Responses to Temperature Shocks: Labor Markets and Migration Decisions in El Salvador

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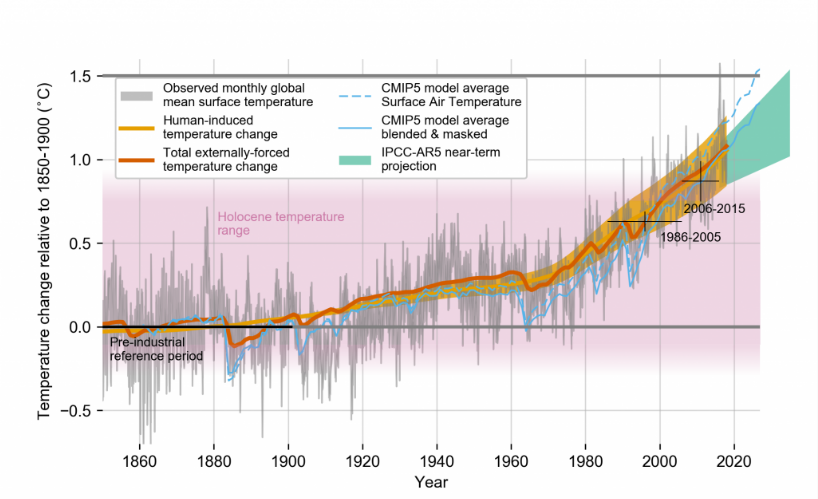
Motivation

Evolution of global mean surface temperature



Source: IPCC (https://www.ipcc.ch/sr15/graphics/)

Motivation

Source: New York Times

Research Question

What are the responses to temperature shocks in El Salvador?

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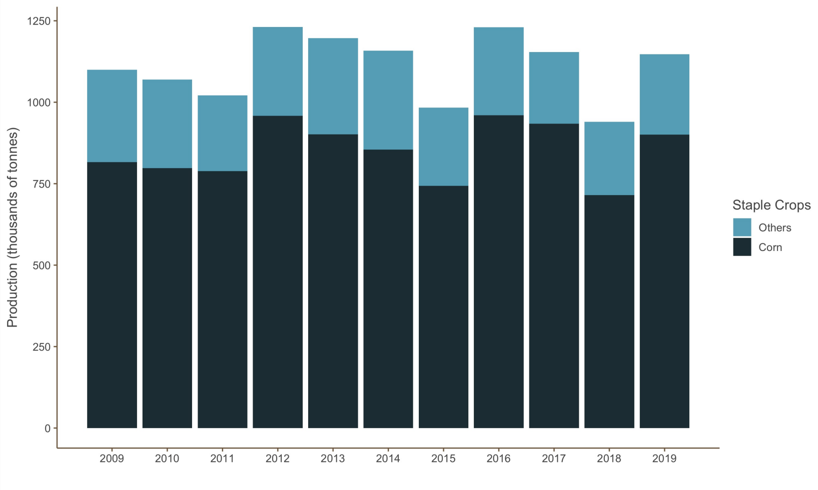
1. Measure effect of extreme temperatures on agricultural production of corn

Production of Corn and Other Staple Crops



Source: FAOSTAT. Staple crops include corn (maize), rice, sorghum, and beans.

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3. Adjustments through **international migration**

4. Heterogeneous effects by landownership and access to risk-coping mechanisms

    Migrant networks

    Access to financial markets

Contributions

1. Responses to weather shocks and natural disasters:
    - In using microdata, we are able to identify the responses of farmers and agricultural workers to temperature shocks
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Contributions

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2. Effect of temperature shocks on agricultural production, labor markets and migration in developing countries:
    - Incomplete markets and a small non-agricultural sector push rural households to rely on migration
    - But households are constrained by migration costs
3. Consequence of climate change and the adaptation strategies used by households:
    - Addressing negative impacts of climate change must be a shared global responsibility

Migration and weather shocks in El Salvador

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- Highly vulnerable to weather shocks
  - During the last decade, **3** extreme droughts fig
- Mostly subsistence agriculture and highly dependent on the rain cycle:
  - **87%** of agricultural producers are small farmers: average land size 1.2 hectares
  - **1.4%** of the land is irrigated

Source: New York Times

Data

Agricultural Survey: Encuesta Nacional Agropecuaria de Propósitos Múltiples (ENAMP): 2013-2018

- Cross-sectional survey of agricultural producers representative at the national and regional level
- Agricultural production and labor demand outcomes

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Household Survey: Encuesta a Hogares de Propósitos Múltiples (EHPM): 2010-2018

- Cross-sectional survey representative at the national and regional level
- Migration and labor outcomes

Temperature - Degree Celsius

NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) Land Surface Temperature and Emissivity: 2010-2018

- 1 km grid
- 8-day average
- Average at the municipality level

High temperature shock

- Number of "hot" weeks during agricultural season (*primera*) at municipality level
- "hot" =1 if temperature is 2 standard deviations above the historical mean (2001-2006)

Temperature shocks: temporal and geographic variation

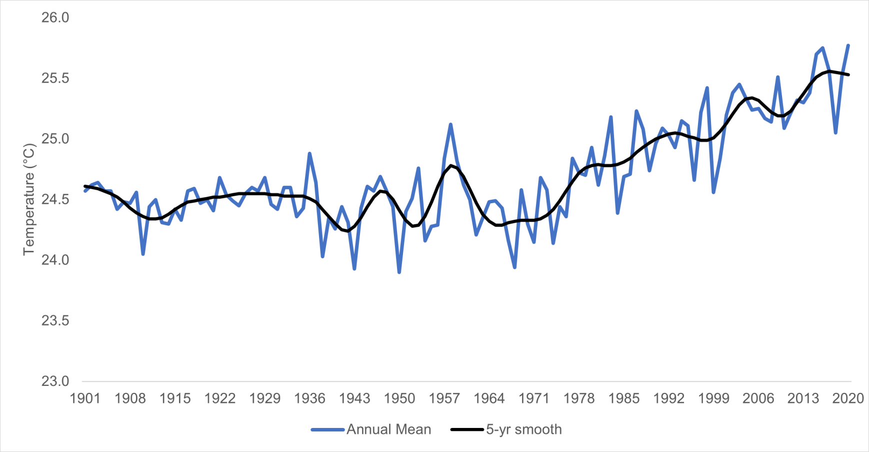

Figure 1: Average Temperature in El Salvador

Source: World Bank (2022). Data from Climatic Research Unit (CRU) of the University of East Anglia.

Temperature shocks: temporal and geographic variation

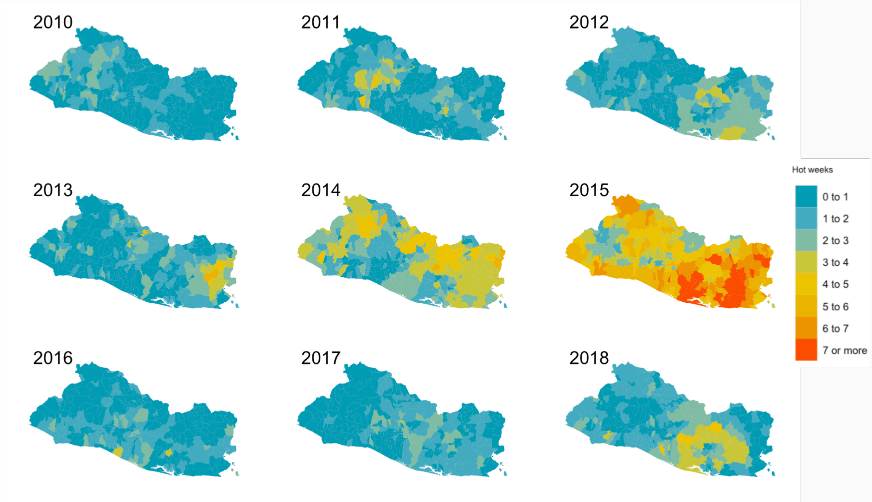

Figure 2: Number of hot weeks per municipality during main harvest season

Predicted Effects of Temperature Shocks

1. Temperature increases:
   $\Downarrow$ agricultural production (total production and production per hectare)

Agricultural Outcomes: Corn Production

$$log(y_{ijt}) = \alpha + \delta_1 T_{ijt} + X'_{ijt}\gamma + \beta Z_{jt} + \mu_j + \phi_t + W'_{j2005} * t + \epsilon_{ijt} \quad (1)$$

- $\boldsymbol{y_{ijt}}$: $=$ Crop yield (total yield or yield per hectare) of agricultural producers $\boldsymbol{i}$, living in municipality $\boldsymbol{j}$, in year $\boldsymbol{t}$ during harvest season

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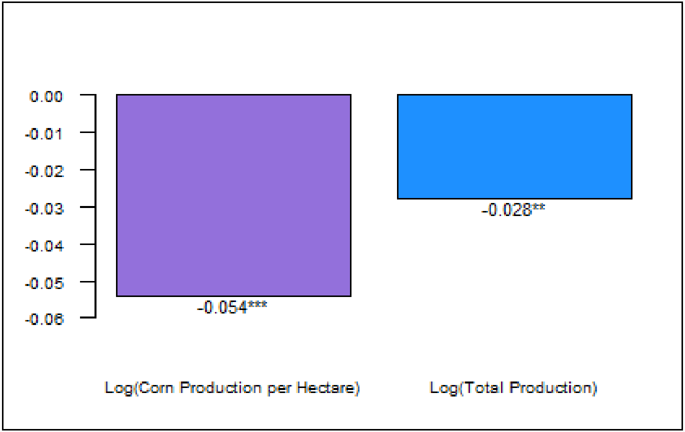
- $\boldsymbol{\mu_j}$, $\boldsymbol{\phi_t}$: municipality and year fixed effects
- $\boldsymbol{W'_{j2005} * t}$: municipality $\boldsymbol{j}$ baseline socioeconomic controls * year $\boldsymbol{t}$
- Clustered standard errors: municipality and year
  - Results robust to using Conley standard errors to account for spatial correlation

Effects on Agricultural Productivity and Total Production



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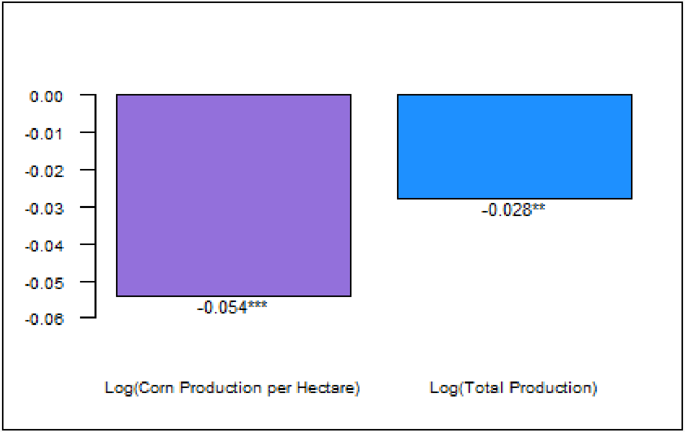

1 additional week with extreme temperature ⇒
↓ total corn production by **2.8%** and land productivity by **5.4%**

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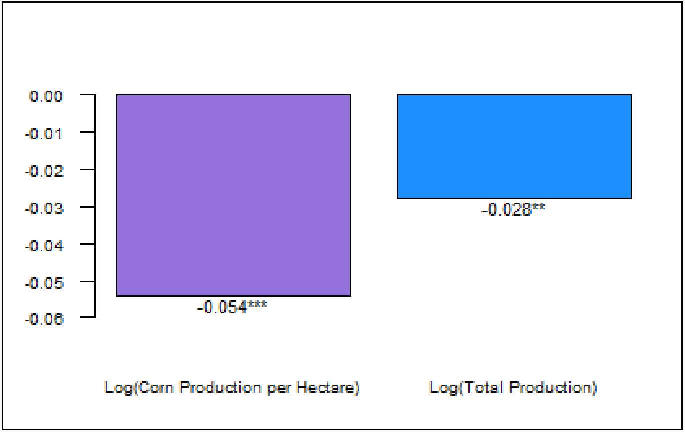

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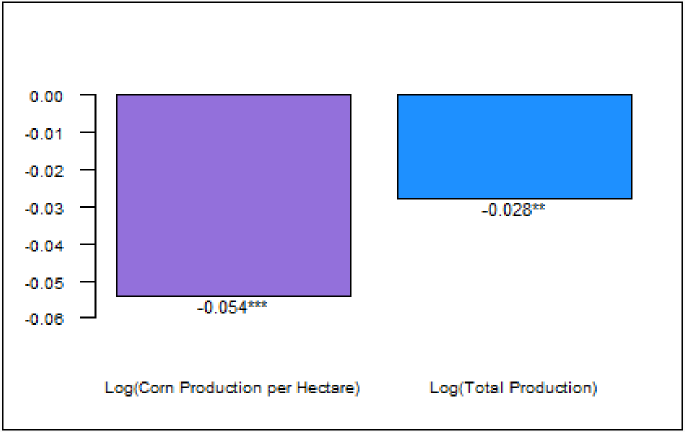

1 SD ↑ in the temperature shock ⇒
↓ total corn production by **1.6%** and land productivity by **3.1%**
⇒ adjustment through use of land (Aragon, Oteiza, Rud, 2021).

Predicted Effects of Temperature Shocks

2. Farmers adjust in the short term to protect agricultural profits and smooth consumption
   $\Rightarrow$ **adjustments through use of agricultural inputs:**

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   $\Rightarrow$ **adjustments through use of agricultural inputs:**
   - $\Downarrow$ chemical agents mostly used for post-harvest activities
   - $\Uparrow$ land allocated to corn production

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Type of worker	All Workers	Non HH Workers	Household Workers
Temperature shock t	-0.018*	-0.029**	0.015
	(0.011)	(0.012)	(0.015)
R^2	0.103	0.113	0.231
Mean	2.17	1.53	1.1
Observations	18,845	18,845	18,845

Dependent variable is the Hyperbolic Sine Transformation of Y
*p<0.1; **p<0.05; ***p<0.01

Predicted Effects of Temperature Shocks

3. Adjustment through local labor market depend on land ownerhsip:

    3.1 If landowner:

    - demand and supply labor simultaneously
    - increases working hours on own land
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    3.2 If non-landowner:

    - reallocates within agricultural sector or to the non-agricultural sector
    - migrates

Adjustments through Labor Markets

Population Group	Employed	Log Hours	Log Hourly Wage
Panel A: Individuals in Agri HH (seasonal)			
Individuals in Landowner HHs	0.001	0.010	-0.014
	(0.002)	(0.004)**	(0.007)**
Obs	78,884	42,201	18,252
Individuals in Non-Landowner HHs	**-0.009**	0.005	0.006
	(0.004)**	(0.008)	(0.008)
Obs	12,796	7,162	6,656
Panel B: Nonagricultural HH			
All HH	0.000	-0.001	0.000
	(0.001)	(0.003)	(0.003)
Obs	323,896	185,573	167,507

Standard errors in parentheses clustered by municipality and year. *p$<$0.1; **p$<$0.05; ***p$<$0.01

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- $\Downarrow$ probability of working for non-landowner agricultural workers
- No evidence of reallocation to non-agricultural sector ▸ evidence

Landowner workers increase working hours

Landowner households adjust by lowering hourly wages

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- Workers in landowning households increase working hours
- Landowner households adjust by lowering hourly wages

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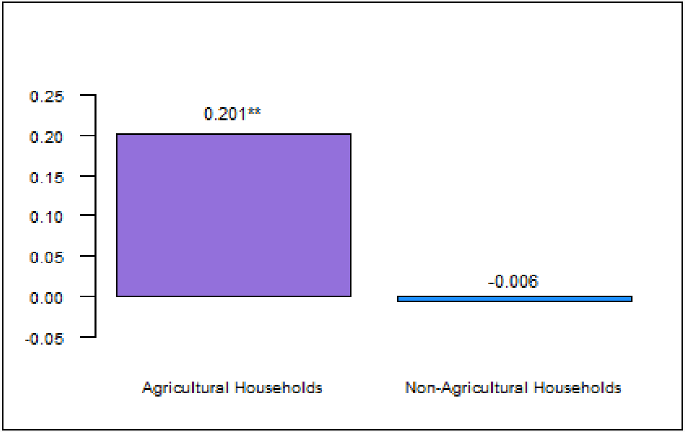
Predicted Effects of Temperature Shocks

4. To compensate for income fall agricultural workers reallocate to other sectors or migrate

    - Migration measured as the probability that a member of the household migrated **internationally** during the survey year

Probability of International Migration

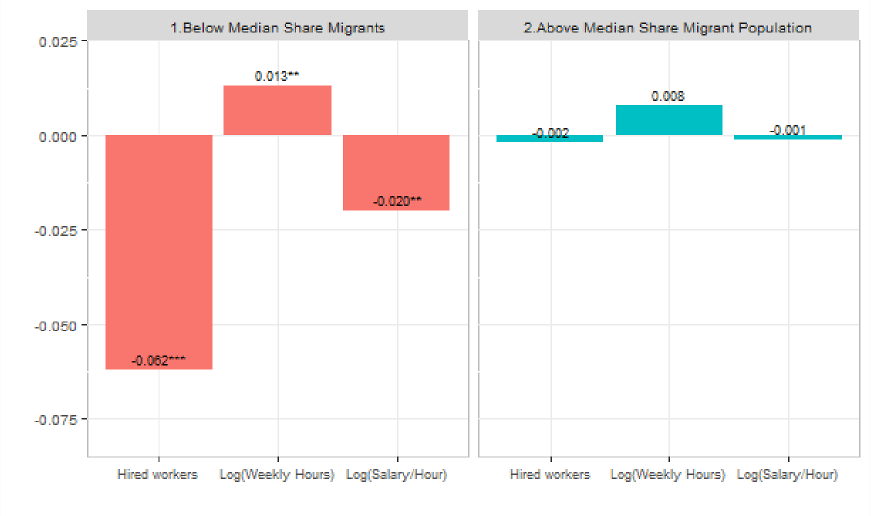


One additional week with extreme temperature increased the likelihood of migration by 20.1% relative to the mean among agricultural households

Predicted Effects of Temperature Shocks

4. Effect on agricultural labor markets and migration depend on access to risk-coping mechanisms:
    - If no access to risk-coping mechanisms, effects transmits to agricultural labor market, $\Downarrow$ agricultural wages and more reliance on migration
    - If access to risk coping mechanisms, effect does not transmit to agricultural labor market, and less reliance on migration

Access to Migrant Networks: Labor Markets



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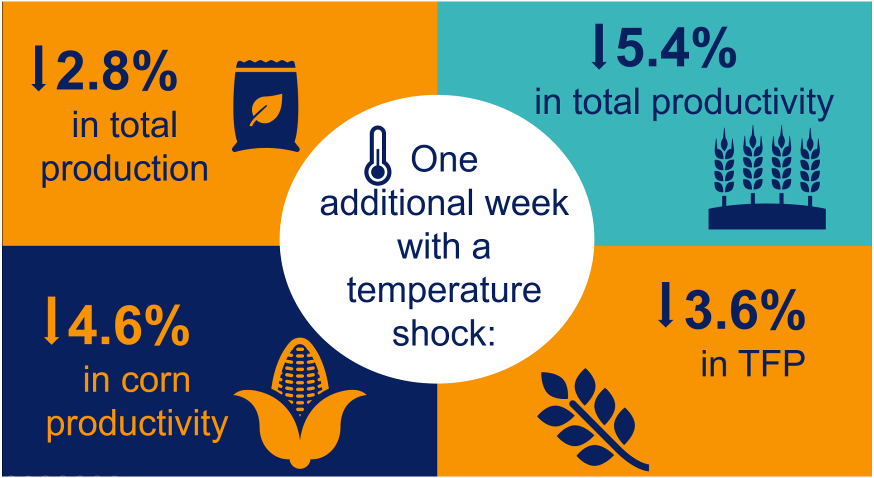
2. Receiving remittances might help to alleviate the negative temperature shock and stay in the place of origin
3. In addition credit-constrained households and non-land owners are more likely to migrate

Robustness tests

1. Definition of temperature shock:
    - Significant effects only when using the shock defined during main harvest season and robust to using different periods ▸ timing
    - Results are robust to alternative measures of temperature shocks ▸ shock
2. Validity identification strategy:
    - Placebo test: estimated effects we find are very unlikely to occur due to chance ▸ placebo
3. Other plausible mechanisms:
    - Results are robust with and without controls for violence
    - Results are driven by rural areas ▸ alt

Conclusions

1. Negative impact of extreme temperatures on agricultural production



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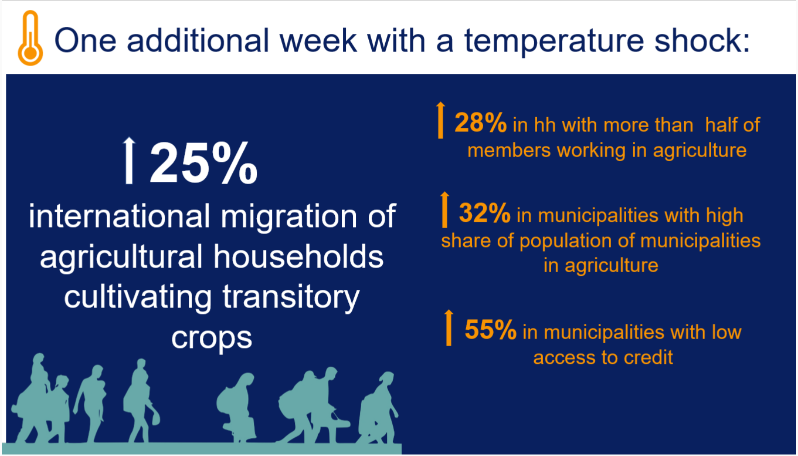
1. Negative impact of extreme temperatures on agricultural production
2. Agricultural producers respond by contracting labor demand for hired workers. The use of other inputs, in particular post-yield inputs, also decrease.
3. Labor markets: transmission mechanism of negative weather shocks, but important heterogeneity by access to land and risk-coping mechanisms

Conclusions

4. Agricultural workers respond by migrating internationally



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  i. Migration as a strategy to survive and compensate for income losses
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  ii. **Migration as a way out of poverty in regions with untenable conditions (changing climate)**
  $\Rightarrow$ Remove obstacles to migration that provides a pathway out of poverty

Thank you!

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Agricultural Seasons

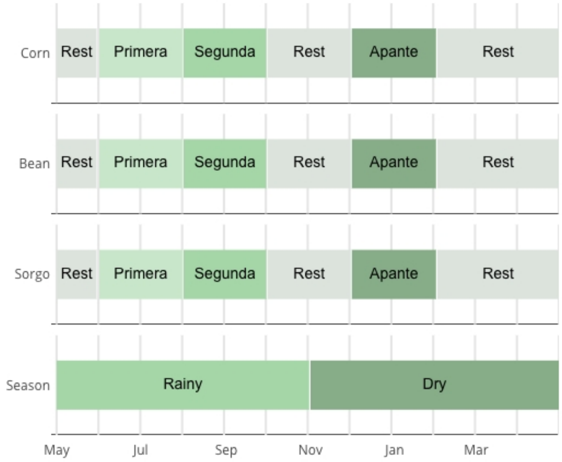

Figure 3: Agricultural Seasons of Main Crops

Impact of Temperature Shocks on Migration Likelihood-Different Shocks and Periods

	Changing the months of the shocks				Changing the range of years		
Population Group	Winter Shock	All-year Shock	Apante Shock	Lean Shock	2009-2018	2013-2018	Excluding 2015
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A							
Agricultural Households (seasona)	0.206	0.055	-0.087	-0.029	0.203	0.243	0.238
	(0.094)**	(0.045)	(0.140)	(0.092)	(0.093)**	(0.111)**	(0.099)**
R2	0.011	0.010	0.010	0.010	0.011	0.012	0.011
Crime, Weather, and Household	X	X	X	X	X	X	X
Year Fixed Effects	X	X	X	X	X	X	X
Municipal Fixed Effects	X	X	X	X	X	X	X
Municipal Socio*Year	X	X	X	X	X	X	X
Geographic*Year	X	X	X	X	X	X	X

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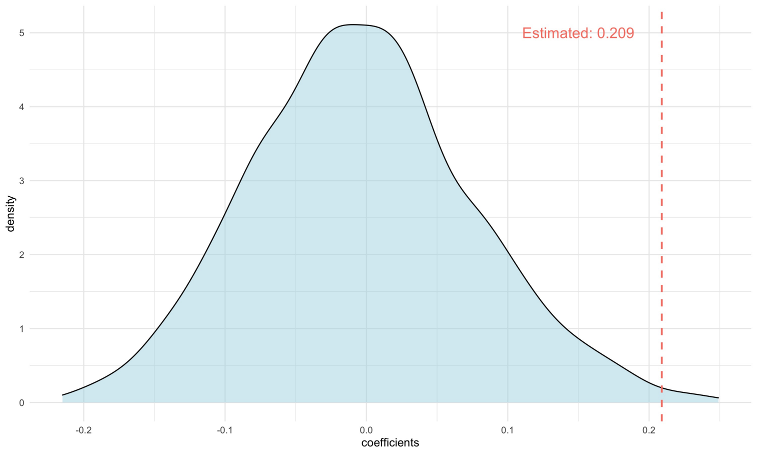
Coefficients on migration likelihood



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Alternative Measures of the Shock

Population Group	1 SD	1.5 SD	Higher 29	Higher 35
Panel A				
Agricultural Households (seasonal)	0.112	0.203	0.102	0.130
	(0.078)	(0.093)**	(0.081)	(0.062)**
R2	0.010	0.011	0.010	0.010
Crime, Weather, and Household	X	X	X	X
Year Fixed Effects	X	X	X	X
Municipal Fixed Effects	X	X	X	X
Municipal Socio*Year	X	X	X	X
Geographic*Year	X	X	X	X

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Alternative Controls and Urban vs Rural

	Agri(seasonal-rural)		Agri(seasonal-urban)	
	(1)	(2)	(3)	(4)
Temperature shock t-1	0.268	0.256	0.034	0.037
	(0.117)**	(0.116)**	(0.071)	(0.068)
Crime shock t-1		0.444		-0.114
		(0.137)**		(0.208)
Mean	0.929	0.929	0.494	0.494
Obs	17,227	17,227	4,456	4,456
R2	0.011	0.011	0.021	0.021

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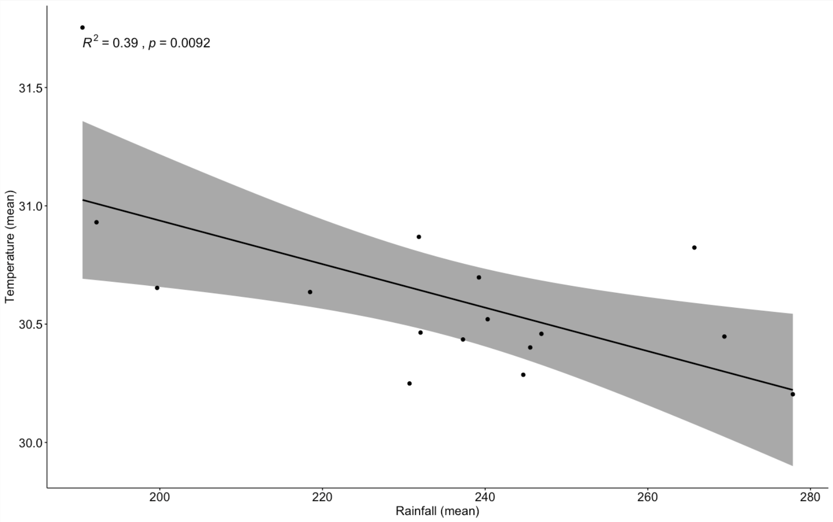
Rainfall and Temperature



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Non-Agro LLM

	Manufacture	Construction	Services	Combined sectores
Temperature Shock	-0.001	0.000	0.003	0.002
	(0.002)	(0.001)	(0.003)	(0.003)
Obs	2,239	2,239	2,239	2,239
Mean	0.131	0.065	0.281	0.477
Year + Municipality FE	X	X	X	X
Rainfall Shock year t-1	X	X	X	X
Drought Shock year t-1	X	X	X	X
Crime Shock year t-1	X	X	X	X
Municipal characteristics*Year	X	X	X	X

back