migration. Lastly, it would be interesting to see the effect that weather-induced migrants have on the local markets.

Overall, our work highlights the relevance of weather for migration. Climate change makes this discussion increasingly relevant.

ACKNOWLEDGEMENTS

We thank Chris Flinn, Valentina Antonaccio, Gonzalo Arrieta, Natalia D’Agosti, William Witheridge, participants on the Applied Micro Lunch and the Applied Micro Breakfast at NYU, and discussants on the Academic Workshop on “Sustainable Development in

Latin America and the Caribbean" at CAF for useful discussions and comments that highly improved our work. We also thank CAF for financially support our project and the Mexican Migration Project and Meteoblue for provide us the data. All mistakes are our own.

REFERENCES

- Abatzoglou, J. T., Dobrowski, S. Z., Parks, S. A. and Hegewisch, K. C. (2018) Terraclimate, a high-resolution global dataset of monthly climate and climatic water balance from 1958–2015. *Scientific data*, **5**, 1–12.
- Chort, I. and De La Rupelle, M. (2022) Managing the impact of climate on migration: Evidence from Mexico. *Journal of Population Economics*, 1–43.
- Dalby, S. (2013) Climate change: new dimensions of environmental security. *The RUSI Journal*, **158**, 34–43.
- Feng, S., Krueger, A. B. and Oppenheimer, M. (2010) Linkages among climate change, crop yields and Mexico–US cross-border migration. *Proceedings of the National Academy of Sciences*, **107**, 14257–14262.
- Hanson, G. H. and Spilimbergo, A. (1999) Illegal immigration, border enforcement, and relative wages: Evidence from apprehensions at the US–Mexico border. *American Economic Review*, **89**, 1337–1357.
- Ibáñez, A. M., Romero, J. and Velásquez, A. (2021) Temperature shocks, labor markets and migratory decisions in El Salvador.
- Jessoe, K., Manning, D. T. and Taylor, J. E. (2018) Climate change and labour allocation in rural Mexico: Evidence from annual fluctuations in weather. *The Economic Journal*, **128**, 230–261.
- Krogstad, J. M., Passel, J. S. and Cohn, D. (5) facts about illegal immigration in the US. *Pew Research Center*, **19**.
- Lee, S. and Ji, Y. (2021) *Agricultural Innovation and Adaptation to Climate Change: Insights from Genetically Engineered Maize*. Center for Agricultural and Rural Development.
- Lobell, D. B., Schlenker, W. and Costa-Roberts, J. (2011) Climate trends and global crop production since 1980. *Science*, **333**, 616–620.
- Massey, D. S. and Capoferro, C. (2004) Measuring undocumented migration. *International Migration Review*, **38**, 1075–1102.
- Massey, D. S. and Zenteno, R. (2000) A validation of the ethnosurvey: The case of Mexico–US migration. *International Migration Review*, **34**, 766–793.
- Munshi, K. (2003) Networks in the modern economy: Mexican migrants in the US labor market. *The Quarterly Journal of Economics*, **118**, 549–599.
- Nawrotzki, R. J. and DeWaard, J. (2016) Climate shocks and the timing of migration from Mexico. *Population and Environment*, **38**, 72–100.
- Reinhold, S. and Thom, K. (2013) Migration experience and earnings in the Mexican labor market. *Journal of Human Resources*, **48**, 768–820.
- Rendon, S. and Cuecuecha, A. (2010) International job search: Mexicans in and out of the US. *Review of Economics of the Household*, **8**, 53–82.
- Schlenker, W. and Roberts, M. J. (2009) Nonlinear temperature effects indicate severe damages to US crop yields under climate change. *Proceedings of the National Academy of Sciences*, **106**, 15594–15598.
- Skoufias, E. (2007) Poverty alleviation and consumption insurance: Evidence from progressa in Mexico. *The Journal of Socio-Economics*, **36**, 630–649.

- Skoufias, E. and Vinha, K. (2013) The impacts of climate variability on household welfare in rural Mexico. *Population and Environment*, **34**, 370–399.
- Skoufias, E., Vinha, K. and Conroy, H. V. (2011) The impacts of climate variability on welfare in rural Mexico. *World Bank Policy Research Working Paper*.
- Thornton, M., Shrestha, R., Wei, Y., Thornton, P., Kao, S. and Wilson, B. (2020) Daymet: Monthly climate summaries on a 1-km grid for North America, version 4. URL: https://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1855.

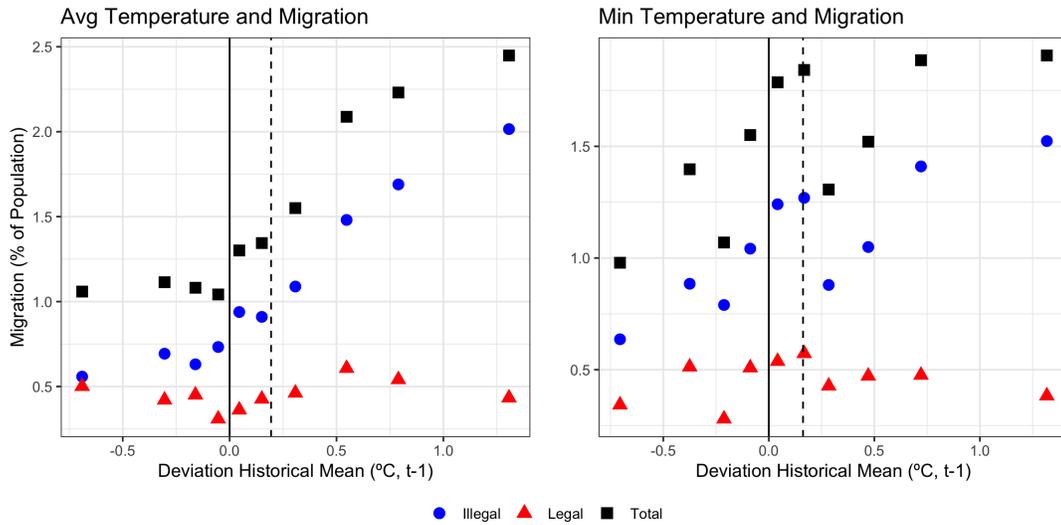


FIGURE A.1 Temperature Shocks and Migration

Notes: The dots reflect the proportion of Mexican migrants in the population for average-temperature and minimum-temperature deviations from the historical mean in the wet season. Specifically, each dot groups observations in deciles of the deviation-from-the-historical-mean distribution and calculates the proportion of migrants for such deciles. The dotted vertical line reflects the average deviation from the historical mean in our period of study. The weather deviation is taken the period before the migration decision. The historical mean is taken over the period 1985-2014.

A | APPENDIX

A.1 | Weather shocks and migration

A.1.1 | Plots

In this section, we add the plots for weather shocks and migration for average and minimum temperature (Figure A.1).

A.1.2 | Robustness Checks

In this section, we add the robustness checks discussed in Section 5: Table A.1 shows the results for days-above-29°C specification; Tables A.2 and A.3 show the results using 8-years-backward windows; Tables A.4 and A.5 show the results using 12-years-backward windows; Tables A.6 and A.7 show the results using 1990-2010 as the historical period; and Tables A.8 and A.9 show the results for communities with less than 100,000 people.

Dependent Variables: Model:	Migrant (1)	Illegal Migrant (2)	Legal Migrant (3)
<i>Variables</i>			
Days Above 29°C (#, t-1)	0.0002*** (0.00004)	0.0002*** (0.00003)	0.000008 (0.00002)
<i>Fixed-effects</i>			
id	Yes	Yes	Yes
year	Yes	Yes	Yes
<i>Fit statistics</i>			
Observations	121,299	121,298	121,298
Adjusted R ²	0.24964	0.18066	0.40719

Clustered (commun) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

TABLE A.1 Temperature Shocks and Migration - Days above 29°C

Notes: The dependent variable for the first column is an indicator variables equal to one if the agent migrates to the US in that period. The dependent variable for the second (third) column is an indicator variables equal to one if the agent migrates illegally (legally) to the US in that period. The independent variable is calculated as total days above 29°C in the wet season a year before the migration decision.

Dependent Variable:	Migrant			
Model:	(1)	(2)	(3)	(4)
<i>Variables</i>				
Dev Precipitation (cl, t-1)	-0.0005** (0.0002)			
Dev Avg Temp (°C, t-1)		0.0063*** (0.0011)		
Dev Max Temp (°C, t-1)			0.0043*** (0.0008)	
Dev Min Temp (°C, t-1)				0.0047*** (0.0010)
<i>Fixed-effects</i>				
id	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
<i>Fit statistics</i>				
Observations	99,101	99,101	99,101	99,101
Adjusted R ²	0.27020	0.27066	0.27057	0.27040

Clustered (commun) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

TABLE A.2 Weather Shocks and Migration - 8 years-window

Notes: The dependent variable is an indicator variable equal to one if the agent migrates to the US in that period. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1985-2014.

Dependent Variables:	Illegal Migrant				Legal Migrant			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Variables</i>								
Dev Precipitation (cl, t-1)	-0.0003 (0.0002)				-0.0002** (8.38×10^{-5})			
Dev Avg Temp (°C, t-1)		0.0066*** (0.0009)				-0.0003 (0.0005)		
Dev Max Temp (°C, t-1)			0.0043*** (0.0007)				-5.6×10^{-5} (0.0003)	
Dev Min Temp (°C, t-1)				0.0052*** (0.0010)				-0.0004 (0.0005)
<i>Fixed-effects</i>								
id	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>								
Observations	99,101	99,101	99,101	99,101	99,101	99,101	99,101	99,101
Adjusted R ²	0.20349	0.20430	0.20410	0.20391	0.41923	0.41920	0.41920	0.41920

Clustered (commun) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

TABLE A.3 Weather Shocks and Migration by Legal Status - 8 years-window

Notes: The dependent variable, for the first (last) 4 columns, is an indicator variables equal to one if the agent migrates illegally (legally) to the US in that period. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1985-2014.

Dependent Variable:	Migrant			
Model:	(1)	(2)	(3)	(4)
<i>Variables</i>				
Dev Precipitation (cl, t-1)	-0.0004** (0.0002)			
Dev Avg Temp (°C, t-1)		0.0060*** (0.0008)		
Dev Max Temp (°C, t-1)			0.0040*** (0.0006)	
Dev Min Temp (°C, t-1)				0.0044*** (0.0008)
<i>Fixed-effects</i>				
id	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
<i>Fit statistics</i>				
Observations	143,223	143,223	143,223	143,223
Adjusted R ²	0.23555	0.23602	0.23594	0.23576

Clustered (commun) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

TABLE A.4 Weather Shocks and Migration - 12 years-window

Notes: The dependent variable is an indicator variable equal to one if the agent moves to the US in that period. The independent variables are calculated as deviations from the historical mean in the wet season a year before the moving decision. The historical mean is taken over the period 1985-2014.

Dependent Variables:	Illegal Migrant				Legal Migrant			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Variables</i>								
Dev Precipitation (cl, t-1)	-0.0004** (0.0002)				-6.91×10^{-5} (6.07×10^{-5})			
Dev Avg Temp (°C, t-1)		0.0062*** (0.0008)				-0.0002 (0.0003)		
Dev Max Temp (°C, t-1)			0.0040*** (0.0006)				-1.42×10^{-5} (0.0002)	
Dev Min Temp (°C, t-1)				0.0046*** (0.0008)				-0.0002 (0.0004)
<i>Fixed-effects</i>								
id	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>								
Observations	143,220	143,220	143,220	143,220	143,220	143,220	143,220	143,220
Adjusted R ²	0.16599	0.16670	0.16655	0.16633	0.40420	0.40420	0.40419	0.40420

Clustered (commun) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

TABLE A.5 Weather Shocks and Migration by Legal Status - 12 years-window

Notes: The dependent variable, for the first (last) 4 columns, is an indicator variables equal to one if the agent moves illegally (legally) to the US in that period. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1985-2014.

Dependent Variable:	Migrant			
Model:	(1)	(2)	(3)	(4)
<i>Variables</i>				
Dev Precipitation (cl, t-1)	-0.0004** (0.0002)			
Dev Avg Temp (°C, t-1)		0.0063*** (0.0009)		
Dev Max Temp (°C, t-1)			0.0041*** (0.0006)	
Dev Min Temp (°C, t-1)				0.0044*** (0.0009)
<i>Fixed-effects</i>				
id	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
<i>Fit statistics</i>				
Observations	121,299	121,299	121,299	121,299
Adjusted R ²	0.24955	0.25006	0.24996	0.24976

Clustered (commun) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

TABLE A.6 Weather Shocks and Migration - Historical Mean 1990-2010

Notes: The dependent variable is an indicator variable equal to one if the agent migrates to the US in that period. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1990-2010.

Dependent Variables: Model:	Illegal Migrant				Legal Migrant			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Variables</i>								
Dev Precipitation (cl, t-1)	-0.0003* (0.0002)				-9.16×10^{-5} (6.39×10^{-5})			
Dev Avg Temp (°C, t-1)		0.0066*** (0.0008)				-0.0003 (0.0004)		
Dev Max Temp (°C, t-1)			0.0043*** (0.0006)				-0.0001 (0.0003)	
Dev Min Temp (°C, t-1)				0.0047*** (0.0008)				-0.0003 (0.0004)
<i>Fixed-effects</i>								
id	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>								
Observations	121,298	121,298	121,298	121,298	121,298	121,298	121,298	121,298
Adjusted R ²	0.18052	0.18135	0.18117	0.18089	0.40720	0.40720	0.40719	0.40720

Clustered (commun) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

TABLE A.7 Weather Shocks and Migration by Legal Status - Historical Mean 1990-2010

Notes: The dependent variable, for the first (last) 4 columns, is an indicator variables equal to one if the agent migrates illegally (legally) to the US in that period. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1990-2010.

Dependent Variable:	Migrant			
Model:	(1)	(2)	(3)	(4)
<i>Variables</i>				
Dev Precipitation (cl, t-1)	-0.0004** (0.0002)			
Dev Avg Temp (°C, t-1)		0.0064*** (0.0009)		
Dev Max Temp (°C, t-1)			0.0042*** (0.0007)	
Dev Min Temp (°C, t-1)				0.0049*** (0.0009)
<i>Fixed-effects</i>				
id	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
<i>Fit statistics</i>				
Observations	112,588	112,588	112,588	112,588
Adjusted R ²	0.25256	0.25309	0.25298	0.25282

Clustered (commun) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

TABLE A.8 Weather Shocks and Migration - Commun less than 100,000 people
Notes: The dependent variable is an indicator variable equal to one if the agent migrates to the US in that period. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1990-2010.

Dependent Variables:	Illegal Migrant				Legal Migrant			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Variables</i>								
Dev Precipitation (cl, t-1)	-0.0003*				-8.53×10^{-5}			
	(0.0002)				(6.48×10^{-5})			
Dev Avg Temp (°C, t-1)		0.0068***				-0.0004		
		(0.0008)				(0.0004)		
Dev Max Temp (°C, t-1)			0.0044***				-0.0002	
			(0.0006)				(0.0003)	
Dev Min Temp (°C, t-1)				0.0052***				-0.0003
				(0.0009)				(0.0004)
<i>Fixed-effects</i>								
id	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Fit statistics</i>								
Observations	112,587	112,587	112,587	112,587	112,587	112,587	112,587	112,587
Adjusted R ²	0.18087	0.18174	0.18153	0.18131	0.41782	0.41782	0.41781	0.41781

Clustered (commun) standard-errors in parentheses

Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

TABLE A.9 Weather Shocks and Migration by Legal Status - Commun less than 100,000 people

Notes: The dependent variable, for the first (last) 4 columns, is an indicator variables equal to one if the agent migrates illegally (legally) to the US in that period. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1990-2010.

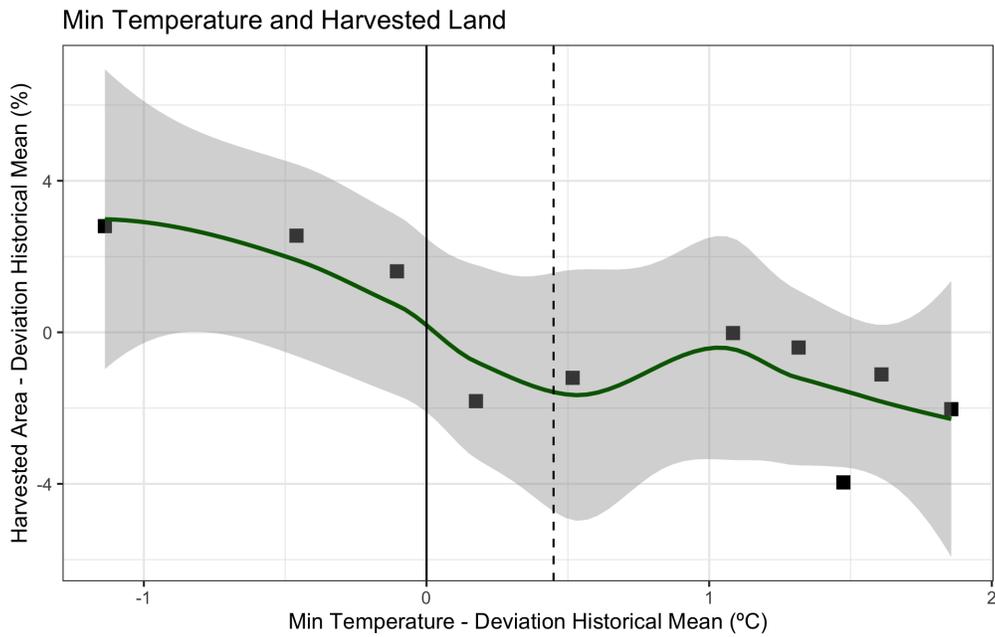


FIGURE A.2 Minimum Temperature Shocks and Harvested Land
Notes: The dots reflects the harvested-land deviations for its historical mean for minimum-temperature deviations from its historical mean. Specifically, each dot groups the municipalities in deciles of the deviation-from-the-historical-mean distribution and calculates the average deviation from the harvested land for such deciles.

A.2 | Agricultural Production

In this section, we add the plot for agricultural production and minimum temperature shocks (Figure A.2).

A.2.1 | Robustness Checks

In this section, we add the robustness checks discussed in Section 5. Table A.10 shows the results for corn production including forage corn.

Dependent Variable:	Log (Corn Prod) - Ton		
Model:	(1)	(2)	(3)
<i>Variables</i>			
Dev Precipitation (cl)	0.0076*** (0.0011)		
Dev Max Temp (°C)		-0.0198*** (0.0048)	
Dev Min Temp (°C)			-0.0016 (0.0061)
<i>Fixed-effects</i>			
id	Yes	Yes	Yes
year	Yes	Yes	Yes
<i>Fit statistics</i>			
Observations	32,315	32,315	32,315
Adjusted R ²	0.90550	0.90539	0.90528

Clustered (id) standard-errors in parentheses

*Signif. Codes: ***: 0.01, **: 0.05, *: 0.1*

TABLE A.10 Weather Shocks and Corn Production - Add Corn for forage
Notes: The dependent variable is the log of total corn production (for grain plus forage) in tons. The independent variables are calculated as deviations from the historical mean in the wet season a year before the migration decision. The historical mean is taken over the period 1990-2010.