Weather Shocks and Food Prices in a Very Diverse Country: Evidence from Colombia

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Motivation and Research Question

Ample literature about short & long term effects of climate change on agriculture (Deschênes and Greenstone, 2007; Schlenker and Roberts, 2009; Burke and Emerick, 2016)

- Focused on single crops (e.g., Burke and Emerick 2016; Cui 2020 on maize and soy in the US; Cui and Xie 2022 for maize in China)
- Or aggregated measures (e.g., Heinen et al. 2019 on CPI for Caribbean countries; Abril-Salcedo et al. 2020 for food CPI in Colombia; Chen and Gong 2021 for agricultural TFP in China)
- Or focused on specific geographic regions (e.g., the US midwest)

Motivation and Research Question

Research question: What are the heterogeneous effects of extreme precipitation events on food prices in Colombia?

- We focus our analysis on wholesale prices
- We address weather shocks at producing municipalities
- We also address differences in growing cycles (i.e., non-perennial Vs. perennial crops), that also bring heterogeneous effects of weather shocks
- We provide estimates of impacts of both local (i.e., panel) and aggregated (i.e., time series) events of weather shocks on food prices
- We also identify some key drivers that help to explain our findings

Why Colombia?

It is a tropical country...

- Tropical areas are expected to experience severe effects of climate change on agricultural production $\rightarrow$ higher temperatures and more volatile precipitation regimes (Dell et al., 2014; Ortiz-Bobea et al., 2021)
- Such these effects can be heterogeneous across regions, according their own geographic, topographic and hydrologic conditions (Carter et al., 2018; Ortiz-Bobea et al., 2021)
- More than 200 crops (perennial and non-perennial) grow in this country

And a developing nation as well

- Approx. 20% of rural labor force works in agriculture (Otero-Cortés, 2019)
- Higher incidence on poverty and food security
- Lack of both adequate production technologies and transportation infrastructure for most growers (Gáfaro and Ocampo, 2019) can exacerbate effects of weather shocks on food prices

Data and Stylized Facts

Price Data: Sistema de información de precios (SIPSA) - DANE

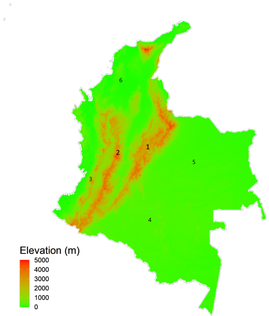
- We consider prices for 28 non-perennial and 17 perennial crops on 20 different wholesale centrals in Colombia (about 7% of total CPI) List of products
- Available since 2013, we conduct our estimations for the period 2015–2022, to account for **relevant weather**
- Also collects info on the origin of the products and their corresponding quantities delivered

Weather Data: Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)

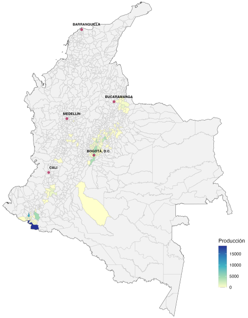
- For each month at any municipality, we compare the observed amount of precipitation with its historical distribution (1981–2012), to identify extreme weather events:
  - **Excessive precipitation:** Above the 80th percentile
  - **Lack precipitation:** Below the 20th percentile

Data and Stylized Facts

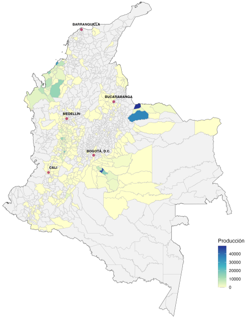
Avg. altitude × municipality



Production of Potato, 2020

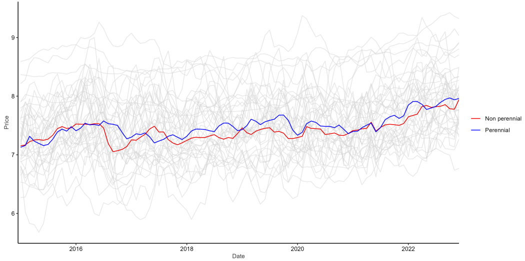


Production of Plantain, 2020

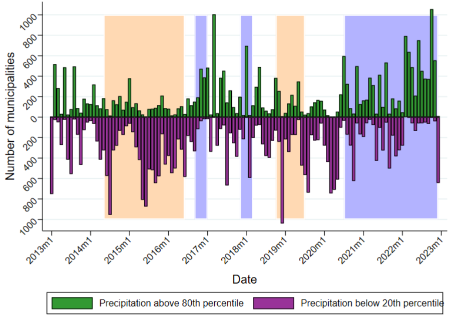


Data and Stylized Facts

Evolution of log(prices)

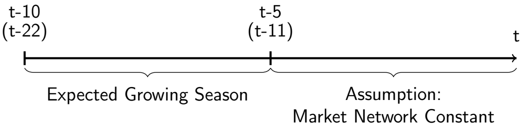


Number of Precipitation Shocks



Methodology: Identifying Relevant Weather

Non-Perennial Crops (Perennial Crops)



$\forall i \in I : weather^s_{jt} = \sum_{m \in M_{jt}} C^s_{mt} \times w_{mjt}$

- $M_{jt} \rightarrow$ Producing municipalities m in t that sent the product to wholesale central j between $t-5(t-11)$ and $t-10(t-22)$
- $\forall s \in S = \{\text{excess, lack}\}$: $C^s_{mt} \rightarrow$ Number of months each event happened at each producing municipality between t and $t-5$
- $w_{mjt} \rightarrow$ Share of producing municipality on total volume of product sent to wholesale central j during expected growing season

Methodology: Effects of Local and Global Weather Shocks

Local Shocks: TWFE models for each product, regressing the wholesale price of i at market j as a function of the extreme weather events at producing municipalities that belong to M_{jt}:

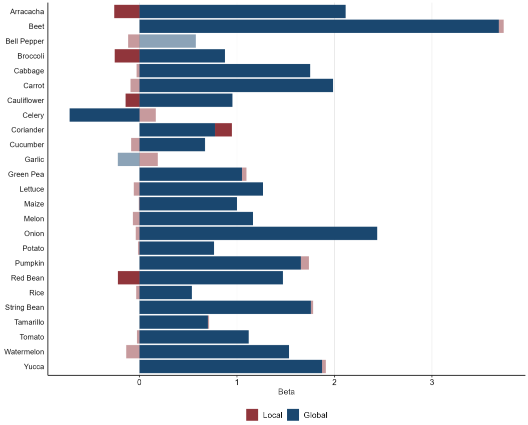
$$\forall i \in I : log(p_{jt}) = \sum_{s \in S} \beta_s weather^s_{jt} + \gamma_j + \delta_t + \epsilon_{jt}$$

Global Shocks: We follow Galiani and Porto (2010) and Cruces et al. (2018) (Effect of global trade shocks on local employment) by conducting WLS estimations of the estimated period FE (δ_t) from TWFE models on average weather shocks in period t:

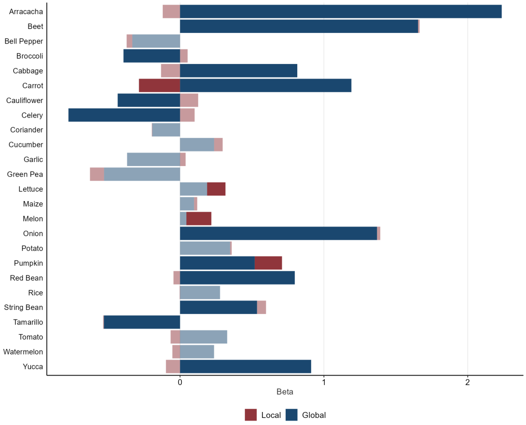
$$\forall i \in I : \widehat{\delta_t} = \omega + \sum_{s \in S} \alpha_s \overline{weather^s_t} + u_t$$

Main Results: Non-Perennial Crops

Excess of Precipitation

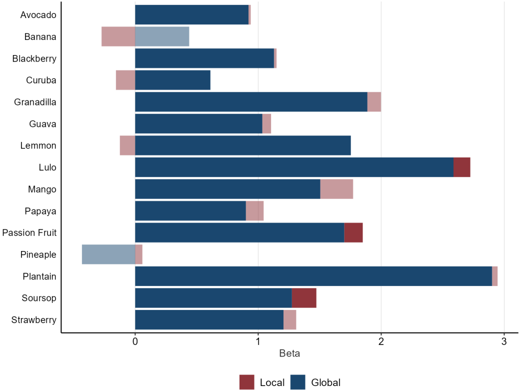


Lack of Precipitation

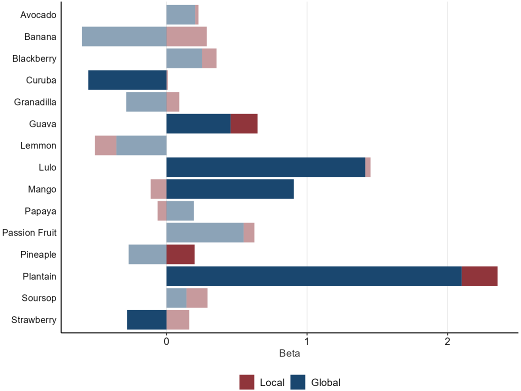


Main Results: Perennial Crops

Excess of Precipitation



Lack of Precipitation



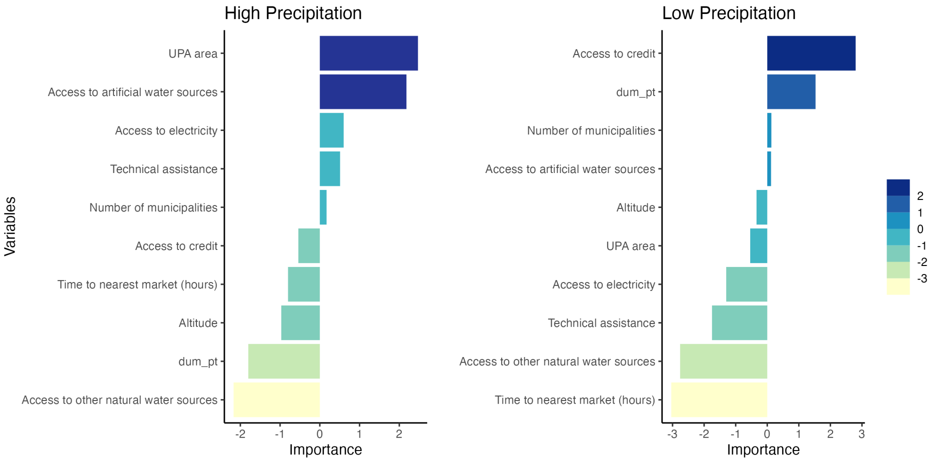
Identifying Mechanisms

Random Forest model to identify key municipality-level drivers of increases in food prices through weather shocks

- Ranks feature variables (taken from 2014 Colombian Agricultural Census) according their importance on explaining the observed variance of the outcome of interest List
- Outcome: $\forall i \in I$ & $\forall s \in S$: $I[=1]$ if both $\widehat{\beta_s}$ and $\widehat{\alpha_s}$ are positive and at least one of them is statistically significant (p-value ≤ 0.1), zero otherwise
- Decision tree created using bootstrap aggregating (Bagging) $\rightarrow$ all drown samples help to create a decision tree to rank the feature variables

Identifying Mechanisms: Main Results

Importance Ranking



Identifying Mechanisms: Main Results

The previous results are informative on the importance of the feature variables on explaining the observed variance of the outcome, but do not say anything about the **direction** of such relationship

To identify such those signs, for each type of precipitation shock we estimate:

$$I\left[\left(\widehat{\beta_s}\ \&\ \widehat{\alpha_s} > 0\right)\&\left(pval(\widehat{\beta_s} \leq 0.1) \mid (pval\widehat{\beta_s} \leq 0.1)\right) = 1\right]_i = \gamma' \bar{X}_i + u_i$$

- Excessive precipitation: Access to non-natural water (+), electricity (-), tech. assistance (+)
- Lack of precipitation: Access to credit (-), type of crop (=1 if perennial) (-)

Final Remarks

- We address heterogeneous effects of precipitation shocks on wholesale food prices in Colombia, a country with geographical and climate diversity, and vast agricultural regions
- Our measures of weather are focused at the producing municipalities
- We find that global (i.e., countrywide) shocks are still the most relevant to explain increases in food prices
- Perennial crops tend to be more resilient
- Better producing infrastructure and technical assistance are key features for resilience

List of Products

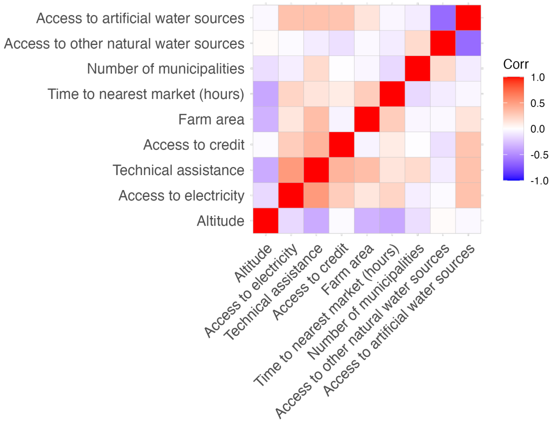
Perennial Crops		
Fruits		**Plantains**
Avocado	Lemmon	Plantain
Banana	Lulo	
Blackberry	Mango	
Curuba	Papaya	
Granadilla	Passion fruit	
Guava	Pineapple	
Soursop		
Strawberry		

Non-perennial Crops			
Cereals and grains	**Fruits**	**Roots and tubers**	**Vegetables**
Maize	Melon	Arracacha	Beet
Red bean	Tamarillo	Potato	Bell pepper
Rice	Watermelon	Yucca	Broccoli
			Cabbage
			Cauliflower
			Celery
			Coriander
			Garlic
			Green Pea
			Lettuce
			Onion
			Pumpkin
			Tomato

Back

Feature Variables on Random Tree Model

Correlation Matrix



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