Climate Change, Violence, and Remittance Flows in Mexico

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Abstract

This paper studies how domestic and international remittances respond to weather shocks in Mexico and whether local violence affects the use of remittances as a coping strategy. I use a novel combination of state-level, administrative, survey, and remotely sensed panel data to investigate these questions. Estimating a gravity model that accounts for network characteristics and potential spatial dependence, I find that remittances are selective, responding positively to drought but negatively to violence. The negative impact of violence is even larger in areas experiencing drought suggesting that households facing violence are especially vulnerable to weather shocks as they are less able to cope via remittances. I further unpack the costs of both drought and organized crime by studying the role of networks and spillovers from neighboring states. I find that network specifics play a key role in remittance patterns and the degree of drought and violence in neighboring states magnifies the main impact, motivating certain policy approaches.

Keywords: Immigration, Drought, Conflict, Mexico, the United States, Remittances
JEL Codes: J11, R23, F24, Q54, Q34

1 Introduction

Economic shocks are an inevitable part of every person's life and smoothing consumption through these shocks is important for overall well-being. Households in low- and middle- income countries are especially vulnerable to shocks and often use a variety of strategies to cope such as adjusting livestock and asset portfolios (Acosta et al., 2021; Dercon, 2002; Kazianga and Udry, 2006; Zimmerman and Carter, 2003), converting agricultural land (Azadi et al., 2018), altering consumption (Gao and Mills, 2018), using savings (Paxson, 1992), off-farm employment (Kochar, 1999; Bezabih et al., 2010; Ito and Kurosaki, 2009), or migration (Rosenzweig and Stark, 1989). But, there are a number of barriers which may prevent families from taking advantage of these options including labor market frictions, gaps in financial markets, and violence, which has long been viewed as a transaction cost but is seldom examined as such in the migration and remittance literature (Becker, 1968). In this paper, I explore how violence can impede the use of remittances as informal insurance to cope with a weather shock.

I focus specifically on Mexico where migration has long been an important strategy for income diversification, consumption smoothing, and economic mobility. The increasing pressures of climate change may impact migration decisions and the effectiveness of remittances as a tool to manage weather fluctuations (Munshi and Rosenzweig, 2016; Bryan et al., 2014; Yang and Choi, 2007; Rapoport and Docquier, 2006). Smoothing consumption through weather shocks is particularly important for families in Mexico where over 70% of agriculture is rain-fed and formal insurance may be limited or incomplete (Fuchs and Wolf, 2011). But, while climate change poses one threat to the economy, continuing violence across parts of Mexico could also impact the effectiveness of migration as a consumption smoothing tool, especially if remittances are targeted for theft or extortion. I specifically study how drought affects remittances at the state level and whether violence augments or undercuts the use of remittances as a coping strategy.

Understanding how remittances respond to drought helps to explain the role migration can play in building climate-resilient communities. As parts of Mexico become hotter and drier, remittances may be an increasingly important income buffer for families. Violence can increase vulnerability to other shocks as it weakens local economic opportunities and institutions, making remittances an even more crucial coping strategy in these areas but only if the funds can safely reach the recipient.

As a first step, I establish the impact of drought in sending and receiving states using novel panel data on state-to-state remittance flows that I construct by combining administrative and survey data. I then assess the impact of violence, another threat to many households, on these remittance flows. Using the interaction between drought and violence, I highlight the specific impact instability has in a state also experiencing drought. The state-level panel data allows me to adopt techniques from the spatial econometric literature to estimate credible, causal parameters that account for the role networks and address spillovers from neighboring states. I include a number of robustness checks and extensions to further unpack the relationship between remittances, climate change, and violence.

Throughout this paper I will discuss remittance-sending states (places a migrant has moved to and from which they send remittances) and remittance receiving states (the origin of the migrant wherein the household accepts these remittances). I find that drought[1] in the receiving state increases international remittances by about 15% suggesting that migration and remitting are important coping strategies for those experiencing drought. That this effect is concentrating in international flows may have distributional impacts in Mexico, as poorer households may not be able to send migrants to the US. Next, I find that violence in the receiving state, proxied by homicide rate, has a significant negative impact on remittance flows, reducing flows by about 0.05%. This effect is smaller than the drought impacts though a Shapley-Owen decomposition shows that a much greater portion of the variation in remittance flows is explained by violence, after controlling for state and time characteristics. Violence also decreases remittances whether they originate in the US or in another part of Mexico. Third, given a particular level of violence, experiencing a drought further reduces remittances flows, suggesting that violence seriously undercuts the utility of remitting as a strategy to cope with the effects of climate change. Finally, I find the remittances respond to conditions in the receiving area but not in the migrant's destination. Both violence

[1] Defined as 1.5 standard deviations below long-term, average precipitation and temperature measures.

and drought in sending states, whether in the US or Mexico, have a limited, typically insignificant effect.

I conduct a variety of robustness checks and provide auxiliary evidence to support the main identification assumptions. One concern may be that violence is endogenous to weather shocks. Currently there is mixed evidence on the impact of weather on violence without an obvious causal relationship in one direction or the other (Koubi, 2019; Adaawen et al., 2019; Maystadt and Echer, 2014). I find an insignificant but positive relationship between drought and homicides at the state level in Mexico and I address the implications in detail in the identification and results sections.

In addition to the main findings, I find evidence of spillovers, in the same direction of the direct effects, for both drought and violence. I find that drought in the three nearest neighbors of a receiving state increases remittances. Similarly, higher violence in a receiving state's neighbors also reduces remittances flows. Ignoring these spillovers would overestimate the direct impact of violence on remittances and including this analysis also highlights the unique cost of regionally correlated violence shocks, such as that associated with organized crime or sectarian conflict. Additionally, the presence of these spillovers motivates policy approaches that coordinate across state and even national borders. Lastly, I find that state-to-state networks play an important role in determining the size of remittance flows which motivates empirical techniques that account for network effects, as well as encourages future work into the specific nature and formation of these networks.

This research relates to the growing body of literature on climate change and migration but specifically analyzes the remittances that come after migration rather than the initial decision to leave. Weather shocks are important push factors that spur migration (Beine and Jeusette, 2021; Mahajan and Yang, 2020), including in Mexico where drought can increase both international and internal migration (Chort and de la Rupelle, 2016; Ruiz, 2017; Khamis and Li, 2020). I contribute to this work by studying the effect of prior migration on households remaining at home and receiving remittances following similar weather shocks. I also build on existing work covering the various strategies households use to cope with shocks by further unpacking how remittances from prior migrants help families respond to weather shocks in locations where conflict is prevalent. This has implications for communities around the world as many countries, such as Yemen or Somalia, are suffering under the devastating effects of climate change and ongoing violence.

Prior work has addressed the role of remittances as insurance, including insuring against bad weather. These papers find evidence of risk-sharing across migration networks and migrants providing insurance to their families (and occasionally families providing insurance for migrants) (Rosenzweig and Stark, 1989; Yang and Choi, 2007; Mazzucato, 2009; de Weerdt and Dercon, 2006; de Weerdt and Hirvonen, 2016; Bettin and Zazzaro, 2017). While migrating may be an important risk-sharing tool, not all destinations may allow a migrant to provide insurance to their home, thus certain remittance-networks may be more active (Gröger and Zylberberg, 2016; Millán, 2020). Studying the insurance role is also part of a larger study of the various determinants of remittances (Rapoport and Docquier, 2006; Hagen-Zanker and Siegel, 2007; Lueth and Luiz-Arranz, 2008). I contribute to this literature using recent, panel, sub-national data to understand the role of remittances in response to climate change and consider situations with existing instability.

I also speak to the literature on the economics of crime (Becker, 1995, 1968) and the costs of crime (Wickramasekera et al., 2015). Specifically, I join work that finds crime and violence has a negative impact on economic activity and development in general (Blanco and Ruiz, 2013; Heinemann and Verner, 2006; Detotto and Otranto, 2010; Motta, 2017) and specifically during the "War on Drugs" in Mexico (Rıos, 2019; Carrasco and Duran-Bustamante, 2022; Enamorado et al., 2014; BenYishay and Pearlman, 2014; Ashby and Ramos, 2013; Bel and Holst, 2018). Violent crime first spiked in Mexico when then-President Felipe Calderón initiated the decapitation strategy to target cartel leaders (Calderón et al., 2015; Guerrero, 2013). Violence fell somewhat in the early 2010s before rising again to a new peak 2018 and remaining high in recent years. While the literature is still small, prior works finds a negative impact of crime on remittances, suggesting that people may send fewer remittances if this money may make family members vulnerable a crime or because potential investments become less valuable (Meseguer et al., 2017; Vargas-Silva, 2009; López García and Maydom, 2021). I build on this literature using a longer and more recent, administrative, panel data set and discuss the interplay of violence and weather shocks on remitting behavior. With eleven years of panel data this analysis can account for unobservable characteristics that impact particular remittance paths. I also discuss spatial correlation in bilateral remittance flows (Laurent et al., 2022) and provide convincing causal estimates of the determinants of remittance flows. In this paper, I link the literature on strategies to cope with weather shocks, the determinants of remittances, and the costs of crime using novel data to address an important empirical question.

Section 2 covers the conceptual model, describing the motivation to remit following a drought and how violence complicates this story. Section 3 describes the empirical model, followed by section 4 discussing the data. Section 5 contains the results from various specifications, including extensions and robustness checks, and section 6 concludes.

2 Conceptual Framework

Consider a representative, individual migrant who leaves a household in location i for destination j. Assume the migrant earns an income in the destination and consumes some while remitting the rest. The migrant may choose to remit because they value the family's consumption at the origin in addition to their own consumption. The migrant may also benefit from a family business or farm if they intend to return home or will receive an agreed upon share of the profits in exchange for sending remittances.

Using m to denote the migrant and n to denote the household at the origin, I translate this into the following utility framework with C_m indicating the migrant's consumption and C_n indicating consumption at the origin. Assume the migrant's utility function is $f(C_m)$ while the rest of the household's is $g(C_n)$. Also, let $f(\cdot)$ and $g(\cdot)$ be logarithmic functions that satisfy the usual properties of a utility function: $f(C_m) = ln(C_m), g(C_n) = ln(C_n)$. Consumption for the migrant is a function of income (Y_m), weather shocks (S_m), and remittances sent (r). Consumption for the household is a function of income (Y_n), weather shocks (S_n), violence (H_n), and remittances received (r).

The relative utility of own consumption and household consumption is denoted with $0 \leq \beta < 1$, where $\beta = 1$ would reflect a migrant who does not derive any utility from their family's consumption[2].

$$U_m = \beta f(C_m(Y_m, S_m, r)) + (1-\beta)g(C_n(Y_n, S_n, H_n, r)) \quad (1)$$

Consumption for the migrant increases with earnings and decreases with the size of remittances. A migrant may also share in profits from a family business or they may save less and consume more in the present if they expect to inherit wealth or land at the origin. Weather shocks decrease the migrant's income. Consumption for the household increases with earnings, including from a home business or farm, and remittances received. Consumption falls due to shocks and if violence increases, either due to theft, fewer wage jobs available, or because returns to investments in the family business fall.

The first outcome is that shocks at the migrant's location should decrease remittances as the income the migrant has available falls. And since the migrant values consumption at home, a weather shock at the origin should increase remittances. Violence in Mexico has a more ambiguous impact. First, as violence likely decreases income and consumption, remittances could increase for the same altruistic motivations that drive the weather shock response. On the other hand, if higher income actually makes the family a target for crime, sending money into an unsafe area may ultimately lower the family's consumption, or utility if there is a direct impact of being a victim of a crime on well-being outside of the impact on consumption. If the migrant is sending money to specifically invest in capital for a home business or farm, higher risk of violence may also reduce remittances. The family may not want to invest in the business if returns fall or, especially if the capital is something fixed to a location like land or an irrigation system, may choose not to invest if they think they may leave the area due to rising violence in the future. This would decrease their demand for remittances from their migrant family members. Thus, the impact of violence on remittances remains an empirical question.

The final piece to consider is an interaction between the weather shock and violence in the case that both increase. For example, in two states that experience drought does the state with a greater

[2] This set up closely follows that of the altruistic migrant in Rapoport and Docquier (2006).

cartel presence receive more remittances? If both individually increase remittances for altruistic reasons, then the case that both occur may have an even bigger positive effect on remittance flows. If persistent drought makes families more vulnerable to violence and violence has a negative impact on remittance flows then the interaction may be negative. Drought may make families more vulnerable to violence if they become more desperate and take more risks that may put them in contact with cartels, such as by borrowing money from a loan shark. Lower incomes may also make it harder for families to protect themselves from violence. Cartels may also be involved in the agriculture sector and if drought impacts those profits they may resort to more theft or extortion (Simon, n.d.). The main analysis will investigate both the direct impacts of drought and violence, and how they interact to affect remittance flows into Mexican states, illuminating some of these theoretical paths.

3 Empirical Framework

To evaluate the motivations to remit, I aggregate the utility model framework to the state level, assuming all migrants have similar preferences and utility functions as the one discussed above. I assume that these individual utility functions underlie total flows of remittances to Mexican state i from either Mexican or US state j. Thus, i in the aggregated empirical model correlates with n in the theoretical model, and j with m. I evaluate the determinants of total remittance flows along these destination-origin pairs and map these results to the predictions of the conceptual framework.

I estimate a gravity model specification with year and state-to-state pair fixed effects. The gravity model is often used to study trade flows in the economics literature and has been applied to migration flows and remittance flows previously (Karemera et al., 2000; Laurent et al., 2022). The model draws on Newton's law of gravity measuring the force between two objects as a function of distance and characteristics, like mass, of those two objects (Bergstrand, 1985; Anderson, 2011). Similarly, the gravity model can estimate the size of a flow between two points as function of supply, or push factors, and demand, or pull factors (Karemera et al., 2000). In this case I estimate the impact of weather shocks and violence in remittance-sending and remittance-receiving states on remittance flows. Following the gravity model literature, I estimate a log-log specification so the coefficients will represent quasi-elasticities. The log specification has the added benefit of addressing the right skew of both remittance flows and homicides (Figures A18, A20, A19, A21). Using a log transformation can introduce problems if there are many zeroes present in the data. First, there are no zero observations for homicides since the model is run at the state level. Second, fewer than four percent of all remittance flows are zero but I add 1 to all data before conducting the transformation. As a robustness check I use the inverse hyperbolic sine transformation on the original remittance data and find nearly identical results (Table D2). Thus, I maintain a log-log specification for all main models for the ease of interpretation and to stay consistent with other research using gravity models.

I estimate the following gravity model where R_{ijt} represents remittance flows to i from j in year t, S are dummy variables indicating a weather shock in the location, and H is a measure of local violence. The fixed effects capture other characteristics that could impact remittance flows such as distance. I also control directly for population in all empirical models and cluster standard errors at the state-pair level. Finally, to address potential reverse causality and allow time for drought to develop and remittances to respond, I lag all independent variables by one year.

$$ln(R_{ijt}) = \alpha_0 + \eta_1 S_{j,t-1} + \eta_2 S_{i,t-1} + \eta_3 ln(H_{i,t-1}) + \eta_4 S_{i,t-2} \times ln(H_{i,t-1}) + \delta_t + \delta_{ij} + \epsilon_{ij} \quad (2)$$

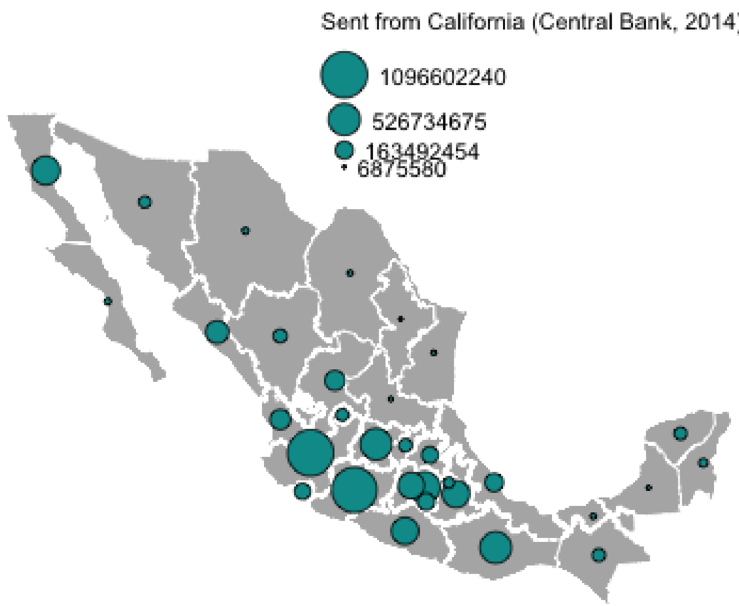
Per the theoretical model, I expect η_1 to be less than zero, η_2 to be greater than zero, and η_3 and η_4 are theoretically ambiguous.

The above gravity model does not account for spatially correlated shocks beyond including clustered standard errors. The spatial economics field has highlighted a number of situations where outcomes are correlated with the outcomes in neighboring locations. For example, commute times may be shorter in one county because of a well maintained highway system. Because these roads would cross into other nearby counties, those likely also have shorter commute times. Unless we can directly control for all regionally correlated variables at the local level, controlling for average conditions in neighboring states may help control for some of the underlying unobservables that impact the region as a whole. Recent developments, particularly in Laurent et al. (2022) have extended this model to consider data that has origin-destination structure. Motivated by their work, I include the average drought and violence experience of the three nearest states as additional controls. This also allows me to address spillovers from neighboring states similar to methods in recent experimental work (Egger et al., 2021; Muralidharan et al., 2022). In contrast to earlier work I use multiple years of panel data at a sub-national level and I do not include the spatially lagged dependent variable as an additional control to protect against overcontrolling since the model already has comprehensive fixed effects that will account for many unobservable factors driving remittance flows between two locations.

There are many reasons why migration decisions and therefore capacity or willingness to remit may be spatially correlated. Imagine a particular immigrant will remit no matter where she lands but she is hoping for a job in New York City where she's heard there are good jobs and a community of immigrants. Given similarities between New York and New Jersey, perhaps she finds herself equally happy with a job in New Jersey. Her remittance flow would be assigned to New Jersey, but her location choice, and therefore the remittance origin, was more about the region than a specific characteristic of New Jersey. Similarly, on the Mexican side, indigenous communities and traditional lands can cover multiple states. Perhaps indigenous people settle near each other even if they moved from different states in Mexico. If they all send remittances back to their respective, neighboring states, these remittance flows are in part regionally determined. Laurent et al. (2022) show that at the international level, countries that receive substantial remittances from a particularly source country often also receive substantial inflows from neighbors of that source country, and vice versa. I find similar patterns for states in Mexico for both international (Figure 1) and domestic remittance flows (Figure 2). As expected, weather shocks and homicides are also spatially correlated in Mexico and the US (Figures 5, 6, 7). In Appendix A, I include plots of Moran's I demonstrating the positive correlation between violence in a state and the average violence in the three neighboring states.

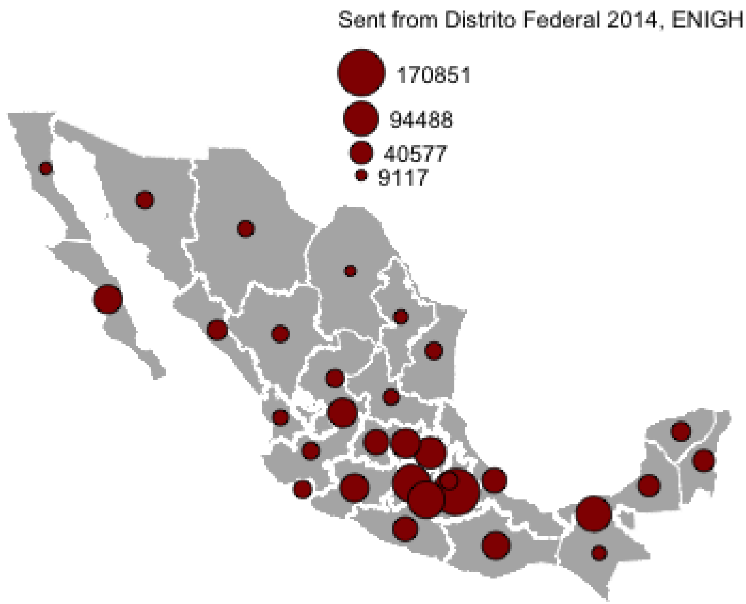
I will control for spatially lagged explanatory (independent) variables within the gravity model framework. To create the lagged variables, I create a spatial weighting matrix for each state in the

Figure 1: Remittance Flows From California in 2014



NOTE: Authors calculations based on remittance data from the Central Bank of Mexico and historical (2006-2009) migration shares from Mexican to US states from the Matrículas Consulares data.

Figure 2: Remittance Flows From Mexico City in 2014



NOTE: Authors calculations based on remittance data from the ENIGH and historical (2005-2009) migration shares between Mexican states from the Census data produced by Ruggles et al. (2020).

US and Mexico where the three nearest neighbors, determined by distance between centroids, each receive a weight of $\frac{1}{3}$, and all other states have weight 0. Using nearest neighbors rather than contiguous states ensures that every state has a complete spatial weighting matrix, with the same weight for each neighbor. It is possible for State A to be one of the neighbors of State B, but State B is not necessarily one of A's three neighbors. For example, Alaska is closest to Washington, Oregon, and Idaho, but each of these has three other neighbors closer than Alaska. Figures A16 and A15 in Appendix A show the neighborhood structure for both countries.

Another possible approach could be to control for the spatially lagged dependent variable on the right hand side of the empirical estimation but this could introduce bias into the estimation as I would be directly including a form of the remittance variable as a regressor. Instead, I will focus on the spatial correlation of the exogenous variables and estimate the following model.

$$ln(R_{ijt}) = \alpha_0 + \eta_1 S_{jt} + \eta_2 S_{it} + \eta_3 ln(H_{it}) + \mu_1 X_j S_{jt} + \mu_2 X_i S_{it} + \mu_3 X_i ln(H_{it}) + \eta_4 S_{it} \times ln(H_{it}) + \delta_t + \delta_{ij} + \epsilon_{ij} \quad (3)$$

Where X_j and X_i are the spatial weighting matrices for sending and receiving locations, in both the international remittance model and domestic remittance model.

I use this specification to consider various measures of weather shocks and violence, different data on remittances, as well as extend the model to include time-varying economic factors in both sending and receiving states that may influence remittance flows but would generally be poor controls due to their correlation with the exogenous shocks.

4 Data

4.1 Dependent Variables

The main remittance data are from the Central Bank of Mexico, apply to an entire year and are available every year in millions of US dollars at the state level. These data only include international remittance and I use the data from 2010 to 2020. These data report the amount coming into each Mexican state but do not specifically note the source state (in the US). To address this, I begin by assuming that the share of the total remittances coming from each state j is the same as the share of migrants from i to j. For international remittances, I use the Matrículas Consulares (MC) data to construct migration shares from Mexican state i to US state j, which are provided publicly by the Mexican government, specifically the Institute for Mexicans in the Exterior (IME). Caballero et al. (2018) show that the data accurately represent migration from Mexico to the US. I use data from the years 2006 to 2009 (so prior to the period of study) and calculate the total number of migrants from state i in those years, and create the share of migrants for each ij pair ($\frac{M_{ij}}{\sum_j M_{ij}}$). I use pre-period data to protect against ongoing migration, which is likely also determined by the same factors that may determine remittances, affecting this calculation.

Using the migration share between ij, I take the total amount of remittances, multiplied by the pre-period migration share to assign values for the flow of remittances from sending to receiving states. For the international analysis, the sending state is always in the US and the receiving state always in Mexico. While some remittances into Mexico certainly come from countries besides the US, 98% of international remittances to Mexico originate in the US. Reducing all international flows by 2% would not make a difference in the results of the gravity model so for simplicity I assume all international remittances originated in the US. This approach may appear similar to a shift-share instrument where the share is the pre-period share of immigrants from i to j and the time-varying shift is each year's total recorded remittances to i. Instead of an instrument on the right hand side of the equation though, this the outcome variable for all models.

Assigning remittance flows to US states using just prior migration requires the assumption that remitting behavior is the same across destinations for immigrants from the same country. To validate this assumption I use data on total remittance flows from each US state to the entirety of Mexico to help validate my procedure. I don't use the US data directly as it suffers from the same issue as the data on total inflows for the Mexican states, is available for fewer years, and millions of dollars are unclassified each year, unlike the Mexican state data where all the remittances the bank observes can be placed in a state. Instead, I take the data I create using just migration shares and aggregate it up to the US state level so I have a data set that looks like the observed, US-based data. I compare the data for each year the observed data is available (2013-2020) and plot the actual versus imputed data in Figure 3. The green, dotted line is a 45 degree angle line that shows the expected trend if the imputed data exactly matched the observed data. As we can see, the imputed data is not terribly far off. In Table D1 I present results assigning remittance flows using these prior migration shares and they are entirely consistent with the main results in the next section.

Essentially, assigning remittance flows based on prior migration flow from i to j assumes remittance-sending behavior is similar for all migrants from i regardless of which US state j they settle in, thus making the share of total remittances flowing out of j to i equal to the share of total migrants to j from i. The correction addresses the fact that some US destinations may be different from others in ways that impact remittances. Thus, there is some condition in j that impacts remittance flows out of that state to any/all i. With the data available, I must assume that this affects all migrants from Mexico similarly, which is likely true for conditions like high cost of living, higher average wages, or access to banking, all of which could affect remittance flows and could affect all immigrants from Mexico in that US state similarly.

To adjust my imputed data I calculate the share of observed remittances coming from each US state for the 2013-2020 period and compare this to the same measure from the imputed data. For example, using just migration shares to assign flows, I assign about 36% of total remittances to California but the observed data only shows 31% of total flows originating in California. I calculate the difference between imputed and observed shares (-0.05 for California) and then return to the migration share data which includes shares for every ij pair. I add this difference to each migration share to obtain a "corrected" share of remittance flows. For example, 29% of all migrants from Baja California traveled to California so prior to the correction I would assign 29% of remittances received in Baja California to California but after the correction I assign 24%. Importantly, these shares still all sum to 1 since for every state I over-assigned remittances, there are others where I under-assigned flows. After the correction my data closely matches the observed data (Figure 4)[3].

I supplement this analysis with additional remittance data from the Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH), the main household survey in Mexico, provided by

[3]This procedure does result in negative assigned remittances but this is limited to very few state-to-state pairs (about 3%). I address this in three ways: 1) replacing negative flows with zero and then adding one to allow for a log transformation, 2) using the inverse hyperbolic sine transformation with the data as is, 3) dropping these flows. The results are robust to each method which I discuss in more detail in the next section.

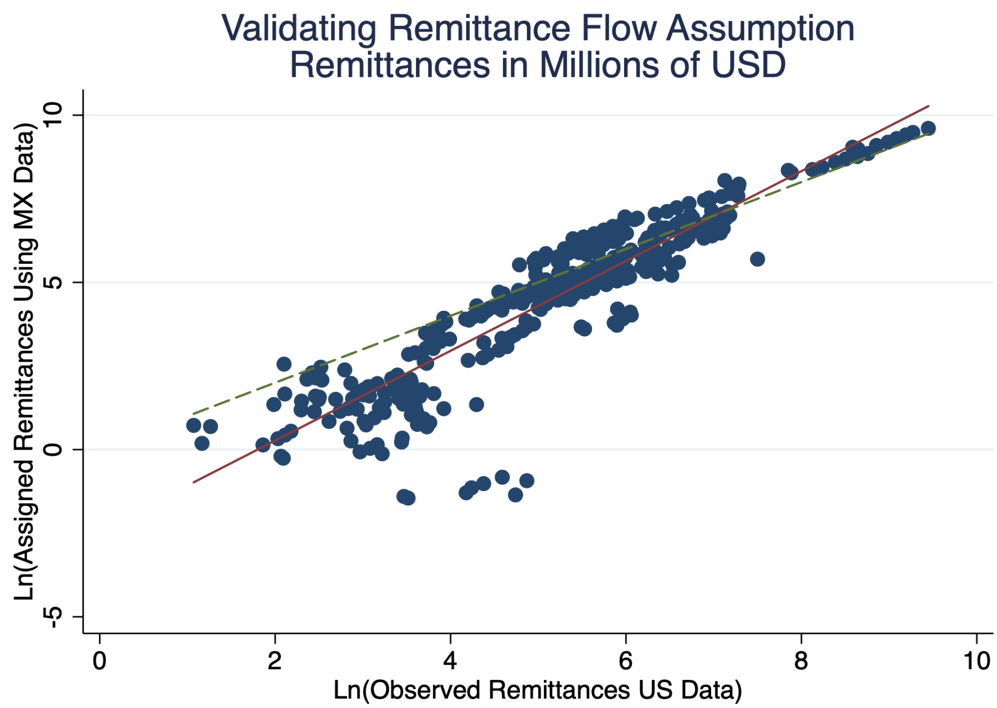


Figure 3: Comparing US Remittances Before Correction

INEGI, the Mexican statistical agency. This survey is conducted only every two years so I use the data from 2010, 2012, 2014, 2016, 2018, and 2020 and aggregate to the state level using the sampling weights provided in the survey. This survey includes both international remittances and household transfers within Mexico and will pick up remittances outside of the formal banking system which the main data may miss. International remittances are reported in their own column in these data. For domestic remittances I use the sum of monetary transfers and the imputed value of non-monetary transfers from household to household within Mexico, available in the ENIGH. These data specifically capture transfers that are not payments for goods or services, nor loans that the family is expected to pay back. These data are reported in pesos and correspond to just one quarter[4], rather than the whole year so I do not directly compare them to the Central Bank data

[4]The survey is conducted from late August to early November each year and the reference quarter is the three months prior to when the household was surveyed.

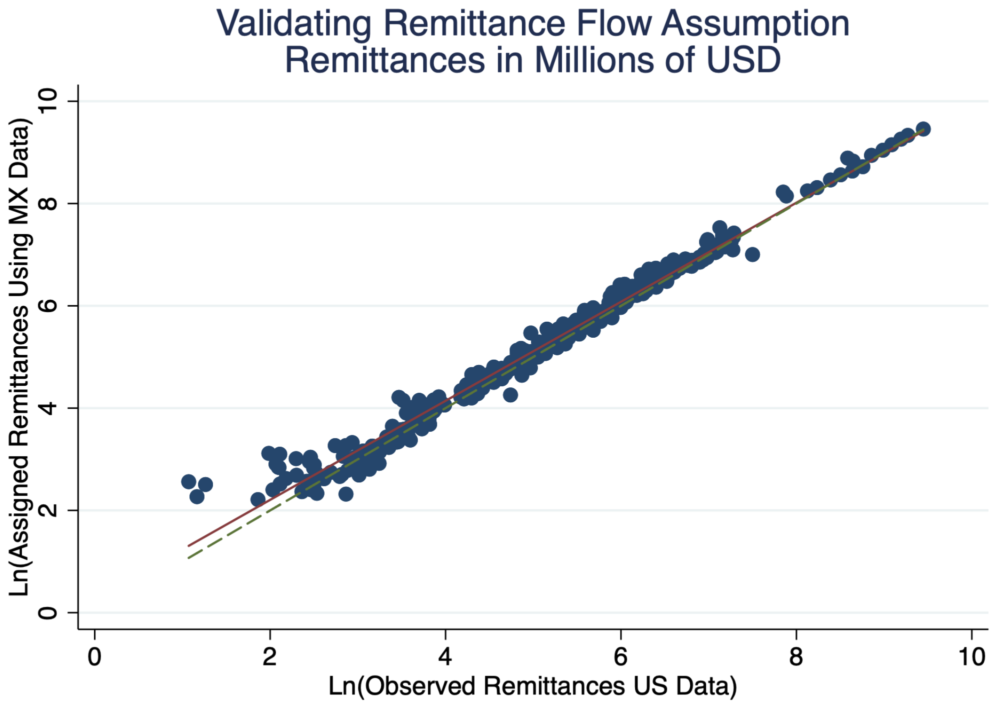


Figure 4: Comparing US Remittances After Correction

but rather use the household survey to extend the main analysis on remittances, climate change, and violence.

I use a similar process to assign internal transfers to ij pairs within Mexico. I use the 2010 Mexican Census (Available from IPUMS International, Ruggles et al. (2020)) to measure the share of migration between two states within Mexico from 2005 to 2009, using a question on where someone lived 5 years before the survey in 2010 to calculate total migration following the methodology in Jones et al. (2019). I include people who moved from one municipality within a state to another municipality within that state when calculating the migration share to account for the prevalence of within state migration and transfers but exclude this channel from the analysis since the state level drought and weather shocks would be the same for both sides of the remittance path. For this data I am not able to make the same adjustments as with the international data so the flows are assigned by just pre-period migration share. Table 1 presents the average remittance inflow at the state level each year. Figures A1, A2, and A3 present the spatial distribution of total remittance receipts in 2014. We can see that the household survey picks up slightly different patterns than the Central Bank data which may reflect differences in the use of formal banking services to make personal transfers.

Table 1: State Level Remittance Inflows

Year	International Remit. (Bank, Millions USD)	International Remit. (ENIGH, pesos)	Domestic Remit. (ENIGH, pesos)
2010	665.7	261845	1.579e+06
2011	712.6		
2012	701.2	95442	640176
2013	697.0		
2014	739.0	157058	1.203e+06
2015	774.5		
2016	843.5	854174	4.842e+06
2017	946.6		
2018	1052	1.068e+06	5.561e+06
2019	1139		
2020	1269	1.397e+06	6.883e+06

The ENIGH reports remittance flows from over three months in pesos while the Central Bank of Mexico records the data in US dollars and for the entire year. Authors calculations.

4.2 Independent Variables

For weather data in both countries I primarily use remotely sensed data on temperature and precipitation. The raw data comes from NASA's Daymet database and I use temperature and precipitation to calculate the 12-month Standardized Precipitation Evapotranspiration Index (SPEI) for states in Mexico and the US. The SPEI is a multiscalar index that neatly summarizes deviations in precipitation and temperature from long term means. I use the Hargreaves function to estimate potential evapotranspiration. The SPEI improves on the earlier Standardized Precipitation Index (SPI) by including the impact of temperature, which other studies have established is a crucial factor when discussing drought and water scarcity (Vicente-Serrano et al., 2010).

For both the US and Mexico I use the 12 month period from December in the year prior to

November to define a drought in the year[5]. I calculate the index using the R package "spei" from Beguería et al. (2014). A location has a drought if the SPEI is less that -1.5 (more than 1.5 standard deviations below the long term norm). Following the typical SPI (and SPEI) scale established in McKee et al. (1993), this corresponds to a severe drought. I choose this threshold as Mexico is a growing middle income country and people have been faced with the consequences of climate change for some time now so I would expect severe drought to have a greater actual impact on households who may have adapted to less severe droughts. I will also present results using less severe measures of drought. Figures 5 and 6 below provide a look at the distribution of the SPEI in 2014 for both the US and Mexico.

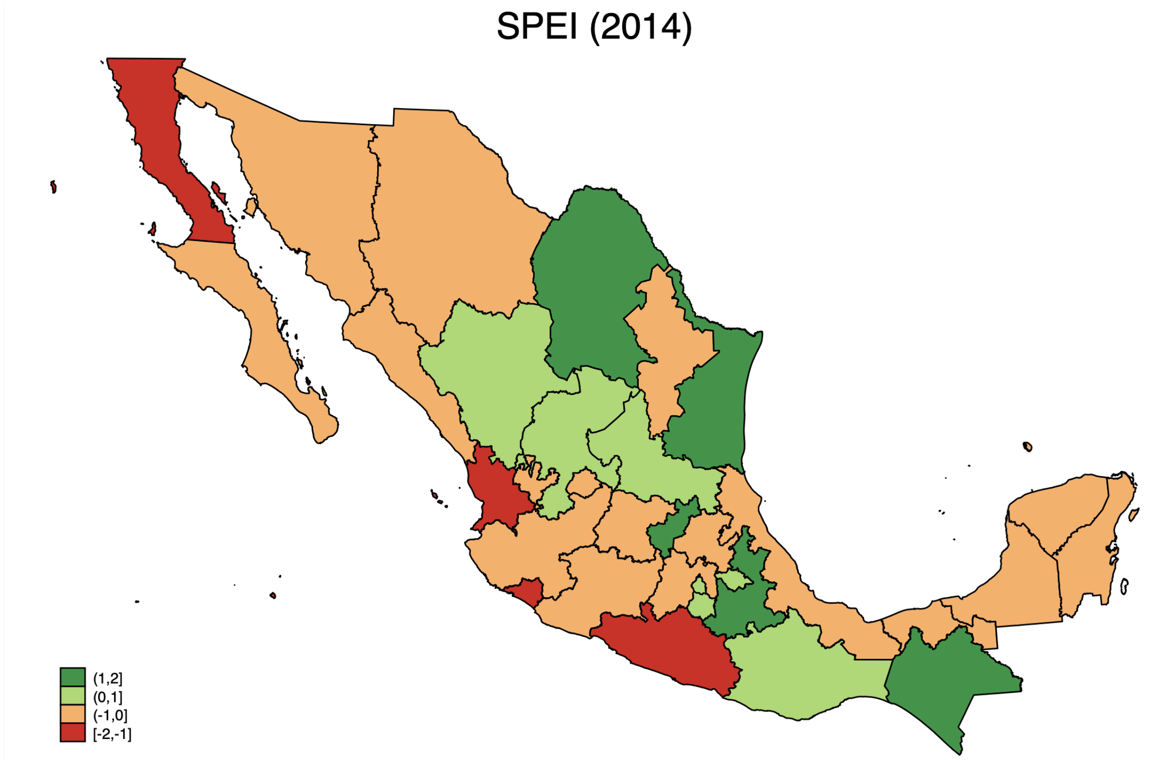
I supplement this measure of drought in Mexico using data from Mexico's drought monitor (Spanish acronym MSM), provided by the national Comission on Water (CONAGUA). The MSM uses a diverse set of weather related indices to determine the level of drought each month for five levels, D0 indicates normal rainfall, D1 is moderate drought, D2 severe drought, D3 extreme drought, and D4 exceptional drought. They use various indicators such as the SPI, vegetation health indices, the Leaky Bucket model capturing soil moisture, total rainfall and rainfall anomalies, measures of the amount of water above dams in the area and local expertise. Combining these various metrics experts determine the level of drought on the fifteenth of each month[6]. I use this data to create two measures of annual, state-level drought, which is reported at the monthly, municipal level originally. I first use an indicator for any severity drought in a month and then assign drought = 1 to a municipality that experiences six or more months of drought conditions in a year and assign the state a drought if 40% or more of municipalities meet this criteria. Figure A12 presents an example of the distribution of drought using this measure in 2014 and we see how it is similar but slightly different from defining drought using just an annual deviation in SPEI. I also replicate this measure but including only those months that reach at least D2 (severe drought).

For the international remittance models I also include data from the North American Drought

[5]The ENIGH data is collected from August to November so I choose this particular 12-month drought definition to try to allow as much of a full year between the drought and the remittances as possible. Since the Central Bank reports remittances for the entire year, this gives at least a month between a recorded twelve month drought and when the first remittances may appear in January

[6]Details at https://smn.conagua.gob.mx/es/climatologia/monitor-de-sequia/monitor-de-sequia-en-mexico

Figure 5: SPEI (2014)



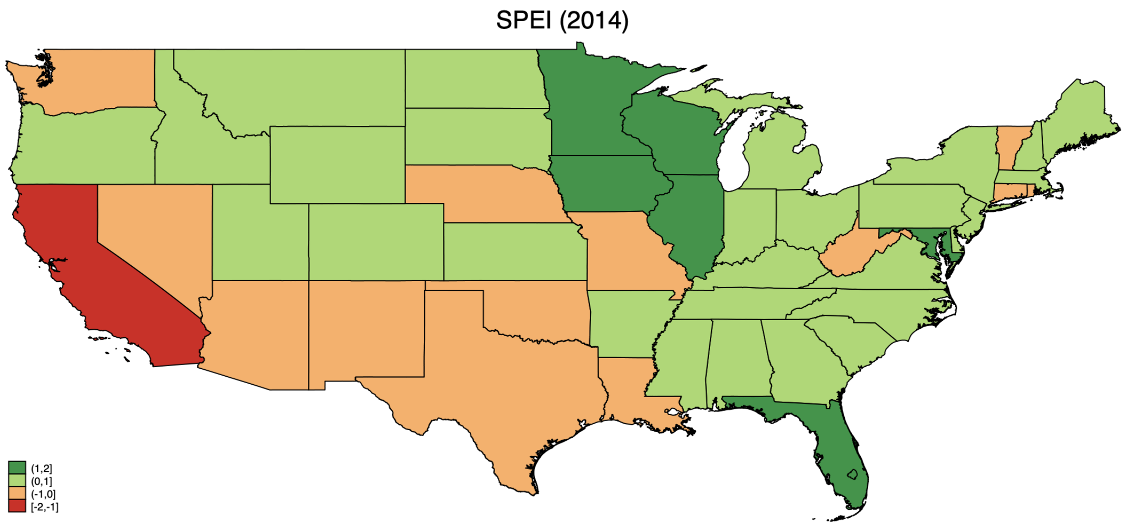
NOTE: Authors calculations based on remotely sensed temperature and rainfall data from the NASA Daymet data calculated using the "spei" R package from Beguería et al. (2014).

Monitor (the MSM derives their data from here)[7]. This data cover US and Mexican states and uses the same D0-D4 scale. I again need to aggregate monthly data to create a drought variable. I first assign a drought if over the course of a year, the average state area in drought is over 40%. This could be either five months of 100% drought conditions or twelve months of 40% drought conditions, for example. I again first include drought classifications from D1 through D4 then a more severe measure that includes D2 to D4. I am able to do this for both the US and Mexico. I also create a continuous measure of drought equal to just the average percent area experiencing drought in a state and year.

I gather state level homicide data from the national mortality statistics and crime rates from

[7] https://droughtmonitor.unl.edu/NADM/Home.aspx

Figure 6: SPEI (2014)

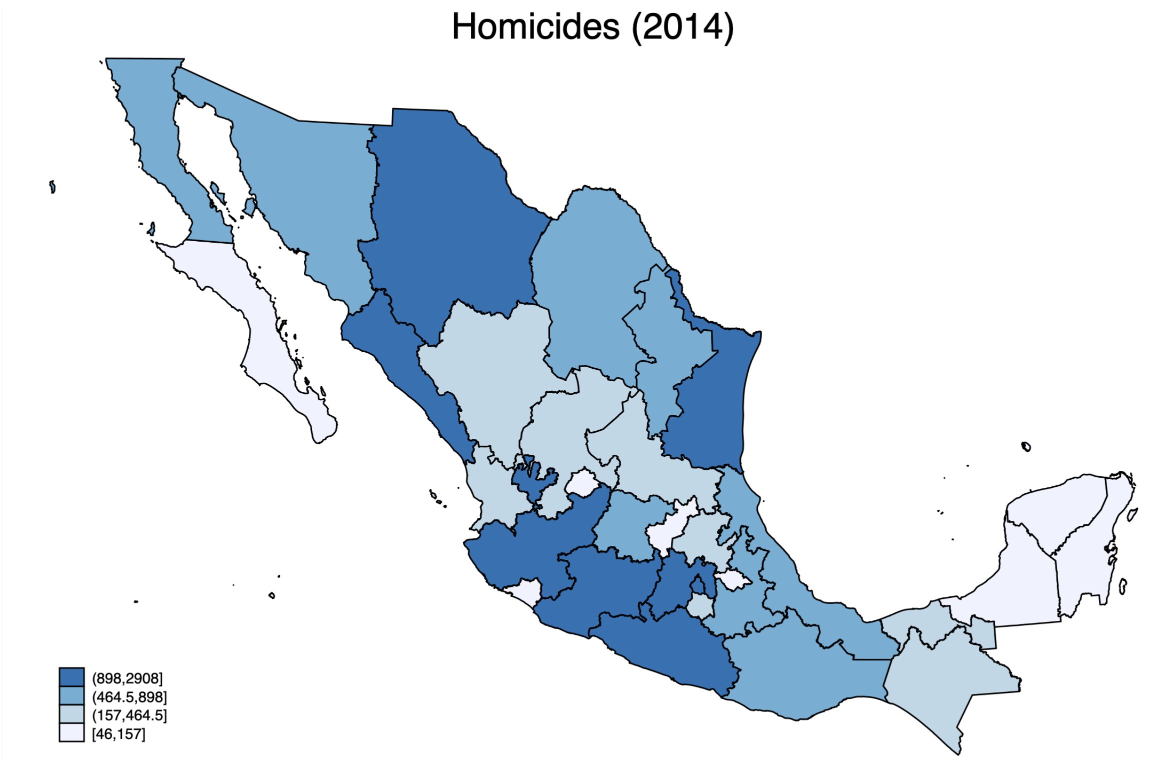


NOTE: Authors calculations based on remotely sensed temperature and rainfall data from the NASA Daymet data calculated using the "spei" R package from Beguería et al. (2014).

open government data on reported crimes in Mexico. I focus mainly on the homicides noted in the national mortality statistics as these are less likely to be impacted by reporting bias while police agencies may have more reason to misreport crimes and homicides noted. Figure 7 shows the distribution of homicides across Mexico. For some specifications I will use the number of cartels operating in that state based on information from the University of Maryland's Tracking Cartels project (Henkin et al., 2020). Increases in violence in Mexico largely stem from multiple cartels fighting over territory so having more cartels in the area is also a proxy for local risk of violence (Figure A17).

As additional measures of local violence or instability I include data from the open data on crime incidence published by National System on Public Security in Mexico. The data classification and aggregation system changed in 2015 but the old method was available through 2017. For the years 2009 to 2017 I use the older data and then 2018 and 2019 are based on the new method. I define violent crimes to include homicide, sexual assault, threats, injuries, extortion, kidnapping, and any other crime noted as occurring "with violence" such as armed robbery. As these data

Figure 7: Total Homicides (2014)



NOTE: Total homicides per state reported in National Mortality Statistics and accessed through INEGI.

are from police reports, homicides may differ from the data provided by the national mortality statistics slightly if there are incentives to under report certain crimes.

Lastly, the main models control for predicted state populations for both the US (Federal Reserve Bank of St. Louis, FRED database) and Mexico (Government Statistics) as more populous states are likely to send more immigrants and receive more remittances. Since I control for predicted populations I do not convert remittances or homicides into per capita measures. For additional controls in the robustness checks, I gather real GDP, the value of agricultural production, and public spending for each Mexican state from INEGI, the Mexican statistical agency. For the US, I collect state-level real GDP from the BEA and the value of agricultural production for the USDA ERS.

Table 2: Summary Statistics of Key Variables

Year	MX States % SPEI < -1.5	US States % SPEI < -1.5	MX States % SPEI < -1	US States % SPEI < -1.5
2009	0.0312	0	0.250	0.0196
2010	0	0.0196	0.0312	0.0392
2011	0.125	0.0980	0.344	0.157
2012	0.0312	0.137	0.156	0.490
2013	0	0	0.0938	0.0588
2014	0.0625	0.0196	0.125	0.0196
2015	0.0312	0.0196	0.0938	0.0980
2016	0.0938	0.0392	0.281	0.157
2017	0.125	0.0196	0.406	0.0588
2018	0.125	0.0392	0.219	0.0588
2019	0.344	0	0.594	0
Year	MX States % CONAGUA Drought (D1-D4)	MX States % CONAGUA Drought (D2-D4)	MX State Avg. Total Homicides	US State Avg. Total Homicides
2009	0.406	0.188	618.8	301.9
2010	0.188	0.125	804.9	288.7
2011	0.469	0.344	850.3	287.5
2012	0.188	0.125	811.3	291.3
2013	0.0312	0	720.4	280.8
2014	0.0625	0.0312	625.3	277.7
2015	0.0312	0.0312	648.8	311.2
2016	0.0625	0.0312	767.5	341.4
2017	0	0	1002	339.1
2018	0.188	0.0625	1146	321.1
2019	0.312	0.0625	1145	326.8

Authors calculations. Droughts based on SPEI are calculated using the R ”spei” package (Beguería et al., 2014) and rainfall and temperature data from the NASA Daymet data. Major storms are reported in the EMDAT database. Homicide data is from Mexico's National Mortality Statistics reported by INEGI. Droughts with drought conditions D1 through D4 reflect droughts based on data from the Commission on Water (CONAGUA) which classifies municipal level droughts for all of Mexico on a scale of D1 (moderate) to D4 (exceptional). I assign a state a drought if more than 40% of municipalities experience six months of drought conditions, either including or excluding D1, that year.

4.3 Identification

I take advantage of the wide variation across fifty US states plus D.C. and thirty-two Mexican states, and multiple years of data to identify my results after controlling for the fixed time and state-pair factors. Controlling for state-to-state pairs not only helps to account for fixed, unobservable characteristics impacting remittance flows in each individual sending and receiving state but also controls for features like network effects between two areas which likely impact the size of prior migration and remittance flows.

To identify the total impacts of weather and violence on remittances I rely on exogenous weather shocks and homicide rates. Weather is plausibly exogenous and I use metrics that account for general differences in climate across regions so each state's shock is defined relative to its own typical weather. For homicides I use a one year lag to address concerns that remittances may directly impact homicide rates if money makes people a target. Generally, this is unlikely as theft may increase if more people have more money but homicides are more likely to be driven by trends in drug trafficking and organized crime. Remittances may increase crimes like armed robbery and thus be endogenous but homicides are less likely to be caused by an increase remittances, especially if a criminal intends to rob or extort someone again in the future.

Homicides are potentially a "bad control" in the sense that drought may impact homicide rates as people become increasingly desperate or if cartels consolidate control by taking advantage of vulnerable populations. Existing research finds mixed impacts of weather shocks on conflict (Koubi, 2019; Adaawen et al., 2019; Maystadt and Echer, 2014) but news reports discuss how cartels in Mexico have used recent droughts to their advantage (Nigthoujam, n.d.). Weather shocks could increase criminal violence if, in desperation, people increase their contact with non-state criminal organizations. Violence could also increase if new areas for illicit profit appear, such as stealing water and reselling it at a high price, and increase cartel presence or competition. If weather shocks induce violence and violence has a negative impact on remittances, then main results studying just the impact of weather would be biased towards zero but this is an important net impact of drought on remittances. Controlling for violence and interacting violence with the weather shock helps untangle these relationships and ask, given a particular level of drought, how does local risk of violence affect remittance flows and how does this compare to non-drought areas. Tables A1, A2 show that key variables of interest are well balanced across high homicide and low homicide states so it's unlikely some underlying pattern of violence or selection into violence (so to speak) is driving the results.

It is also possible that remittance flows change future migration patterns and since I use migration shares to assign the remittance flows this could potentially confound results. I therefore use migration flows from years before my period of interest (2006-2009) to calculate the migration share and then use this weight to assign remittance flows in each of the years of interest. Due to strong network effects, migration patterns from Mexico to the US are often quite stable across time so it is unlikely that the migration share from i to j or within Mexico changed dramatically from 2006-2009, to 2020. Figure A4 shows the very strong correlation between migration shares between pairs in 2006-2009 to migration share between pairs in 2015-2019 so this assumption seems reasonable. One potential issue may be that if migration flows from one state to another did change over this time period or there was substantial outmigration from a particular area back to a particular state then I would incorrectly assign the size of the remittance flow. The results are also robust to controlling for contemporaneous migration rates (Table D5).

5 Results

Table 3 considers just the impact of drought in sending and receiving states on remittance flows. The first column controls for the impact of drought in neighboring states while the second does not. On the receiving side, experiencing a drought significantly increases remittance flows. Experiencing a drought increases remittances into that state by about 2.6%. Given that the average size of these flows is over 700 million US dollars, this is not a small amount of money. Though people may already remit as much as they can, leaving little room to adjust further, I find robust evidence that migration and remittances help households offset losses due to drought in Mexico. I do not find evidence that drought in sending states reduces remittance flows. People may migrate specifically because they are looking for jobs that are less weather dependent and thus are able to continue providing remittances even when faced with their own drought shock.

In Table 4 I conduct similar analysis considering only the impact of violence on remittance flows. Violence in the receiving state reduces remittances by about 0.05% to 0.1%. Comparing columns one and two, I note that results are similar whether including spatially lagged controls but there is impact on both the estimated effect of violence and the amount of variation the model explains. I investigate that further in the next section.

If droughts increase violence and instability, which lowers remittances, then the results in Table 3 are attenuated by this, which we observe with the smaller coefficients in this table compared to the results in Table 5. As a check, Table A4 shows that drought in US states connected to Mexican states by prior migration does not impact homicides in Mexican those states. Drought in a Mexican state state has a positive though insignificant relationship with violence in that state, in line with the literature's inconclusive findings on weather and violence. It would be interesting to study this phenomenon further in the case of Mexico but that is beyond the scope of this paper. For now I will allow that it is possible drought is correlated with higher rates of violence in my data. By controlling for both drought and violence in Table 5, I show the impact of drought on remittances outside of its impact through the violence channel and the direct impact of violence.

The main results demonstrate the impact of drought and violence, proxied here by homicides, on remittance flows into Mexico. All results include controls for weather and homicides in neighboring states. I also include additional data on remittances from household surveys in Mexico (the ENIGH) to support the main results in column 1 and include any remittances made domestically and/or outside the formal banking system. First, drought in the receiving state has positive and significant impact on international remittances. Having a drought increases international remittances recorded in the Central Bank data by about 15%. Remittances recorded in the ENIGH are even more responsive though this may be a feature of non-classical measurement error. Cervantes González and Jiménez Torres (2023) highlight that the household survey underestimates remittances from abroad by up to 92% and that this error is getting worse over time, so recent years suffer from greater error. The large result seen may be due to just the 2011 drought at the beginning of the sample period. The error also appears worse in certain states for no predictable reason. Remittances to wealthier households are also much more likely to be recorded in the ENIGH so if wealthy households report differently and experience migration, remittances, and drought in fundamentally different ways than other households, these results may be affected by this survey error. Overall, I interpret these results with caution and just highlight that they are consistent with the main results using the Central Bank data.

Violence in receiving states has a consistent negative impact on all remittance flows. A 1% in-

Table 3: Impact of Drought on Remittances

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought	0.0259***	0.0205	-0.0120
	(0.0051)	(0.0201)	(0.0143)
Sending Drought	0.0045	0.1007*	-0.0007
	(0.0052)	(0.0539)	(0.0169)
Within R^2	0.04427	0.02464	0.06818
Observations	17,952	9,792	5,952
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional, US to Mexico) in the state pair and year, recorded in US dollars. Fewer than 5% of flows are zero but to use the natural log specification I add 1 to all flows before taking the log. A state has a drought if the SPEI is less than < -1.5. All models control for spatially lagged drought measures, which is the average drought experience of the three nearest neighbors based on straight-line distance between centroids. Models 1 and 2 are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. Standard errors are clustered at the pair level. Column 3 is estimated on a balanced panel of 992 Mexican states pairs, excluding the own state pair, and standard errors are clustered at the state level.

crease in homicides, controlling for state population, reduces international remittances by 0.04 to 0.08% and domestic remittances by 0.03%. The interaction term between drought and homicides also shows that for two states with similar drought experiences, greater risk of violence significantly decreases remittances into that state, which may have been critical for households coping with the drought shock. Finally, remittance flows respond to conditions in receiving states but not sending states. Interestingly, this is true for both domestic and international flows so it appears remitting behavior is largely based on the family at home rather than the migrant's experience.

Lastly, Table 6 supports these results by evaluating the remittances response to drought in subsamples of states with different numbers of cartels as shown in Figure A17. The positive impact of receiving drought on remittance flows is entirely concentrated in states with fewer than four

	Ln(Remittances, bank)		Ln(Remittances, ENIGH)	
	Int.	Int.	Int.	Dom.
	(1)	(2)	(3)	(4)
Ln(Receiving Homicides)	-0.0423***	-0.0583***	-0.1032***	-0.0360***
	(0.0032)	(0.0037)	(0.0199)	(0.0099)
Ln(Sending Homicides)	0.0032	-8.64×10^{-5}	0.0326	-0.0021
	(0.0083)	(0.0087)	(0.0430)	(0.0133)
Within R^2	0.09788	0.07457	0.03056	0.09071
Observations	17,952	17,952	9,792	5,952
Pair fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Population Controls	✓	✓	✓	✓
Spatially Lagged Controls	✓		✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in models 1 and 2 is the natural log of remittance flows (unidirectional) in the state pair and year recorded by the Central Bank of Mexico. Column 2. Columns 3 and 4 use remittances recorded in the ENIGH. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Column 1 includes controls for spatially lagged independent variables and column 2 does not. Columns 3 and 4 evaluate the impact of drought on homicides in Mexican states; a state has a drought if the SPEI is less than < -1.5. For columns 1- 3, models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. Standard errors are clustered at the pair level. For column 4 the model is estimated on a balanced panel of 992 Mexican states pairs, excluding the own state pair, and standard errors are clustered at the state level.

Table 4: Impact of Violence

cartels operating.

These initial results intentionally control for very little, using just the exogenous variation in weather and homicides to estimate the total impact of the shocks on remittance flows. This includes a direct weather impact plus the impact of changes in the economy and stability that follow from the weather shock. It's important to understand the total impact of weather shocks on remittances given the potentially competing forces.

Remittances can help cope with drought but high risk of violence could prevent this. Where drought and higher rates of violence are present, the impact of violence is even more negative, as seen by the significant negative coefficients on the interaction term. Taking violence into ac-

Table 5: Impact of Drought and Violence on Remittances

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought	0.1420***	0.9484***	0.0076
	(0.0219)	(0.0782)	(0.0429)
Sending Drought	-0.0222	0.2516	-0.0010
	(0.0188)	(0.2493)	(0.0801)
Ln(Receiving Homicides)	-0.0413***	-0.0784***	-0.0340***
	(0.0033)	(0.0199)	(0.0096)
Drought X Ln(Receiving Homicides)	-0.0172***	-0.1443***	-0.0042
	(0.0032)	(0.0117)	(0.0072)
Ln(Sending Homicides)	0.0033	0.0275	-0.0021
	(0.0083)	(0.0427)	(0.0135)
Drought X Ln(Sending Homicides)	0.0052	-0.0292	0.0001
	(0.0035)	(0.0468)	(0.0117)
Adjusted R^2	0.99858	0.92480	0.96720
Within Adjusted R^2	0.10303	0.03858	0.09107
Observations	17,952	9,792	5,952
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table 6: Impact of Drought in States with More Cartels Operating

	Ln(International Remittances, bank)	
	(1)	(2)
	Fewer than 4 Cartels	4 or More Cartels
Receiving Drought	0.0563***	-0.0036
	(0.0078)	(0.0059)
Sending Drought	0.0027	0.0063
	(0.0080)	(0.0063)
Within Adjusted R^2	0.03845	0.06049
Observations	8,976	8,976
Pair fixed effects	✓	✓
Year fixed effects	✓	✓
Population Controls	✓	✓
Spatially Lagged Controls	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional, US to Mexico) in the state pair and year, recorded in US dollars. Fewer than 5% of flows are zero but to use the natural log specification I add 1 to all flows before taking the log. A state has a drought if the SPEI is less than < -1.5. Both columns control for spatially lagged drought measures, which is the average drought experience of the three nearest neighbors based on straight-line distance between centroids. All models are estimated on a balanced panel of state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020, subsetting the data based on the number of cartels in the receiving Mexican state. Standard errors are clustered at the pair level.

count also increases the amount of variation the model explains (outside of the impact of the fixed effects) substantially, implying this is an important part of the story. Using a Shapley-Owen decomposition, I find that violence-related variables (including the interaction between drought and homicides) explain about 43% of the variation not explained by the fixed effects while the drought-related variables in both sending and receiving states explain about 3.6%. Violence is clearly an important factor determining remittances into Mexico. Remittances offer a vital tool to offset losses due to drought worsened by climate change but continued violence in Mexico appears to prevent families from taking full advantage of this strategy.

5.1 Spillovers, Network Effects and the Timing of Shocks

My empirical method also allows me to investigate the impact of drought or violence in neighboring states on local remittances. Table B1 shows that the results are consistent when excluding the spatial controls altogether but that including these controls is important to explain the variation in the model and to accurately measure the direct effect. Table B2 shows that more drought in the three states that neighbor a receiving state increase remittances in the state including for domestic remittances, where I otherwise find no direct impact of drought. For households close to state borders, droughts in commuting zones may negatively impact the family, thus leading to a greater dependence on remittances. Similarly, if goods markets, especially for food, are regional, drought in nearby states could raise prices again negatively impacting the family's consumption and increasing remittances. Widespread drought could also spread any government response thin across the different locations. Overall, the spillover effect augments the main effect I find of drought on remittances and suggests that systemic approaches to climate change adaptation that incorporate all of Mexico may be much more beneficial than each state implementing individual policy plans.

I similarly find that violence in neighboring states augments the main impact of violence on remittances. Higher homicide rates nearby significantly decrease remittances into the receiving state. Many cartels, particularly the major actors in Mexico, cross state boundaries so the zone affected by similar violence is not contained to one state. Particularly for households near the border, violence that occurs across a state line may affect them. This finding may also reflect the idea that the negative impact of violence on remittances is a result of especially powerful violent actors and organized crime creating a generally unsafe and uncertain environment. This type of atmosphere comes from the control cartels have over swaths of territory, rather than more random crime that may pop up in a place and time. Highlighting these spillovers again motivates certain policy prescriptions. There are many obvious consequences of organized crime and these results only add to the call to introduce an effective strategy to address violence across Mexico. Reducing violence can not only increase remittances into a state but a coordinated effort in all states can multiply this effect by also reducing the spillovers.

As a second check, I repeat this analysis but instead of weighting the three nearest neighbors by $\frac{1}{3}$, I create a spatial weighting matrix that includes all other states within the country, weighted by their inverse distance in kilometers, normalized so that the sum of the weights still equals one. In Table B3 I find highly consistent results for the spillover from violence in other states. I find mixed evidence on the direction of drought spillovers. In the Central Bank data, the spillover is negative and significant but the main impact of drought in remittance receiving states is bigger, while in the household survey data I find a positive impact of drought in neighboring states along with a larger main impact. Drought across all of Mexico may trigger a uniquely large government, and perhaps international, response, decreasing the need for remittances or their may be some interesting non-monotonicity in spillovers from states that are nearby. Drought in a neighboring state could reduce remittances if one migrant is sending money to family in both states. If certain neighboring states are more closely tied than other neighbors, giving each neighbor the same weight may incorrectly value to closeness of two neighbors. Distance, though, also does not necessarily imply economic closeness. Exploring the exact nature of these neighborhood ties is beyond the scope of this work but would be very interesting to dig into.

As with the main results, I find very little reaction to violence and drought in remittance sending states although there is some evidence that increased violence in neighboring states can spillover and reduce remittance flows out of US states. This holds for both weighting schemes. Overall, I find that remittances respond to changing conditions in Mexico and including spatially lagged control variables helps accurately estimate the main impact of a spatially dependent variable while also providing some insights into the spillover effects and suggesting potential avenues for future research into the economic relationships of neighboring states in Mexico.

By using bilateral remittance flows I am also able to address the role networks play in determining remittances. A state-level fixed effect for both the sending and receiving states would account for fixed, unobserved characteristics of that state that impact remittance flows but the state-pair fixed effect also capture factors that may be unique to a specific network. For example, immigrants from Michoacán in California may be different from immigrants from Michoacán in Illinois and this could impact remittances. To measure this, I run identical specifications to the main model but use separate state fixed effects rather than the pair. As expected, the actual impact of violence and drought remains the same but the importance of networks is evident in the change in R^2. Table B4 demonstrates the large decrease in explained variation when I remove the pair effect. I compare this table to the results in Table 5 and find that the total R^2 falls by close to 50 percentage points demonstrating the important these network specific characteristics are.

This improves our understanding of remittance behavior showing that networks play a substantial and important role. Prior work has highlight the role of networks in migration flows so it is not surprising that networks also impact remittances but estimating the size of this network effect is informative. This therefore motivates including controls for networks in remittance research as well as future work into the formation and evolution of these networks themselves.

Lastly, while this work primarily focuses on the short-term impact of and response to drought and violence, I find that these results persist for at least two years. Table B5 demonstrates that a drought two years prior has a positive, significant impact on international remittance flows and when considering two droughts in a row, both have a positive and significant impact. The negative impact of a spike in violence also holds for shocks two years prior as does the coefficient on the interaction between drought and violence. I again do not find evidence that remittances respond to drought or violence in sending states. I do not find evidence that contemporaneous drought increases remittance flows suggesting it takes at least some time for households to feel the effect of drought and for money to change hands. I find that contemporaneous drought has a negative impact on remittances which may reflect a few possibilities. First, I am unable to also include contemporaneous violence due to the potential reverse causality but if drought in the current year increases violence that I do not control for, the negative impact I find of drought may be reflecting that. Second, families may begin to notice or feel the impact of the drought after a few months and go to other coping strategies first, perhaps asking family abroad to reduce remittances in the short term to save up for a bigger transfers when the household really needs it. Overall, I find that the main results persist for two years and future work could investigate the long term impacts of drought and violence on migration and remittance flows in Mexico.

5.2 Robustness Checks

These results are robust to using alternate measures of drought including defining drought as an SPEI less than -1 rather than -1.5 (Table C1), using drought measures providing by CONAGUA rather than calculated using remotely sensed weather data directly (Table C2), using state-area measures of drought provided by the North American Drought Monitor both to create a dummy for drought (Table C3) and as a continuous measure of the average state area experiencing drought (Table C4).

Key results are also robust to using violent crime as a proxy for violence rather than homicides (Table D10). One difference for the models using crime in the receiving state is that violent crime alone has a positive impact on remittances though the interaction term with drought is negative. It may be that high reported crime is seen as a sign of effective policing. This data also relies on police reports, publicly available from the government of Mexico. It is possible that crime is under-reported and thus the data does not reflect the true violence of an area. I also must define crimes in the data as violent and there were changes to the reporting system in 2017 thus the crimes are categorized slightly differently for later years. I define violent crime as sexual crimes, homicide, kidnapping, injuries, extortion, threats, and anything ”with violence” but it is possible that this is picking up many robberies. There may also be more reverse causality driving this result if remittances increase theft but not an overall situation of instability, which is in line with Mahesh (2020) who finds that remittances increase nonviolent crime.

Since I use a log transformation of the dependent variable which does include a few (fewer than 4%) zero observations, I add one to each flow in the main analysis. To show that this is not driving results nor are a few observations at the low extreme, I replicate the analysis using the inverse hyperbolic sine transformation, which allows for zeroes, and run the main specification excluding zero flows. The results in Tables D3 and D2 are essentially the same to the main findings, showing the results are not driven by the data transformation or the few zero flows. In Table D4 I exclude potentially overly influential states such as California, with very high levels of migration, and Montana, with very low levels of migration and again these confirm the main results.

I also address whether changes in contemporary migration are driving results. The state-pair and year fixed effects should control for most migration that may be driven by network effects or other fixed origin and destination conditions, or annual changes in conditions but I also control for annual migration rates along each state-pair using the Matrículas Consulares data. Table D5 shows that the direct impact of prior year migration on international remittance flows is a tight zero and all the key results are virtually unchanged.

I take two approaches to address concerns about creating state-to-state flows out of the raw data. As discussed in section 4.1, the international models are consistent when using just prior migration shares to assign remittance shares to US states (Table D1, also recall the domestic models always assign flows this way). I also run a basic model just examining the impact of drought and violence on total remittances into each Mexican state, ignoring the impact of different sending states (Table D6). For this analysis I am able to expand the years of data to include 2003 to 2020 for the Central Bank data and 2008 to 2020 for the ENIGH. The results are again consistent with the other findings though I lose significance in some cases and have far fewer observations.

Following the climate literature, I have intentionally excluded controlling for other economic conditions that may impact remittances and may also be impacted by drought and violence. The main results are unchanged when I control for receiving state government spending, which may be particularly important during a weather shock (Table D7), sending and receiving state GDP (Table D8), and the value of agricultural production normalized by GDP in sending and receiving states (Table D9).

6 Conclusion

For decades households in Mexico have used migration as a strategy to diversify income streams, which may be particularly important now as families face more frequent and more severe droughts, and high risks of violence. In this paper, I study how remittance flows respond to drought in Mexico and whether violence mitigates this potentially important coping strategy. I use bilateral, domestic and international remittance flows to Mexican states to address the question at a sub-national level and account for spillovers from neighboring states in both sending and receiving areas.

I find that experiencing a drought increases remittances in Mexico but that this effect is larger and significant only for international remittances suggesting past immigration to the US provides critical support during drought that internal migration may not be able to provide. Upon migrating, I find no evidence that drought or violence in the sending state impacts remittances, highlighting the value of migration as an informal insurance strategy. These results are robust to different specifications and drought measures.

Regarding violence, I find that an increase in homicides decreases remittance flows into a state. I also find that for two states experiencing drought, a state with a greater risk of violence receives significantly less money in remittances. I find that homicides reduce international remittances by about 0.05% and domestic remittances by about 0.034%. Drought increases remittances by 15% but high homicides in a drought-affected area continues to reduce remittances. Additionally, the widespread nature of violence increases the impact in local areas. I find that high homicide rates in neighboring states also decrease remittances.

Due to anthropogenic climate change, drought conditions will only worsen in Mexico and in many parts of the world that still rely on rain-fed agriculture. Migration provides a chance to diversify incomes across sectors and across climate zones which can in turn help households insure themselves against drought but this is far from a perfect solution. First, climate change is a global phenomenon and thus not all destinations and jobs may be protected from climate shocks. Second, I find that international remittances primarily respond to drought in Mexico but increasingly strict immigration enforcement and the very dangerous journey may prevent many people from using this strategy. Net migration between Mexico and the US is falling which may mean future generations will rely less on remittances as informal insurance. This can also have distributional impacts if lower-income people are less able to make the expensive international journey. Low income people who lack access to formal banking and work in the agricultural sector may be more reliant on remittances as a strategy to cope with drought. Harsh immigration policy and hostile attitudes in the US make it more difficult for both new and existing immigrants from

Mexico to work in the US, potentially cutting off income diversification strategies that low-income households rely even as weather shocks become more severe.

Additionally, violence not only has a direct impact on people's well-being but I find that it can indirectly hurt a local economy by preventing remittance inflows. When discussing the cost of organized crime in Mexico, it will be important to not just account for the direct impacts on human life and the economy, but the many ways ongoing cartel activity harms families in Mexico. Remittances were equivalent to 4% of Mexico's GDP in 2022 so any disruption due to violence is quite costly.

These results offer a few policy implications. Expanding coverage and access to drought insurance may help farmers and others who rely on water directly, while improving irrigation may also help farms withstand drought and keep food prices lower. One caveat to expanding irrigation is that extreme drought in Mexico and across the world has impacted lakes, rivers, and water tables as well. The stress of expanding irrigation on water reserves may offset the potential gains. Improving access to credit and formal banking may also help some households cope with weather shocks without relying on remittances. Safe, reliable ways to send and store money may also help families, particularly in unstable areas, make the most of remittance dollars. Proactive policies to mitigate the impact of climate change may reduce household's need to find alternative coping strategies. Developing policies to respond to weather shocks and adapt economies ahead of disasters are important and reducing criminal violence should be included in climate policy discussions. Improving public safety not only has a general benefit to the local community, but these results suggest it is also an important part of building resilience to climate change. That higher homicide rates in neighboring states also augment the impact of local violence motivates systematic efforts to promote public safety across state lines and address regional violence associated with cartel territories.

Future work could expand this analysis to other shock-prone areas affected by conflict, especially to compare state-led and criminal violence. There is also more work to be done on the distributional impacts of imperfect insurance markets in the face of climate change. This work focused on state-level patterns but examining how households respond to weather shocks and are impacted by violence will improve our understanding of the relationship between climate, violence, and remittances and provide more ideas for policy. Experimental methods may also help identify specific policy prescriptions. There is a growing body of work on climate change and migration and remittances are an important part of that story.

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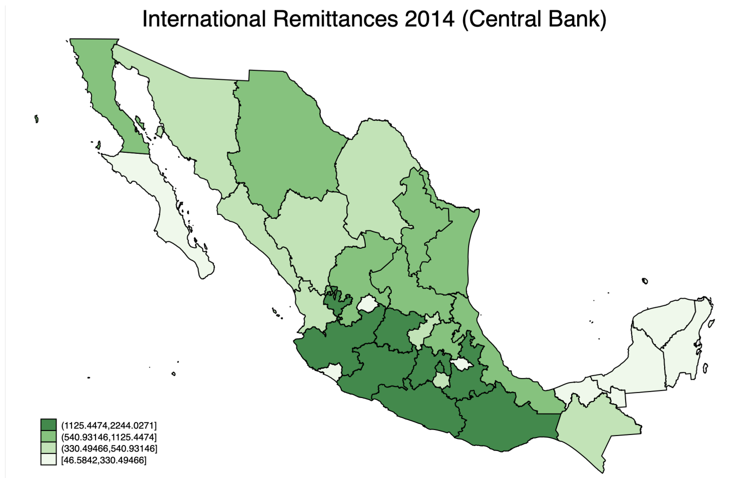
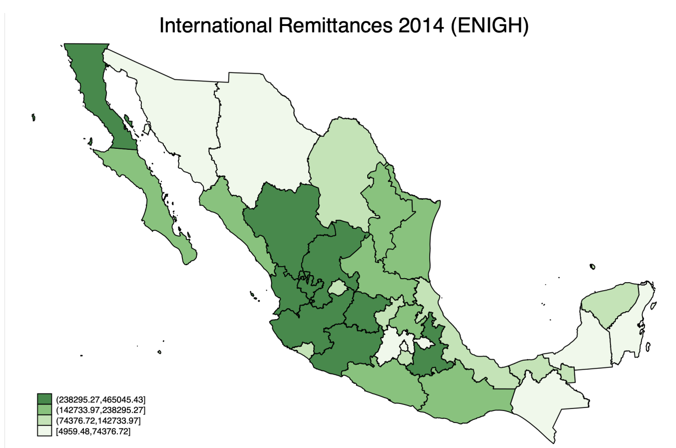
Figure A1: International Remittances



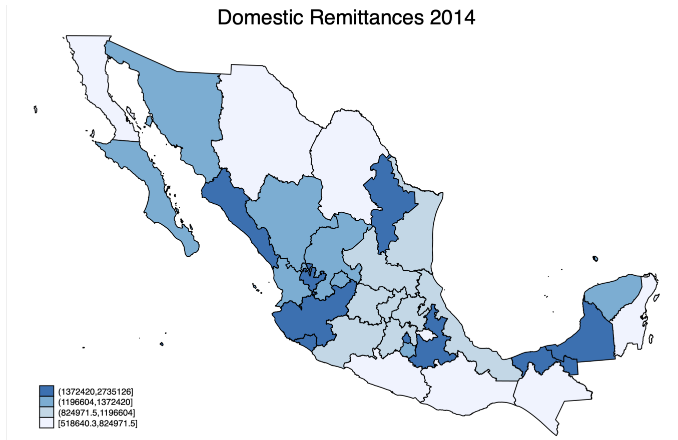
NOTE: Total remittance flows into each state as reported in by the Central Bank of Mexico, in millions of dollars, for the year 2014.

Figure A2: International Remittances



NOTE: Total remittance flows into each state as reported in the ENIGH, in pesos, over a three month period in the year 2014. The survey is collected between August and November and asks recipient about remittances in the three months prior to the survey date.

Figure A3: Domestic Remittances



NOTE: Total remittance flows into each state as reported in the ENIGH, in pesos, over a three month period in the year 2014. The survey is collected between August and November and asks recipient about remittances in the three months prior to the survey date.

Appendix A: Data Appendix and Figures

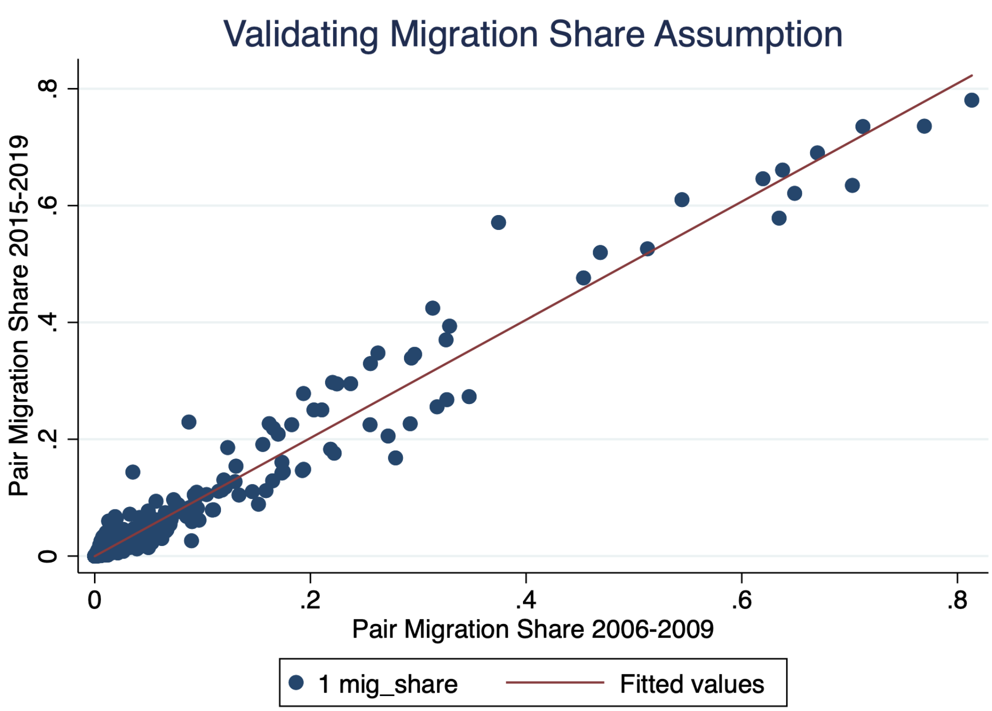
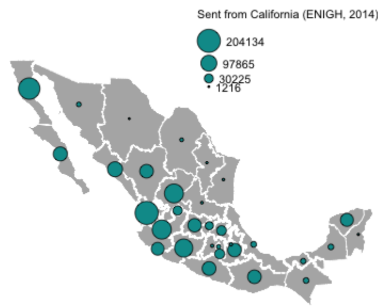


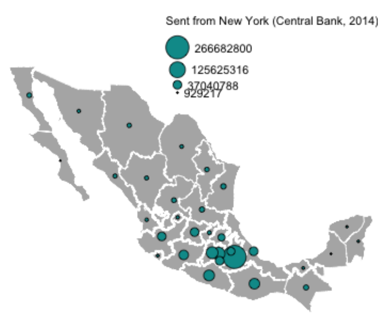
Figure A4: Correlation Between Pair Migration Shares Over Time

Figure A5: Remittance Flows from California (ENIGH)



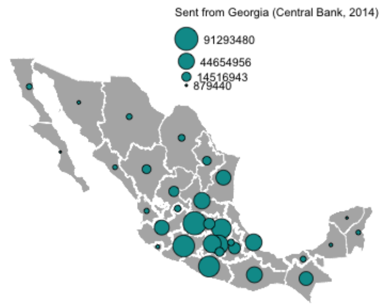
NOTE: Authors calculations based on remittance data from the ENIGH and historical (2006-2009) migration shares from Mexican to US states from the Matrículas Consulares data.

Figure A6: Remittance Flows from New York



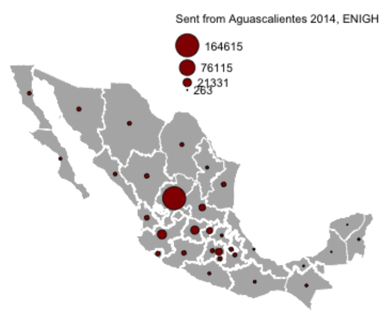
NOTE: Authors calculations based on remittance data from the Central Bank of Mexico and historical (2006-2009) migration shares from Mexican to US states from the Matrículas Consulares data.

Figure A7: Remittance Flows from Georgia



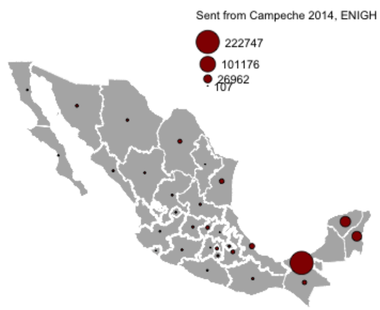
NOTE: Authors calculations based on remittance data from the Central Bank of Mexico and historical (2006-2009) migration shares from Mexican to US states from the Matrículas Consulares data.

Figure A8: Remittance Flows from Aguascalientes



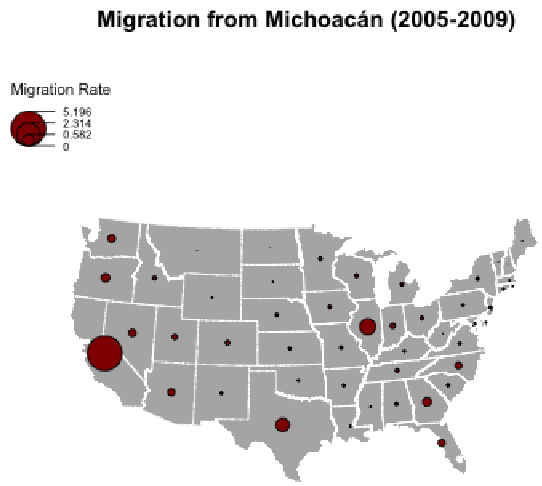
NOTE: Authors calculations based on remittance data from the ENIGH and historical (2006-2009) migration shares between Mexican states from Census data produced by Ruggles et al. (2020).

Figure A9: Remittance Flows from Campeche



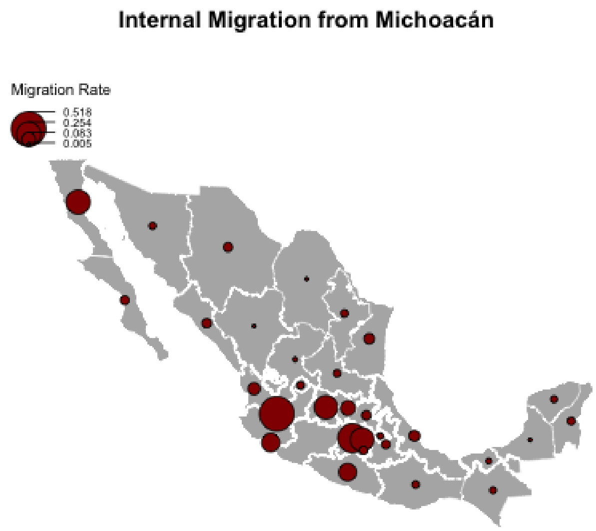
NOTE: Authors calculations based on remittance data from the ENIGH and historical (2006-2009) migration shares between Mexican states from Census data produced by Ruggles et al. (2020).

Figure A10: International Migration Shares from Michoacán



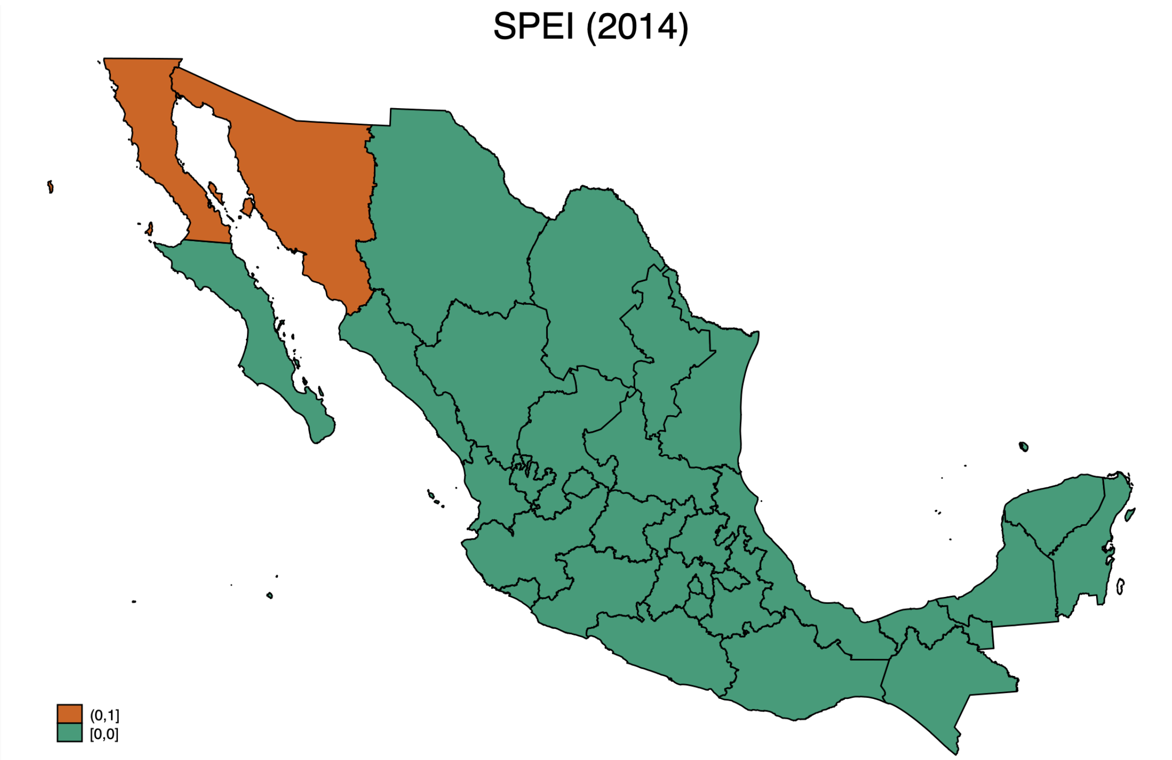
NOTE: Authors calculations of share of migrants to each US state from Michoacán for the years 2006 to 2009 according the Matrículas Consulares

Figure A11: Internal Migration Shares from Michoacán



NOTE: Authors calculations of share of migrants to each other Mexican state from Michoacán for the years 2005 to 2009 according the 2010 Census

Figure A12: Drought Conditions per CONAGUA (2014)



NOTE: Authors calculation of drought based on data from Mexico's Commission on Water, CONAGUA. States are assigned a drought if more than 40% of municipalities have experienced drought conditions for at least 6 months of 2014.

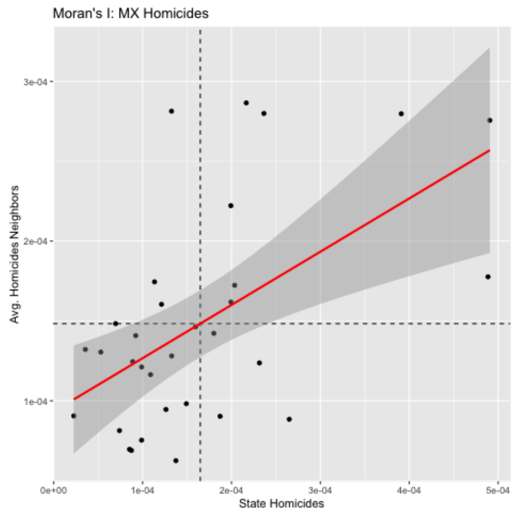


Figure A13: Moran's I: MX Homicide Rate

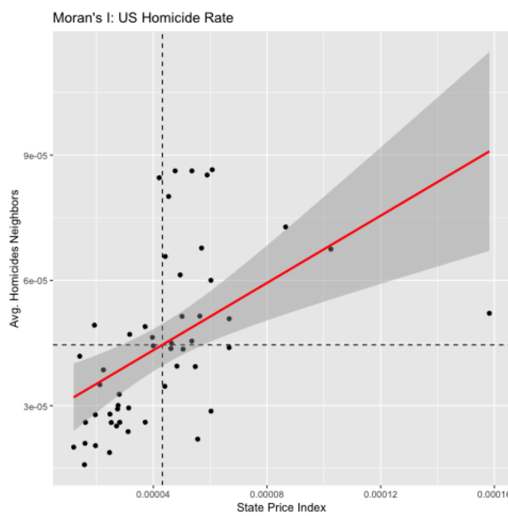


Figure A14: Moran's I: US Homicide Rate

Figure A15: Three Nearest Neighbors

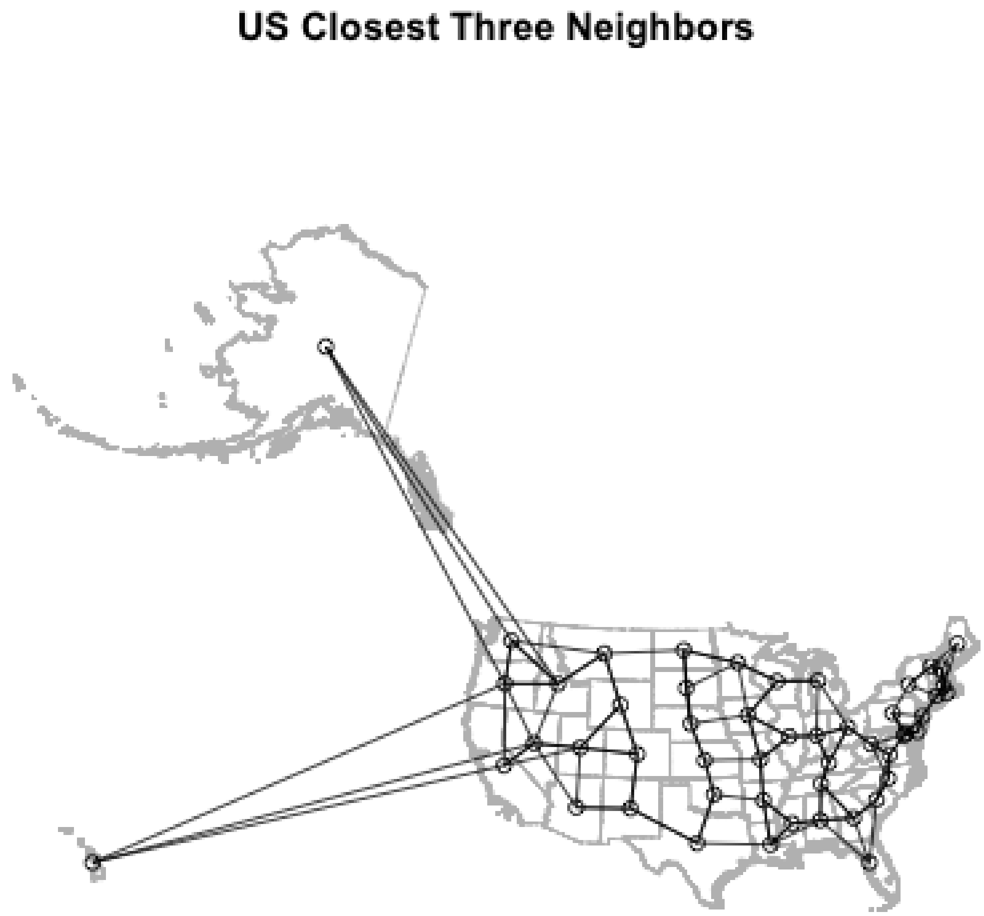


Figure A16: Three Nearest Neighbors

Figure A17: Map of Cartel Territory

SOURCE: Tracking Cartels Project, START, University of Maryland

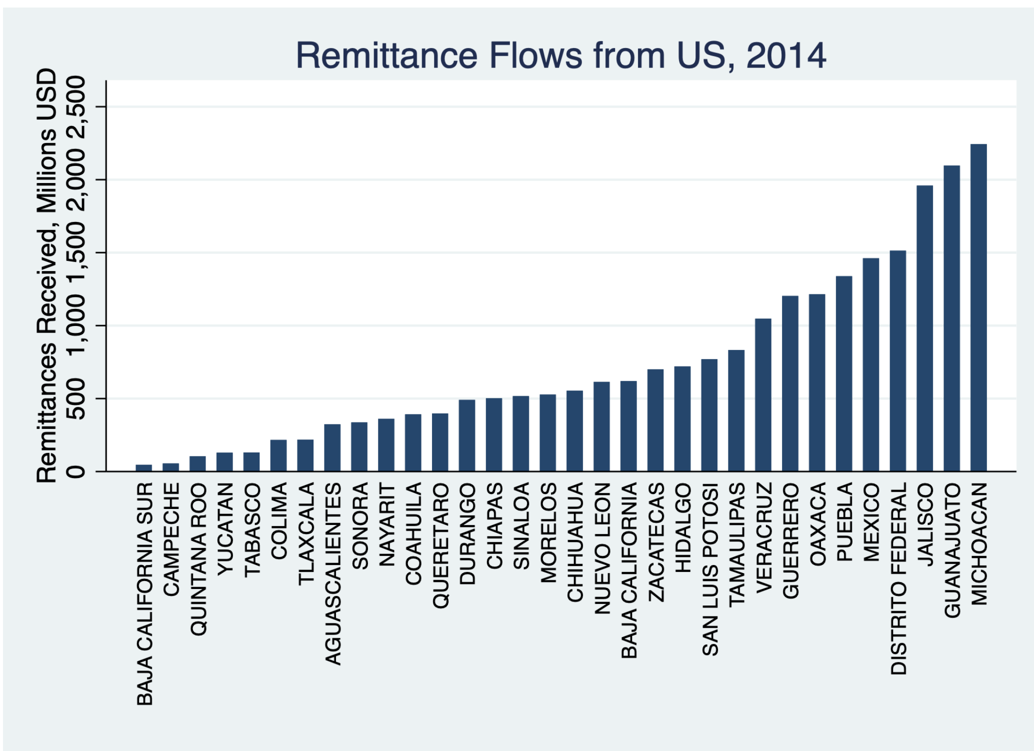


Figure A18: Distribution of Total Remittances (Bank)

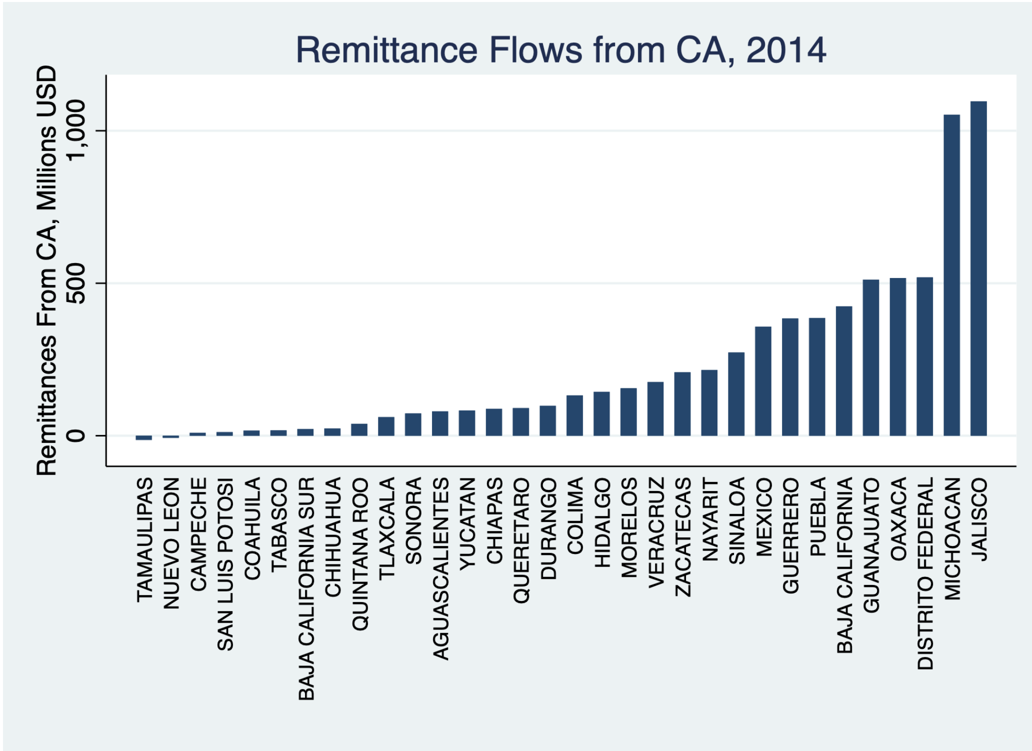


Figure A19: Distribution of Remittances from CA (Bank)

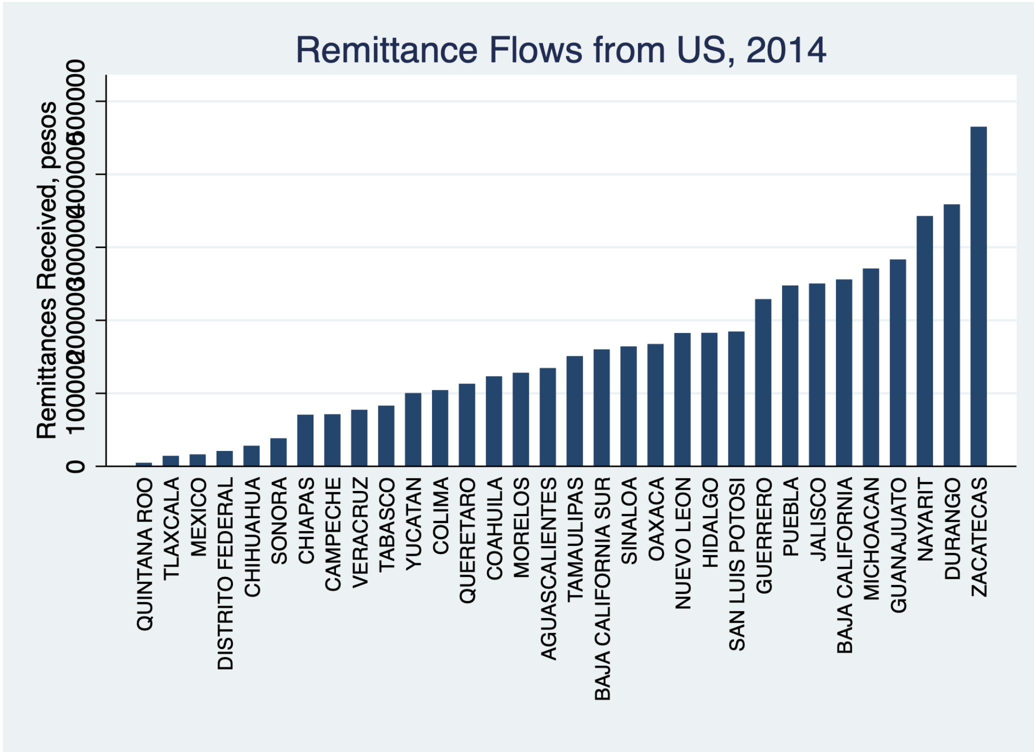


Figure A20: Distribution of Total Remittances (ENIGH)

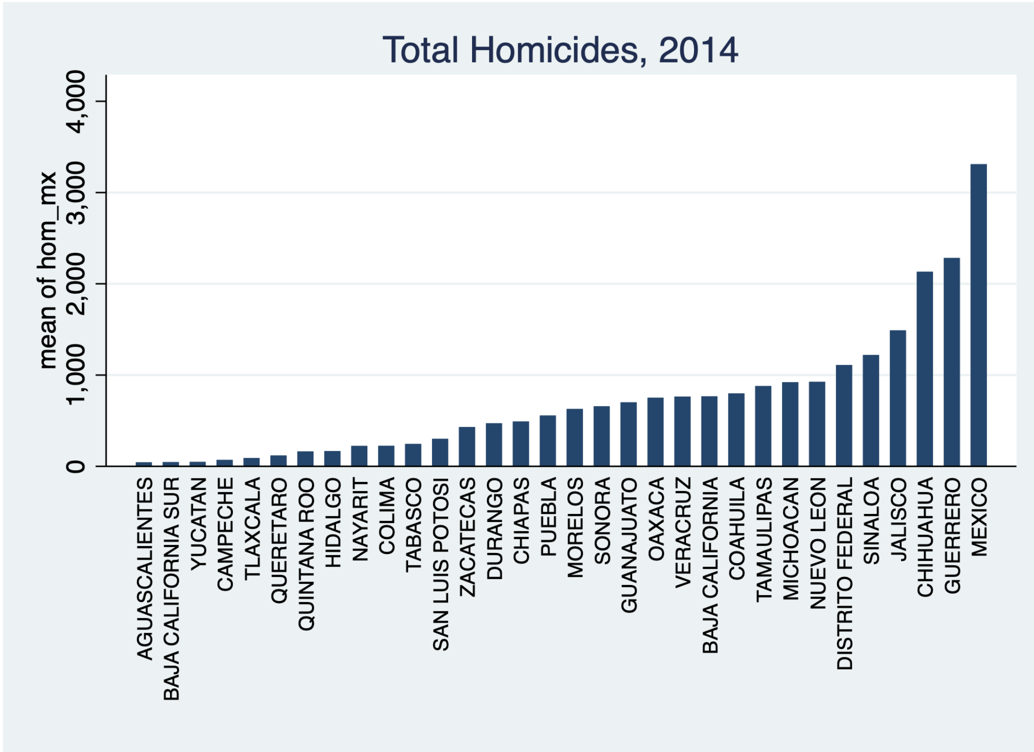


Figure A21: Distribution of Homicides

Variable	(1) Low Hom. Rate N	Mean/(SE)	(2) High Hom. Rate N	Mean/(SE)	(1)-(2) Pairwise t-test N	Mean difference
MX Drought (SPEI < -1.5)	176	0.074	176	0.102	352	-0.028
		(0.020)		(0.023)		
MX Drought (CONAGUA D1-D4)	176	0.159	176	0.193	352	-0.034
		(0.028)		(0.030)		

Significance: ***=.01, **=.05, *=.1. Disasters, storms, and floods are from EM-DAT data. Drought is defined as an SPEI < -1.5 based on the authors calculations and remotely sensed data from the DAYMET dataset. Disasters exclude droughts. I compare states above and below median homicide rate (homicides per 10,000) for 2010, the beginning of the period.

Table A1: Balance Table: Weather Shocks

Variable	(1) Low Hom. Rate N	Mean/(SE)	(2) High Hom. Rate N	Mean/(SE)	(1)-(2) Pairwise t-test N	Mean difference
International Migration Rate	16	0.032	16	0.037	32	-0.005
		(0.006)		(0.007)		
Internal Migration Rate	16	0.051	16	0.055	32	-0.004
		(0.005)		(0.005)		

Significance: ***=.01, **=.05, *=.1. I calculate migration rates as total migrants from 2005 to 2009 (2006 to 2009 for international) over the state population in 2010. I compare states above and below median homicide rate (homicides per 10,000) for 2010, the beginning of the period.

Table A2: Balance Table: Migration Rates

	Ln(Remittances, bank)	asinh(Remittances, bank)
	Int.	Int.
	(1)	(2)
Receiving Drought	0.0258***	0.0273***
	(0.0051)	(0.0061)
Sending Drought	0.0046	0.0090
	(0.0050)	(0.0066)
Within R^2	0.04413	0.03079
Observations	17,952	17,952
Pair fixed effects	✓	✓
Year fixed effects	✓	✓
Population Controls	✓	✓
Spatially Lagged Controls		✓

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in column 1 is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. For column 2 I leave use the inverse hyperbolic sine transformation of the dependent variable which allows for zeroes and a few negative flows. Both models uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. A state has a drought if the SPEI is less than < -1.5. Column 1 does not include any spatially lagged independent variables as controls. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table A3: Impact of Drought on Remittances

	Ln(Receiving Homicides)	Ln(Sending Homicides)
	(1)	(2)
Receiving Drought	0.0798	
	(0.0979)	
Sending Drought		-0.0101
		(0.0353)
Within R^2	0.05388	0.00632
Observations	352	561
MX State fixed effects	✓	
Year fixed effects	✓	✓
US State fixed effects		✓
Population Controls	✓	✓
Spatially Lagged Controls	✓	✓

All models control for state fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable is the natural log of homicides in the state and year. A state has a drought if the SPEI is less than < -1.5. Both models include any spatially lagged independent variables as controls. Column 1 estimated on a balanced panel of 32 Mexican States from 2010 to 2020. Column 2 estimated on a balanced panel of 51 US States + D.C. from 2010 to 2020. Standard errors are clustered at the state level.

Table A4: Impact of Drought on Violence

Appendix B: Investigating Spatial Lags, Networks, and Timing

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought	0.1491***	0.9574***	0.0234
	(0.0225)	(0.0759)	(0.0451)
Sending Drought	-0.0222	0.2281	-0.0018
	(0.0186)	(0.2431)	(0.0817)
Ln(Receiving Homicides)	-0.0569***	-0.0991***	-0.0656***
	(0.0038)	(0.0194)	(0.0106)
Drought X Ln(Receiving Homicides)	-0.0182***	-0.1451***	-0.0054
	(0.0032)	(0.0115)	(0.0075)
Ln(Sending Homicides)	6.61×10^{-5}	0.0238	-0.0006
	(0.0087)	(0.0424)	(0.0135)
Drought X Ln(Sending Homicides)	0.0052	-0.0222	0.0002
	(0.0034)	(0.0459)	(0.0120)
Within Adjusted R^2	0.08006	0.03549	0.07265
Observations	17,952	9,792	5,952
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls			

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. The models do not include any spatially lagged independent variables as controls. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table B1: Impact of Drought and Violence on Remittances

Table B2: Impact of Drought and Violence on Remittances

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Spatial Lag Receiving Drought	0.0140*	0.1589***	0.0946***
	(0.0083)	(0.0384)	(0.0285)
Receiving Drought	0.1420***	0.9484***	0.0076
	(0.0219)	(0.0782)	(0.0429)
Spatial Lag Sending Drought	-0.0006	0.1108	8.71×10^{-5}
	(0.0083)	(0.0825)	(0.0268)
Sending Drought	-0.0222	0.2516	-0.0010
	(0.0188)	(0.2493)	(0.0801)
Spatial Lag Receiving Homicides	-0.0847***	-0.1316***	-0.1968***
	(0.0077)	(0.0350)	(0.0244)
Ln(Receiving Homicides)	-0.0413***	-0.0784***	-0.0340***
	(0.0033)	(0.0199)	(0.0096)
Drought X Ln(Receiving Homicides)	-0.0172***	-0.1443***	-0.0042
	(0.0032)	(0.0117)	(0.0072)
Ln(Sending Homicides)	0.0033	0.0275	-0.0021
	(0.0083)	(0.0427)	(0.0135)
Spatial Lag Sending Homicides	-0.0412***	-0.0801	0.0090
	(0.0151)	(0.0793)	(0.0253)
Drought X Ln(Sending Homicides)	0.0052	-0.0292	0.0001
	(0.0035)	(0.0468)	(0.0117)
Within Adjusted R^2	0.10303	0.03858	0.09107
Observations	17,952	9,792	5,952
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table B3: Impact of Drought and Violence on Remittances: Inverse Distance

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	(1)	(2)	(3)
Spatial Lag Receiving Drought	-0.1829***	1.501***	-0.0498
	(0.0373)	(0.1951)	(0.1131)
Receiving Drought	0.1708***	1.089***	0.0572
	(0.0196)	(0.0769)	(0.0463)
Spatial Lag Sending Drought	0.0078	0.3323	0.0197
	(0.0254)	(0.2887)	(0.1448)
Sending Drought	-0.0226	0.2460	-0.0023
	(0.0183)	(0.2439)	(0.0810)
Spatial Lag Receiving Homicides	-0.5805***	-2.362***	-0.7330***
	(0.0304)	(0.1692)	(0.0946)
Spatial Lag Sending Homicides	-0.1367**	-0.2823	0.0151
	(0.0539)	(0.2953)	(0.1125)
Ln(Receiving Homicides)	-0.0431***	-0.0978***	-0.0596***
	(0.0032)	(0.0206)	(0.0100)
Drought X Ln(Receiving Homicides)	-0.0207***	-0.1555***	-0.0090
	(0.0029)	(0.0115)	(0.0075)
Ln(Sending Homicides)	0.0016	0.0238	-0.0010
	(0.0077)	(0.0416)	(0.0131)
Drought X Ln(Sending Homicides)	0.0052	-0.0268	0.0003
	(0.0034)	(0.0458)	(0.0118)
Within Adjusted R^2	0.15873	0.06394	0.08741
Observations	17,952	9,792	5,952
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of all other same-country states, weighted by the inverse of straight-line distance between centroids in kilometers. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table B4: Impact of Drought and Violence on Remittances: Role of Networks

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought	0.1420***	0.9484***	0.0076
	(0.0219)	(0.0785)	(0.0431)
Sending Drought	-0.0222	0.2516	-0.0010
	(0.0188)	(0.2503)	(0.0805)
Ln(Receiving Homicides)	-0.0413***	-0.0784***	-0.0340***
	(0.0033)	(0.0200)	(0.0096)
Drought X Ln(Receiving Homicides)	-0.0172***	-0.1443***	-0.0042
	(0.0032)	(0.0118)	(0.0072)
Ln(Sending Homicides)	0.0033	0.0275	-0.0021
	(0.0083)	(0.0429)	(0.0135)
Drought X Ln(Sending Homicides)	0.0052	-0.0292	0.0001
	(0.0035)	(0.0470)	(0.0118)
Adjusted R^2	0.43117	0.61523	0.50904
Observations	17,952	9,792	5,952
Send-state fixed effects	✓	✓	✓
Receive-state fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Columns 1 and 2 use international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 3 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 4 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table B5: Impact of Drought and Violence on Remittances: Timing of Shocks

	Ln(Remittances, bank)			
	(1)	(2)	(3)	(4)
Receiving Drought, t-2	0.1133***	0.1126***		
	(0.0270)	(0.0270)		
Receiving Drought, t-1		0.0265***	0.1313***	
		(0.0052)	(0.0210)	
Receiving Drought, t			-0.0325***	-0.1017***
			(0.0034)	(0.0230)
Sending Drought, t-2	0.0031	0.0033		
	(0.0055)	(0.0055)		
Sending Drought , t-1		-0.0226	-0.0224	
		(0.0188)	(0.0186)	
Sending Drought, t			0.0043	-0.0125
			(0.0056)	(0.0183)
Ln(Receiving Homicides, t-2)	-0.0259***	-0.0270***		
	(0.0040)	(0.0040)		
Drought X Ln(Receiving Homicides), t-2	-0.0101**	-0.0101**		
	(0.0042)	(0.0043)		
Ln(Sending Homicides), t-1	0.0033	0.0034	0.0038	0.0035
	(0.0086)	(0.0086)	(0.0081)	(0.0081)
Drought X Ln(Sending Homicides) , t-1	0.0012	0.0053	0.0052	
	(0.0009)	(0.0035)	(0.0034)	
Ln(Receiving Homicides) ,t-1			-0.0378***	-0.0406***
			(0.0033)	(0.0034)
Drought X Ln(Receiving Homicides) , t-1			-0.0156***	
			(0.0030)	
Drought, t x Ln(Rec. Homicides, t-1)				0.0106***
				(0.0034)
Drought, t x Ln(Send Homicides, t-1)				0.0033
				(0.0035)
Within Adjusted R^2	0.07151	0.07411	0.12455	0.11984
Observations	17,952	17,952	17,952	17,952
Pair Fixed Effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Population Controls	✓	✓	✓	✓
Controls for Spatial Lags	✓	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. I do not include contemporaneous homicides due to the potential reverse causality, therefore the interaction term for column 4 is drought in the current year interacted with homicides from the prior year. Due to data limitations, I also only ever include one year lags for violence in the US, which has no substantial impact on remittance flows in any model. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Appendix C: Other Drought Data

Table C1: Impact of Moderate Drought and Violence on Remittances

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought	0.0109	0.6056***	0.4124***
	(0.0111)	(0.1003)	(0.0727)
Sending Lag Receiving Drought	-0.0004	0.0453	-0.0011
	(0.0050)	(0.0487)	(0.0186)
Sending Drought	-0.0115	0.0322	0.0028
	(0.0108)	(0.1005)	(0.0573)
Ln(Receiving Homicides)	-0.0403***	-0.0255	-0.0079
	(0.0032)	(0.0199)	(0.0105)
Drought X Ln(Receiving Homicides)	-0.0038**	-0.1374***	-0.0673***
	(0.0018)	(0.0147)	(0.0110)
Ln(Sending Homicides)	0.0032	0.0337	-0.0016
	(0.0084)	(0.0409)	(0.0137)
Drought X Ln(Sending Homicides)	0.0032	-0.0024	-0.0007
	(0.0021)	(0.0191)	(0.0087)
Within Adjusted R^2	0.10103	0.08712	0.11141
Observations	17,952	9,792	5,952
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table C2: Impact of Drought (CONAGUA) and Violence on Remittances

	Ln(International Remittances)			
	Bank	ENIGH	Bank	ENIGH
	(1)	(2)	(3)	(4)
Receiving Drought	0.0530***	0.3815***	0.0873***	-0.3628**
	(0.0155)	(0.1055)	(0.0167)	(0.1661)
Sending Drought	-0.0222	0.2516	-0.0222	0.2516
	(0.0189)	(0.2528)	(0.0189)	(0.2485)
Ln(Receiving Homicides)	-0.0425***	-0.0980***	-0.0398***	-0.1047***
	(0.0033)	(0.0199)	(0.0031)	(0.0198)
Drought X Ln(Receiving Homicides)	-0.0081***	-0.0254*	-0.0202***	0.0336
	(0.0024)	(0.0154)	(0.0026)	(0.0241)
Ln(Sending Homicides)	0.0033	0.0275	0.0033	0.0275
	(0.0083)	(0.0426)	(0.0083)	(0.0430)
Drought X Ln(Sending Homicides)	0.0052	-0.0292	0.0052	-0.0292
	(0.0035)	(0.0476)	(0.0035)	(0.0467)
Within Adjusted R^2	0.10421	0.04437	0.11123	0.03577
Observations	17,952	9,792	17,952	9,792
Pair fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Population Controls	✓	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Columns 1 and 3 use international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Columns 2 and 4 use international remittances reported in the ENIGH in pesos over a three-month period. A receiving state has a drought if more than 40% of municipalities experience six months of D1-D4 conditions for columns 1 and 2 and D2-D4 for columns 3 and 4. A sending state (US) has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. Standard errors are clustered at the pair level.

Table C3: Impact of Drought (NADM) and Violence on Remittances

	Ln(International Remittances)			
	Bank	ENIGH	Bank	ENIGH
	(1)	(2)	(3)	(4)
Receiving Drought	0.0999***	0.3192***	0.1610***	-0.2716*
	(0.0198)	(0.1039)	(0.0192)	(0.1441)
Sending Drought	-0.0166	-0.0534	-0.0072	0.0818
	(0.0152)	(0.1017)	(0.0180)	(0.1810)
Ln(Receiving Homicides)	-0.0444***	-0.1310***	-0.0394***	-0.1390***
	(0.0031)	(0.0183)	(0.0031)	(0.0187)
Drought X Ln(Receiving Homicides)	-0.0155***	0.0086	-0.0384***	-0.0678***
	(0.0031)	(0.0159)	(0.0031)	(0.0220)
Ln(Sending Homicides)	0.0030	0.0308	0.0032	0.0309
	(0.0082)	(0.0425)	(0.0082)	(0.0413)
Drought X Ln(Sending Homicides)	0.0027	0.0168	0.0009	-0.0087
	(0.0029)	(0.0206)	(0.0032)	(0.0314)
Within Adjusted R^2	0.12024	0.05613	0.11781	0.09157
Observations	17,952	9,792	17,952	9,792
Pair fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Population Controls	✓	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Columns 1 and 3 use international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Columns 2 and 4 use international remittances reported in the ENIGH in pesos over a three-month period. A state has a drought if more than 40% of the state area experiences D1-D4 conditions for columns 1 and 2 and D2-D4 for columns 3 and 4. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. Standard errors are clustered at the pair level.

Table C4: Impact of Drought and Violence on Remittances

	Ln(International Remittances)			
	Bank	ENIGH	Bank	ENIGH
	(1)	(2)	(3)	(4)
Receiving % of Area Drought	0.0006**	0.0012	0.0006*	0.0060***
	(0.0003)	(0.0014)	(0.0004)	(0.0006)
Sending % of Area Drought	-0.0002	0.0004	-4.36×10^{-5}	0.0008
	(0.0002)	(0.0006)	(0.0001)	(0.0008)
Drought % X Ln(Receiving Homicides)	-0.0002***	0.0002	-0.0002***	-0.0009***
	(3.96×10^{-5})	(0.0002)	(5.4×10^{-5})	(0.0001)
Ln(Receiving Homicides)	-0.0462***	-0.1270***	-0.0419***	-0.0852***
	(0.0030)	(0.0199)	(0.0031)	(0.0185)
Ln(Sending Homicides)	0.0028	0.0328	0.0032	0.0308
	(0.0082)	(0.0429)	(0.0083)	(0.0426)
Drought % X Ln(Sending Homicides)	2.72×10^{-5}			
	(4.15×10^{-5})			
Within Adjusted R^2	0.13099	0.04019	0.10525	0.04386
Observations	17,952	9,792	17,952	9,792
Pair fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Population Controls	✓	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Columns 1 and 3 use international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Columns 2 and 4 use international remittances reported in the ENIGH in pesos over a three-month period. Drought is the percent of the state area experiencing D1-D4 conditions for columns 1 and 2 and D2-D4 for columns 3 and 4. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. Standard errors are clustered at the pair level.

Appendix D: Robustness Checks

Table D1: Main Results: Assign Remittances with Migration Flow Only

	Ln(International Remittances)		asinh(International Remittances)	
	Bank	ENIGH	Bank	ENIGH
	(1)	(2)	(3)	(4)
Receiving Drought	0.1552***	1.036***	0.1552***	1.063***
	(0.0221)	(0.0881)	(0.0221)	(0.0893)
Sending Drought	-0.0075	-0.2485	-0.0075	-0.1744
	(0.0193)	(0.2293)	(0.0193)	(0.2350)
Ln(Receiving Homicides)	-0.0471***	-0.0851***	-0.0471***	-0.0880***
	(0.0039)	(0.0205)	(0.0039)	(0.0207)
Drought X Ln(Rec. Homicides)	-0.0194***	-0.1579***	-0.0194***	-0.1614***
	(0.0032)	(0.0130)	(0.0032)	(0.0132)
Ln(Sending Homicides)	-0.0129	-0.0176	-0.0129	-0.0148
	(0.0101)	(0.0436)	(0.0101)	(0.0450)
Drought X Ln(Send. Homicides)	-0.0002	0.0273	-0.0002	0.0181
	(0.0035)	(0.0434)	(0.0035)	(0.0442)
Within Adjusted R^2	0.07626	0.03047	0.07626	0.02888
Observations	17,952	9,792	17,952	9,792
Pair fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Population Controls	✓	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in Columns 1 and 2 is the natural log of remittance flows, adding one to all observations. The dependent variable in Columns 3 and 4 specifications is the inverse hyperbolic sine of remittance flows (unidirectional) in the state pair and year, including zeroes. Columns 1 and 3 use international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Columns 2 and 4 use international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. Remittance flows are assigned to US states based on the share of migrants from Mexican state *i* to US state *j* in the 2006-2009 period. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table D2: Main Results: Inverse Hyperbolic Sine Transformation

	asinh(Remittances, bank)	asinh(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought	0.1322***	0.8636***	0.0079
	(0.0246)	(0.0985)	(0.0429)
Sending Drought	-0.0444**	0.5003	-0.0007
	(0.0222)	(0.3317)	(0.0801)
Ln(Receiving Homicides)	-0.0379***	-0.0712***	-0.0341***
	(0.0047)	(0.0244)	(0.0096)
Drought X Ln(Receiving Homicides)	-0.0155***	-0.1311***	-0.0042
	(0.0037)	(0.0154)	(0.0072)
Ln(Sending Homicides)	0.0067	0.0542	-0.0023
	(0.0092)	(0.0466)	(0.0135)
Drought X Ln(Sending Homicides)	0.0105**	-0.0564	4.59×10^{-5}
	(0.0041)	(0.0610)	(0.0117)
Within Adjusted R^2	0.06780	0.03081	0.09110
Observations	17,952	9,792	5,952
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the inverse hyperbolic sine of remittance flows (unidirectional) in the state pair and year, including zeroes. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table D3: Main Results Without Zero Flows

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought	0.1533***	1.018***	0.0291
	(0.0216)	(0.0713)	(0.0375)
Sending Drought	0.0009	-0.0341	-0.0025
	(0.0184)	(0.2249)	(0.0793)
Ln(Receiving Homicides)	-0.0447***	-0.0917***	-0.0407***
	(0.0027)	(0.0184)	(0.0087)
Drought X Ln(Receiving Homicides)	-0.0193***	-0.1552***	-0.0071
	(0.0031)	(0.0105)	(0.0067)
Ln(Sending Homicides)	-6.85×10^{-5}	-0.0068	0.0001
	(0.0083)	(0.0425)	(0.0132)
Drought X Ln(Sending Homicides)	-0.0004	0.0037	0.0005
	(0.0034)	(0.0430)	(0.0116)
Within Adjusted R^2	0.12316	0.04389	0.09716
Observations	17,347	9,462	5,928
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero and I exclude these from this analysis. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Though there are no outliers in a traditional sense, Table D4 excludes the three states with the highest total remittances and the three lowest to show these results are not being driven by a few states at the extremes. In particular, one may be concerned that California, which dominates most migration shares and frequently experiences drought, may be driving the results but the table below shows that is not the case. I also test whether these results are due to my assumption that remittance shares are proportional to past migration shares following the correction discussed in Section 4. A difference between these data could derive from the millions of dollars the bank couldn't assign to US states or because of a problem with the assumption that migration shares map directly to remittance shares, which could affect my results. To address this concern, Table D4 shows that the results are still consistent after removing the least accurate matches.

Table D4: Main Results Without Influential States

	International Remittances			
	No Major/Minor States		No Bad Matches	
	Bank	ENIGH	Bank	ENIGH
	(1)	(2)	(3)	(4)
Receiving Drought	0.1454***	0.9796***	0.1454***	0.9785***
	(0.0231)	(0.0800)	(0.0231)	(0.0799)
Sending Drought	-0.0097	0.8211*	-0.0162	0.6336
	(0.0227)	(0.4529)	(0.0242)	(0.5203)
Ln(Receiving Homicides)	-0.0416***	-0.0778***	-0.0416***	-0.0779***
	(0.0033)	(0.0209)	(0.0033)	(0.0209)
Drought X Ln(Receiving Homicides)	-0.0175***	-0.1483***	-0.0175***	-0.1482***
	(0.0034)	(0.0120)	(0.0034)	(0.0120)
Ln(Sending Homicides)	0.0032	0.0210	0.0036	0.0206
	(0.0092)	(0.0465)	(0.0083)	(0.0435)
Drought X Ln(Sending Homicides)	0.0022	-0.1274	0.0040	-0.0884
	(0.0044)	(0.0823)	(0.0049)	(0.0991)
Within Adjusted R^2	0.11093	0.04164	0.11088	0.04155
Observations	15,840	8,640	15,840	8,640
Pair fixed effects	✓	✓	✓	✓
Year fixed effects	✓	✓	✓	✓
Population Controls	✓	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero and I add 1 to all remittances flows before taking the natural log. Columns 1 and 3 use international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Columns 2 and 4 uses international remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. Models 1 and 2 exclude US states with the 3 most and 3 fewest number of immigrants from Mexico (California, Texas, Illinois, Maine, North Dakota, Montana). Models 3 and 4 exclude US states where the remittance data used here doesn't match other data on remittances out of the US well (California, Texas, Illinois, New York, Louisiana, Montana). A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table D5: Main Results Controlling for Prior Year International Migration

	Ln(Remittances, bank) Int. (1)	Ln(Remittances, ENIGH) Int. (2)
Receiving Drought	0.1421***	0.9493***
	(0.0219)	(0.0782)
Sending Drought	-0.0222	0.2570
	(0.0188)	(0.2493)
Ln(Receiving Homicides)	-0.0413***	-0.0784***
	(0.0033)	(0.0199)
Drought X Ln(Receiving Homicides)	-0.0172***	-0.1444***
	(0.0032)	(0.0117)
Ln(Sending Homicides)	0.0034	0.0278
	(0.0083)	(0.0427)
Drought X Ln(Sending Homicides)	0.0052	-0.0303
	(0.0035)	(0.0468)
Immigrants	-2.74×10^{-6}	-9.18×10^{-6}
	(3.2×10^{-6})	(1.2×10^{-5})
Within R^2	0.10376	0.04002
Observations	17,952	9,792
Pair fixed effects	✓	✓
Year fixed effects	✓	✓
Population Controls	✓	✓
Spatially Lagged Controls	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero but to use the natural log specification I add 1 to all flows before taking the log. Column 1 uses data on international remittances from the Central Bank and Column 2 uses the ENIGH data. A state has a drought if the SPEI is less than < -1.5. Migration rate is the number of migrants from a particular state in Mexico to the paired state in the US divided by the state population. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. Standard errors are clustered at the pair level.

Table D6: Impact of Drought and Violence On Total Remittances in MX States

	Ln(Remittances, bank) (1)	Ln(Remittances, ENIGH) (2)	(3)
Receiving Drought	0.0261	0.8583**	0.5577**
	(0.1811)	(0.3735)	(0.2524)
Spatial Lag Receiving Drought	-0.1096	0.0882	-0.0180
	(0.0865)	(0.2642)	(0.1939)
Spatial Lag Receiving Homicides	0.0942	-0.1163	-0.2117
	(0.0657)	(0.1981)	(0.1802)
Ln(Receiving Homicides)	0.0036	-0.0345	0.0246
	(0.0327)	(0.1360)	(0.0690)
Drought X Ln(Receiving Homicides)	-0.0021	-0.1289**	-0.0893*
	(0.0310)	(0.0583)	(0.0455)
Within Adjusted R^2	0.06965	0.02140	0.04484
Observations	576	224	224
State fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for receiving state fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittances into the state. Columns 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 3 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 4 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state is assigned a drought if the SPEI is < -1.5. All models, except column 2, control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. All models are based on a balanced panel of 32 states from 2003 to 2020. Standard errors are clustered at the state level.

Table D7: Main Results: Control for Government Spending

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought	0.1295***	0.9703***	-0.0277
	(0.0220)	(0.0770)	(0.0408)
Sending Drought	-0.0236	0.2508	-0.0010
	(0.0189)	(0.2536)	(0.0784)
Ln(Receiving Homicides)	-0.0406***	-0.0723***	-0.0323***
	(0.0033)	(0.0199)	(0.0098)
Drought X Ln(Receiving Homicides)	-0.0152***	-0.1440***	0.0042
	(0.0032)	(0.0115)	(0.0069)
Ln(Sending Homicides)	0.0033	0.0291	-0.0022
	(0.0085)	(0.0437)	(0.0133)
Drought X Ln(Sending Homicides)	0.0054	-0.0290	0.0001
	(0.0035)	(0.0475)	(0.0114)
Ln(Receiving Gov't Spending)	-0.0297	-0.0658	0.1351***
	(0.0242)	(0.0841)	(0.0516)
Within Adjusted R^2	0.10828	0.02553	0.04603
Observations	17,391	9,486	5,766
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero and I exclude these from this analysis. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. All models also control for government spending in the receiving state, using data provided by INEGI. International models are estimated on a balanced panel of 1,581 state-state pairs, covering 31 Mexican States (spending data not available for the City of Mexico) to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 930 state-state pairs, covering 31 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table D8: Main Results: Control for State GDP

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought	0.1602***	1.080***	0.0536
	(0.0219)	(0.0691)	(0.0448)
Sending Drought	-0.0220	0.2539	0.0061
	(0.0188)	(0.2443)	(0.0793)
Ln(Receiving Homicides)	-0.0421***	-0.0902***	-0.0381***
	(0.0034)	(0.0196)	(0.0094)
Drought X Ln(Receiving Homicides)	-0.0197***	-0.1654***	-0.0115
	(0.0032)	(0.0108)	(0.0074)
Ln(Sending Homicides)	0.0033	0.0282	-0.0027
	(0.0082)	(0.0414)	(0.0133)
Drought X Ln(Sending Homicides)	0.0052	-0.0297	-0.0010
	(0.0035)	(0.0457)	(0.0115)
Ln(Receiving GDP)	0.2104***	1.661***	0.5797***
	(0.0258)	(0.1051)	(0.0728)
Ln(Sending GDP)	-0.0049	0.0494	0.0893
	(0.0541)	(0.2363)	(0.1000)
Within Adjusted R^2	0.11350	0.06643	0.10461
Observations	17,952	9,792	5,952
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero and I exclude these from this analysis. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. All models also control for state GDP. US data provided by the BEA and Mexican data by INEGI. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table D9: Main Results: Control for State Agricultural Sector Size

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought	0.1422***	0.9590***	0.0098
	(0.0221)	(0.0789)	(0.0433)
Sending Drought	-0.0223	0.2597	0.0051
	(0.0188)	(0.2484)	(0.0799)
Ln(Receiving Homicides)	-0.0411***	-0.0766***	-0.0337***
	(0.0032)	(0.0201)	(0.0097)
Drought X Ln(Receiving Homicides)	-0.0173***	-0.1467***	-0.0046
	(0.0032)	(0.0120)	(0.0072)
Ln(Sending Homicides)	0.0023	0.0216	-0.0011
	(0.0084)	(0.0430)	(0.0136)
Drought X Ln(Sending Homicides)	0.0053	-0.0304	-0.0012
	(0.0035)	(0.0466)	(0.0117)
Ln(Receiving Ag. Sector Value/GDP)	-0.0092	-0.1069	-0.0203
	(0.0195)	(0.0900)	(0.0508)
Ln(Sending Ag. Sector Value/GDP)	0.0293	0.2056*	-0.0570
	(0.0242)	(0.1236)	(0.0608)
Within Adjusted R^2	0.10291	0.03909	0.09106
Observations	17,600	9,600	5,952
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero and I exclude these from this analysis. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. All models also control for the value of agricultural production, normalized by state GDP. Mexican GDP and agricultural data provided by INEGI; US GDP data from the BEA, and agricultural value data from the USDA ERS. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.

Table D10: Main Results: Violent Crime

	Ln(Remittances, bank)	Ln(Remittances, ENIGH)	
	Int.	Int.	Dom.
	(1)	(2)	(3)
Receiving Drought X Violent Crime	-0.0303***	-0.1769***	-0.0862***
	(0.0031)	(0.0129)	(0.0086)
Receiving Drought	0.3210***	1.756***	0.8269***
	(0.0301)	(0.1255)	(0.0873)
Sending Drought	0.0045	0.1007*	-0.0007
	(0.0053)	(0.0545)	(0.0163)
Ln(Receiving Violent Crime)	0.0264***	0.2418***	0.1315***
	(0.0054)	(0.0278)	(0.0156)
Within Adjusted R^2	0.05354	0.05412	0.08790
Observations	17,952	9,792	5,952
Pair fixed effects	✓	✓	✓
Year fixed effects	✓	✓	✓
Population Controls	✓	✓	✓
Spatially Lagged Controls	✓	✓	✓

Standard errors in parentheses. Significance: ***=.01, **=.05, *=.1

All models control for state-to-state pair fixed effects and year fixed effects, as well as the natural log of annual population estimates. The dependent variable in all specifications is the natural log of remittance flows (unidirectional) in the state pair and year. Fewer than 5% of flows (in both international and domestic data) are zero and I exclude these from this analysis. Column 1 uses international remittance data from the Central Bank which reports annual remittance flows in US dollars each year. Column 2 uses international remittances reported in the ENIGH in pesos over a three-month period, and Column 3 uses domestic remittances reported in the ENIGH in pesos over a three-month period. The survey is only issued in even numbered years. A state has a drought if the SPEI is less than < -1.5. All models control for spatial lags of the independent variables, which is the average drought experience or number of homicides of the three nearest neighbors based on straight-line distance between centroids. These models use total violent crimes as reported by the Mexican Government in police data as a proxy for violence, rather than homicides. International models are estimated on a balanced panel of 1,632 state-state pairs, covering 32 Mexican States to 51 US States + DC from 2010 to 2020. The domestic models are estimated on a balanced panel of 992 state-state pairs, covering 32 Mexican States and excluding the own-state pair from 2010 to 2020. Standard errors are clustered at the pair level.