Impact of Climate Change on Food Consumption: Evidence from India.

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Outline

Introduction and Motivation

Introduction

Economists have mostly focused on estimating the impact of weather on agricultural production.

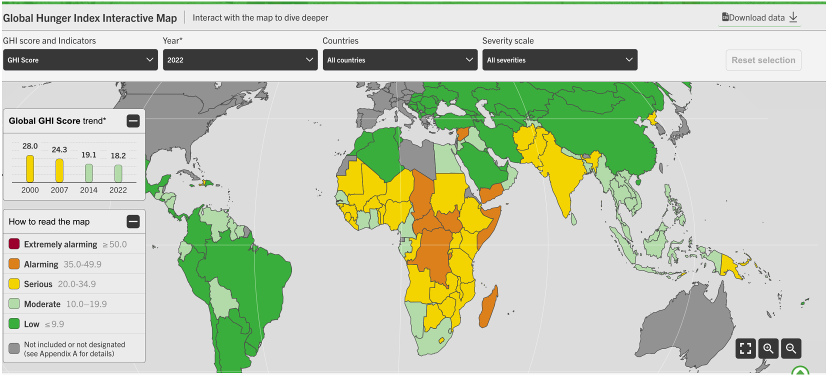
- Higher temperatures reduce agricultural yields.

But whether this reduction in yields effects humanity's nutrition is unknown.

Research Question

We use household-level survey data *(1994-2012)* from India and combine it with weather data to analyse how higher temperatures effect nutrition.

Global Hunger Index (India ranks 107^{th} out of 121 countries)



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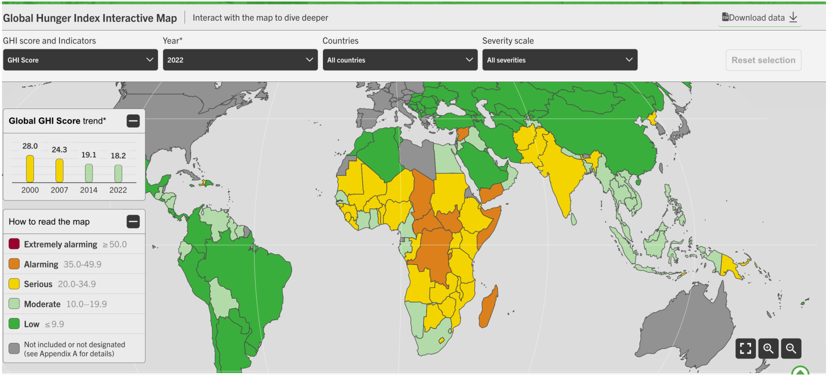

- India has frequent heat waves
- Identified by IPCC (2018) as the most vulnerable nation in terms of food production due to global warming

Outcomes of Interest

1. Calories
2. Protein
3. Fat
4. Food Diversity
5. Diet Diversity

Data

Data on Food Consumption

3 rounds of Household Consumption Surveys of NSS

1. 50^{th} (1993-1994)
2. 61^{st} (2004-2005)
3. 68^{th} (2011-2012)

Representative estimates at the country, state and NSS region level.

NSS Consumer Expenditure Survey

- Recall period of past 30 days for food items
- Total consumption spending per item = Consumption from Market + Consumption from Home Production, valued at locally prevailing prices.
- Data on demographic and economic characteristics of the household such as its religion, caste, the primary cooking and lighting fuel is also collected
- Conversion of Quantities into Calories, Protein and Fat using conversion factors provided by NSS
- We split households into two sub-samples depending on its sector.

Weather Data

Daily gridded $(1^\circ \times 1^\circ)$ resolution data on temperature and rainfall over the period 1969-2013 were obtained from IMD

- Temperatures are assigned to households at the NSS region level
- Both day and night temperatures may affect nutrition.
- We therefore measure temperature using daily mean temperature.
- Since NSS records consumption in the past 30 days preceding the survey, we average the daily mean temperature and rainfall in this 30 day period for each NSS region.

Weather Data

- The temperature variables have been scaled in the regressions by dividing by 100.
- As the dependent variable is logged in all the models $\implies$ estimates on the temperature variables are to be interpreted as percentage changes.

Model

Model

- The linear model we estimate is as follows:

$$\log(Y_{irt}) = \delta_r + \nu_m + \gamma_y + \beta_1 \mathit{MeanT}_{rt} + \beta_2 \mathit{Rain}_{rt} + \alpha X_{irt} + u_{irt} \tag{1}$$

- i household
- r region
- t time from d to $(d - 30)$
- $log(Y_{irt})$ is logarithm of one of five dependent variables
- $MeanT$ is the average of the daily mean temperature and it varies by region and t.
- X_{ir} household level explanatory variables
- δ_R NSS Region FE & ν_m interview Month FE & γ_y interview Year FE

Binned Model (Bins of 3 degrees each of daily MeanT)

- (4,19],(19,22],(22,25],(25,28],(28,31],(31,36].
- We count the number of days daily MeanT during the recall period fell in each of the bins.

$$\log(Y_{irt}) = \delta_r + \nu_m + \gamma_y + \sum_{j=2}^{6} \omega_j B_{rt}^{j} + \beta_2 Rain_{rt} + \alpha X_{ir} + u_{irt} \quad (2)$$

- $B^j \rightarrow$ count of the number of days daily MeanT in time t in region r in temperature bin j.

Public Distribution System (PDS)

- Khera (2011) estimates per-capita PDS grain purchased for 19 of the largest states from 1999-2008.
- A state is classified as ‘PDS functioning’ in a year if the per-capita purchase of grain from PDS is $\geq$ to 1 kg
- We use this to construct an indicator variable for states with a functioning PDS.

Public Distribution System (PDS)

PDS may mitigate the impact of heat shocks on food consumption in states with lower levels of corruption.

- Heat shocks $\rightarrow$ deviations from the monthly historical average temperature
  1. For every NSS region we generate a distribution of mean temperature for each 30 day interval in our sample from 1969-2012.
  2. We calculate the mean and SD of this distribution

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  2. We calculate the mean and SD of this distribution
  3. $\frac{MeanT_{rt} - Mean_{MeanT_{rt}}}{SD_{MeanT_{rt}}}$
- We interact heat shock the indicator variable for a functioning PDS.

Model

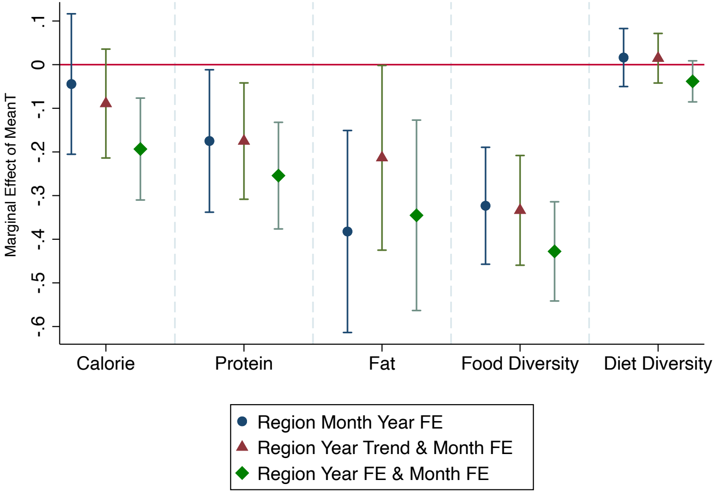
- (-2,-1],(-1,-0.5],(-0.5,0.5],(0.5,1],(1,2],[> 2]
- The third bin is the omitted category.

$$\log(Y_{irt}) = \delta_r + \nu_m + \gamma_y + \sum_{j=2}^{5} \omega_j B_{rt}^j + \zeta PDS_{sy} + \sum_{j=2}^{5} \eta_j B_{rt}^j * PDS_{sy} + \beta_2 Rain_{rt} + \alpha X_{ir} + u_{irt} \quad (3)$$

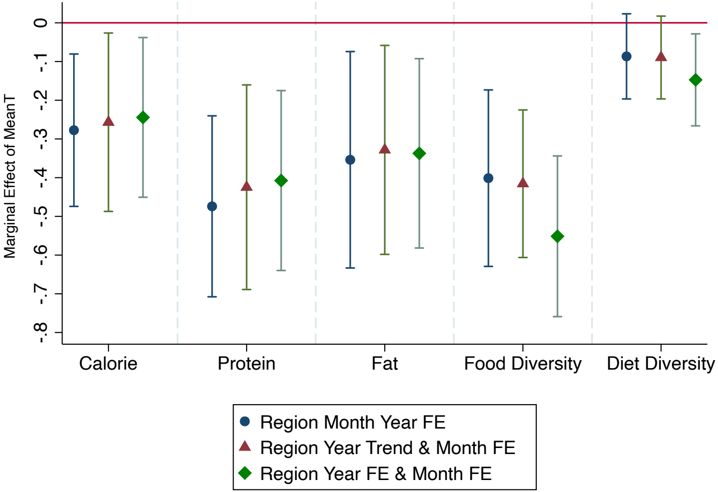
- The term $\eta_j B_{rt}^j * PDS_{sy} \implies$ the interaction of the PDS indicator variable with each of the bins.
- PDS $\implies$ food, the effect of heat shocks should be lower in states with a functional PDS $\implies$ $+$ coef on interaction

Results

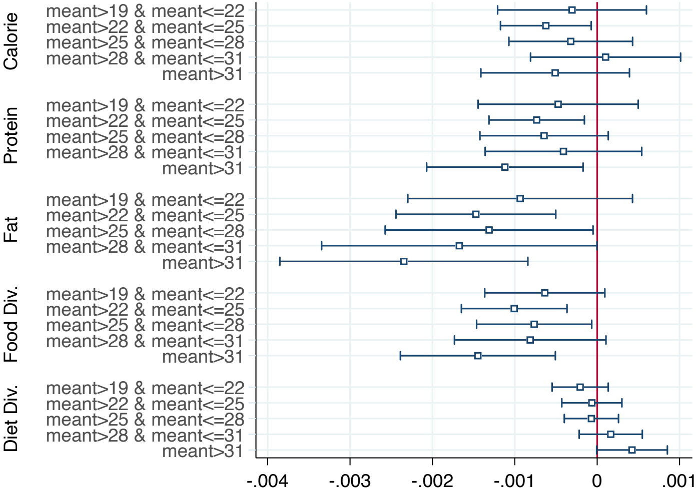
Results: Linear Model (Rural Sample)



Results: Linear Model (Urban Sample)



Results: Binned Model (Rural Sample)



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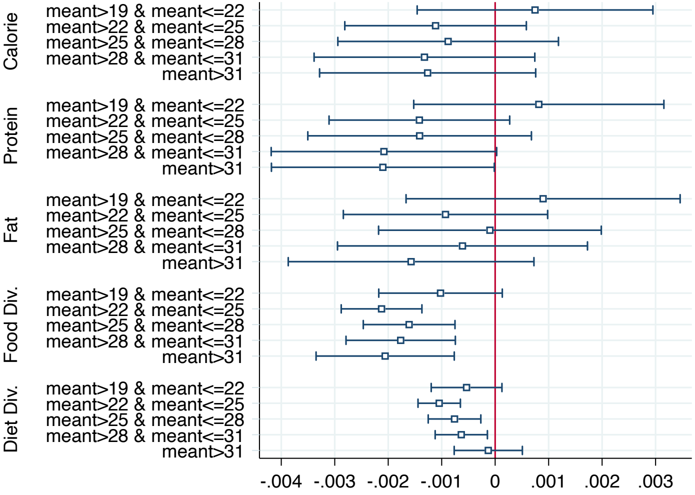
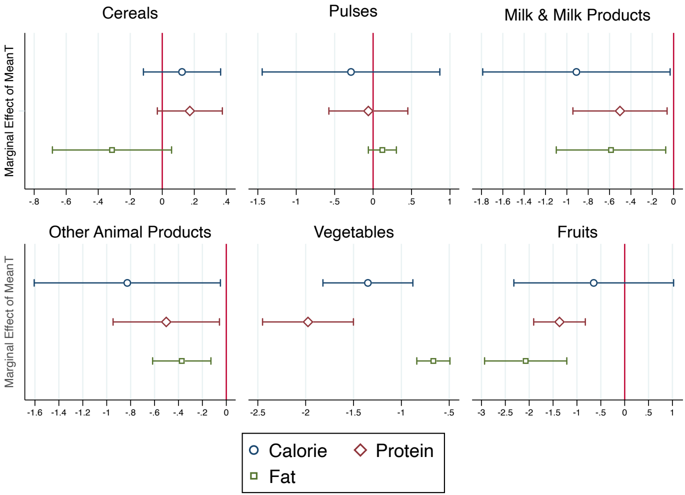
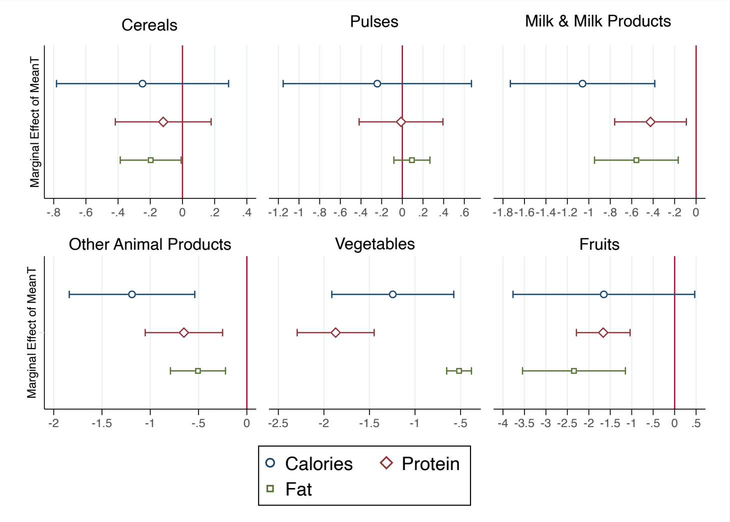


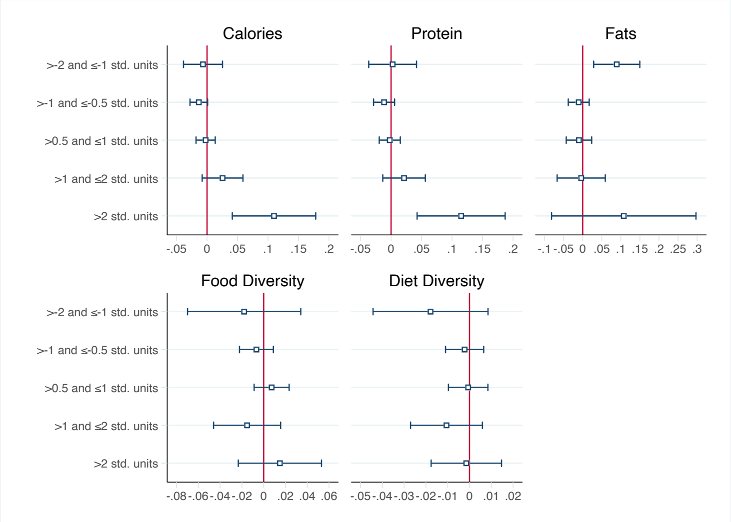
Impact of Average Mean Temperature on Nutrition by Food Group: Rural Sample



Impact of Average Mean Temperature on Nutrition by Food Group: Urban Sample



Impact of Heat Shocks on Nutrition by Public Distribution System (Rural Sample)



Impact of Heat Shocks on Nutrition by Public Distribution System (Urban Sample)

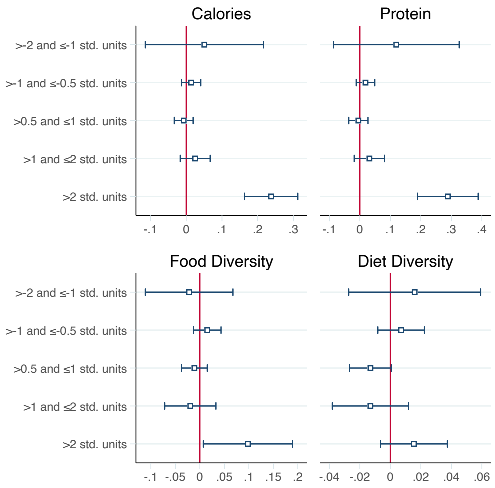


Table: Impact of Average Mean Temperature on Consumption of Perishables and Non-Perishables

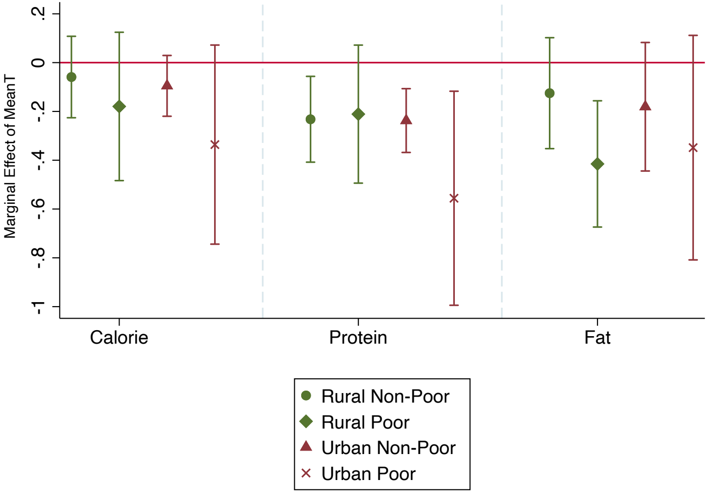
	Rural Sample					
	Perishable			Non-Perishable		
	Calorie	Protein	Fat	Calorie	Protein	Fat
MeanT	-1.701***	-1.717***	-2.016***	0.069	0.103	-0.343
	(0.543)	(0.457)	(0.525)	(0.159)	(0.133)	(0.209)
Observations	171012	170849	171330	171012	170849	171330
	Urban Sample					
	Perishable			Non-Perishable		
	Calorie	Protein	Fat	Calorie	Protein	Fat
MeanT	-1.619***	-1.626***	-1.700***	-0.458	-0.352	-0.438
	(0.476)	(0.330)	(0.445)	(0.492)	(0.372)	(0.307)
Observations	117026	116982	117163	117026	116982	117163

Table: Impact of Refrigeration Technology on Consumption of Perishables

	Rural			Urban		
	Calorie	Protein	Fat	Calorie	Protein	Fat
MeanT	-1.240*	-1.411***	-1.693***	-2.081***	-2.079***	-2.429
	(0.637)	(0.513)	(0.525)	(0.646)	(0.506)	(0.59
MeanT*Fridge	1.685***	1.562 ***	2.401 ***	2.508 ***	2.179 ***	2.791
	(0.567)	(0.439)	(0.554)	(0.536)	(0.402)	(0.51
Observations	111994	111847	112237	76695	76664	7679

Results of Non-Perishables

Impacts by Economic Status



Conclusion

Conclusion

1. **Statistically Significant Small Effects for All Food Items**
For example, a 1°C increase in mean temperature over the recall period of about 30 days decreases household-level protein consumption by about 0.2% in rural India and by about 0.4% in urban India.

2. **Effects are larger when we focus on Food Groups**

- Perishables/Non-Perishables - Results suggest that that consumption of food items that are non-perishable is not affected by higher temperatures.
- Refrigeration Technology - Fridge ownership offsets the negative impact of temperature on food consumption.
- Impacts by Economic Status - Poor households' consumption of perishables is significantly impacted by temperature increases compared to non-poor households.
- Impacts by Social Safety Nets - Being in a state where the PDS is functional helps reduce the negative impact of temperature.

Conclusion

1. Higher temperatures have a significant impact on food-consumption but only for perishable food items.
2. The poorest are most vulnerable as they do not own a fridge.
3. Social Safety nets such as PDS $\uparrow$ food supply to households $\implies$ $\downarrow$ the impact of heat shocks
4. Higher temperatures will further make it harder for poor households to maintain diet diversity and this may $\uparrow$ malnutrition that further $\uparrow$ poverty.

Thank You!

References

IPCC (2018). *Summary for Policymakers*, volume b, pages 1–24. Cambridge University Press.

Khera, R. (2011). Trends in diversion of grain from the public distribution system. *Economic and Political Weekly*, pages 106–114.

Table: Impact of Refrigeration Technology on Consumption of Non-Perishables

	Rural			Urban		
	Calorie	Protein	Fat	Calorie	Protein	Fat
MeanT	-0.156	-0.029	-0.639**	-1.442*	-1.088*	-1.025**
	(0.198)	(0.165)	(0.249)	(0.841)	(0.642)	(0.508)
MeanT*Fridge	-0.118	-0.008	0.085	1.086	0.948*	0.824*
	(0.243)	(0.230)	(0.254)	(0.746)	(0.565)	(0.433)
Observations	111994	111847	112237	76702	76671	76798

Results of Perishables