The Impact of Climate Change on China's Rural Labor Reallocation

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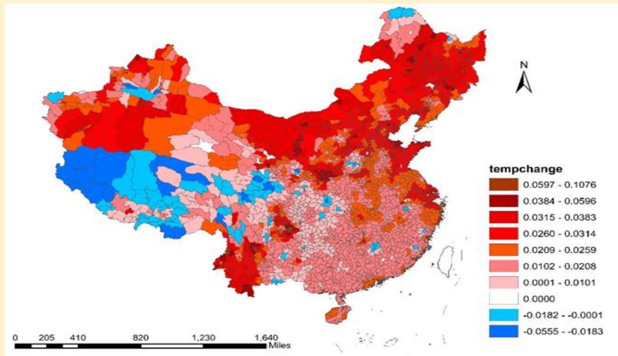
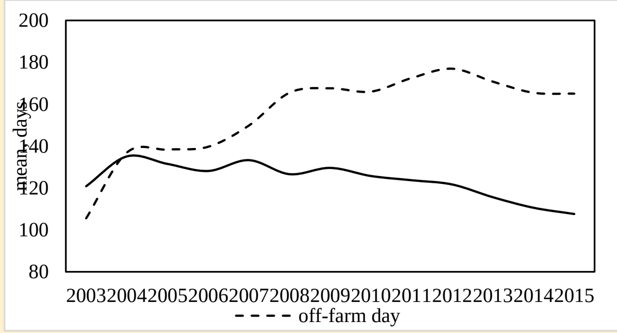
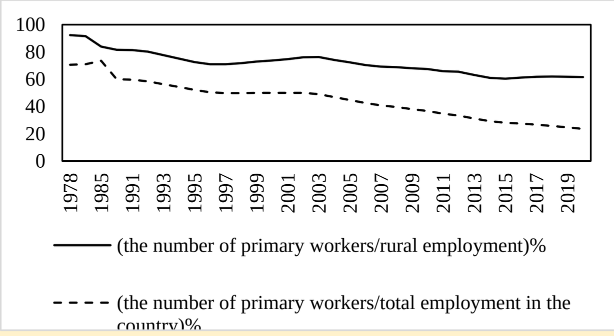
Background

△In the past 50 years, the Earth's surface temperature has increased by an average of 1.1 °C per year in China, and the rate of warming has accelerated.
△The proportion of China's rural person in the primary industry has dropped from 76.2% in 2003 to 61.5% in 2020;
By 2020, the proportion of employment in the primary industry in total employment has dropped to 23.6%.
△There is a relationship between climate change and labor force.







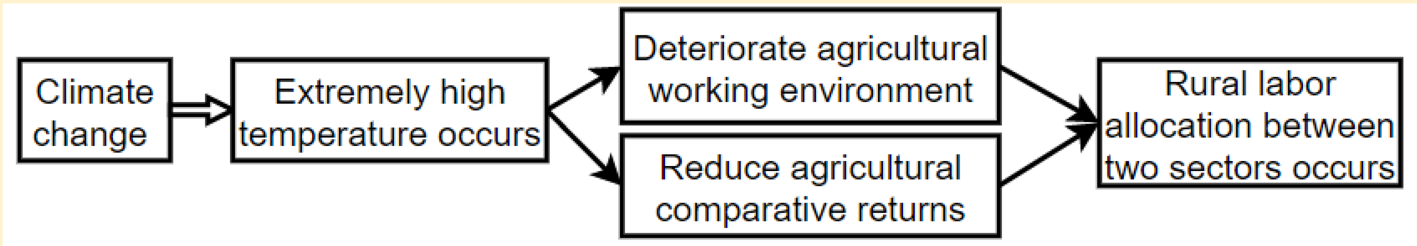
Objectives

Identify the effect of high temperature caused by climate change on the China's rural labor allocation:
——How extreme heat affect the number of days when doing agriculture work?
——And how about the number of days when doing non-farm work?
——Is there some heterogeneities about education level and district?

Mechanism

△ Climate change affects the labor force by changing the working environment. High temperatures and high humidity make agricultural labor more likely to be exposed to unsafe work conditions, leading to a decrease in labor productivity or a decrease in working hours.

△ Climate change has an impact on the time distribution of labor by changing comparative benefits between sectors. The disproportionate impact of climate change on the agricultural and non-farm sectors has led to a gap in the marginal rate of return for labor between the two sectors, which in turn triggers economic mechanisms and thus affects labor allocation.

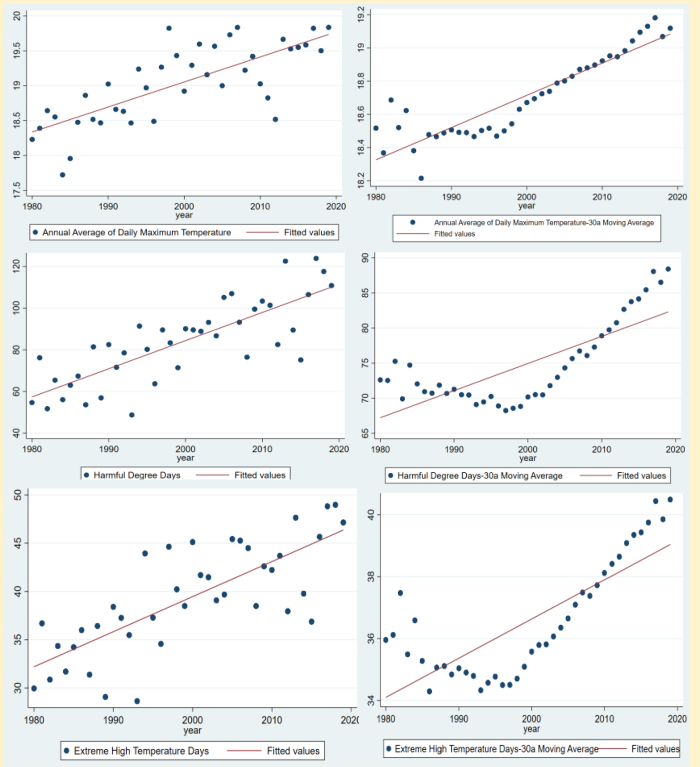


Data resource and measurement

Data resource consists of two parts: one is socioeconomic data, and the other is China's meteorological data.

The socioeconomic data is a tracking data in rural areas from 2003 to 2019, including more than 20000 households and more than 50000 individuals in 359 villages around the country. The samples we used are about 140000 (unbalanced panel).
The China's daily meteorological data comes from the China Meteorological Data Sharing Service System (http://cdc.nmic.cn).

Three metrics were constructed to measure high temperatures:
△ The mean maximum temperature (MMT), which is the annual aggregate average of the daily maximum temperature of a village in a given year.
△ Extreme high temperature days (EHTD), that is, the number of days in a village with a temperature exceeding 30℃ in an annual.
△ Harmful Degree Days (HDD), which adds up the maximum daily temperature of the year above 30℃.
We calculated a 30-year moving average, including the survey year, to characterize long-term climate change.



Estimating Model

It is generally believed that the individual's time endowment is given, there is a strong correlation between the number of agricultural days and non-farm days in a year,
ie. $cov(\epsilon_{ihct}.Farm, \epsilon_{ihct}.Non\_farm) \neq 0$,
using Seemingly Unrelated Regression can improve the effectiveness of the estimate.

$$Non\_farm_{ihct}=\beta Weather_{ct} + \mu X_{iht} + \omega_i + \tau_t + \epsilon_{ihct}$$
$$Farm_{ihct}=\beta Weather_{ct} + \mu X_{iht} + \omega_i + \tau_t + \epsilon_{ihct}$$

Descriptive statistics for variables

Variables	Obs	Mean	Std	Min	Max
Dependent Variables:					
Off-farm-day	144986	118.95	107.6	0	365
Farm-day	144986	97.87	90.61	0	365
Individual Variables:					
Gender	144986	0.59	0.49	0	1
Age	144986	45.14	12.90	18	74
Education years	142092	7.03	2.68	0	30
Health Status	144806	1.56	0.77	1	5
Household Variables:					
Total dependent rate	138742	0.20	0.51	0	5
Main source of income	144729	1.68	1.24	1	8
Area of cultivated land operated	136089	9.30	14.02	0	300
Average mechanical costs per acre	135094	79.95	51.15	0	300
Village Variables:					
Village topography	144385	1.95	0.82	1	3
Non-farm wage level（log）	143219	10.63	1.68	0	19.99
County Variables:					
County GDP per capita（log）	93004	9.58	0.78	7.7	11.80

i, h, c and t represent individuals, households, villages, and years, respectively.
Non_farm_{ihct} and Non_farm_{ihct} respectively represent the number of days that the individual i of household h in village c put into agricultural production and the number of days they put in non-agricultural work in t years, respectively.
$Weather_{ct}$ represents the climate variables of the t year in c county, including the temperature series variables, precipitation, hours of sunshine, and relative humidity.
X_{iht} is a series of control variables, namely the individual, household, village and county control variables mentioned above.
Individual fixed-effect ω_i and time-fixed effect τ_t are also included in the model to minimize missing variable bias. Where ϵ_{ihct} is the error term.

Results

Baseline results

High temperatures caused by climate change have reduced agricultural work days and increased non-farm work days. The coefficient of influence of long-term high temperature changes is much greater than that of short-term.
The frequent occurrence of high temperature weather caused by climate change significantly affects the allocation of working days of farmers, who in turn will adapt to climate change by adjusting the allocation of working days between the agricultural and non-agricultural sectors.

Effects of short/long term high temperatures on the supply of agricultural and non-farm working days

Variable	Short term		Long term	
	Non-farm-day	Farm-day	Non-farm-day	Farm-day
MMT	4.227^{***}	-2.438^{***}		
	-5.82	(-4.59)		
TAP	-1.612^{***}	-0.303		
	(-3.26)	(-0.82)		
MMT(30a-ma)			29.84^{***}	-13.57^{***}
			-14.22	(-6.06)
TAP(30a-ma)			-15.55^{***}	-1.538
			(-5.90)	(-0.70)
Individual	Y	Y	Y	Y
Household	Y	Y	Y	Y
Village	Y	Y	Y	Y
County	Y	Y	Y	Y
Year	Y	Y	Y	Y
Observation	114873	114873	116314	116314
Adjusted R2	0.4064	0.5415	0.3739	0.4261

Heterogeneity analysis

Differences in education levels in the impact of climate change on labor allocation

	Panel A: off-farm-day			Panel B: farm-day		
	grade=1	grade=2	grade=3	grade=1	grade=2	grade=3
MMT	3.945^{***}	2.630^{***}	3.32	-1.437^{**}	-0.922	-0.513
	-6.14	-3.32	-1.59	(-2.45)	(-1.49)	(-0.36)
TAP	-0.159	0.525	-0.0248	-0.693^{*}	-0.247	0.39
	(-0.43)	-1.12	(-0.02)	(-1.87)	(-0.64)	-0.47
Control variables	Y	Y	Y	Y	Y	Y
Observation	150537	149611	23738	150537	149611	23738
Adjusted R2	0.008	0.014	0.014	0.09	0.054	0.054
Chow test for difference of coefficients of MMT						
Panel A: off-farm-day						
grade=1 vs grade=2	F=591.479			Prob>F 0.000		
grade=2 vs grade=3	F=188.973			Prob>F 0.000		
grade=1 vs grade=3	F=108.040			Prob>F 0.000		
Panel B: farm-day						
grade=1 vs grade=2	F=746.347			Prob>F 0.000		
grade=2 vs grade=3	F=182.597			Prob>F 0.000		
grade=1 vs grade=3	F=109.945			Prob>F 0.000		

Different education level

when the years of education is ≤ 6, grade = 1;
when the years of education is 6<edu ≤9, grade = 2;
when the years of education is 9<edu, grade = 3.
The effect of "promoting non-farm and inhibiting agriculture" of high temperature is mainly manifested in groups with ≤6 years of schooling.
The impact on the labor force with junior high school education is mainly reflected in the increase in the number of non-farm employment days, while the impact on the reduction of agricultural labor time is not significant.

Different district

We divide China into "north and south", "east, central and western" and "seven major regions". There is a significant spatial heterogeneity in the impact of the temperature on working time. The increase in non-farm working days caused by high temperature is mainly concentrated in the western region. The high temperatures leads to an increase in agricultural working days in the northeast, a feature that is significantly different from the rest of the country.

Regional differences in the impact of climate change on labor allocation

	North and South		East, Central and Western		Seven Major Regions	
	Non-farm	Farm	Non-farm	Farm	Non-farm	Farm
MMT	7.21^{***}	-1.87^{***}	6.78^{***}	-1.52^{**}	2.33	-3.02^{***}
	-7.08	(-3.60)	-5.99	(-2.22)	-0.95	(-2.72)
MMT× south	-4.13^{***}	1.03				
	(-2.78)	-1.41				
MMT× central			-4.14^{***}	0.1		
			(-2.78)	-0.13		
MMT× western			4.90^{**}	-0.89		
			-2.09	(-0.81)		
MMT× East China					-2.38	-1.09
					(-0.83)	(-0.80)
MMT× Northeast					4.55^{*}	3.52^{***}
					-1.65	-2.69
MMT× Central China					1.76	2.04
					-0.55	-1.47
MMT× Southern China					6.76^{**}	-0.12
					-2.32	(-0.07)
MMT× Southeast					6.88^{*}	-1.34
					-1.82	(-0.84)
MMT× Northwest					12.44^{***}	1.74
					-3.2	-1
Observation	134324	306385	134324	306385	134324	306385
Adjusted R2	0.026	0.067	0.026	0.067	0.027	0.068

Conclusions

The high temperature caused by climate change will significantly reduce the number of agricultural days and increase the number of non-farm working days of rural labor.
The impact of high temperatures on labor allocation varies across educational levels and regions.