The impact of extreme weather on agriculture in China

Guang Chen[1] and Akira Hibiki[2]

Introduction

With the world's industrialization process, the earth's surface temperature has gradually risen. According to the WMO (2019), the global mean temperature in 2019 was approximately 1.1 ± 0.1 °C higher than the 1850-1900 baseline used as an approximation of preindustrial levels. China's warming rate over the same period is higher than the global average, which may be related to rapid urbanization (Blue Book on Climate Change in China, 2022). As a developing country with a large population and a fragile ecological environment, China is vulnerable to the adverse effects of climate change, especially agriculture.

Previous studies have mainly concluded that climate change primarily affects agricultural production through temperature, precipitation, extreme weather, etc. Burke, M. and Emerick (2016) found that longer term impact of temperature on the crop yield is smaller than the short-term impact because of adaptation. Chen and Gong (2021) found that extreme heat has negative effects on China’s agricultural TFP. We In this study, we focus on the impact of extreme temperature and precipitation on agriculture in China and especially how the advanced technology reduces the negative impact. We also analyze the impact of weather on agricultural energy consumption as the proxy of adaptation.

Methods and data

This study uses the bins approach as the basic method a to analyze the impact of extreme weather:

$$z_{it} = D_{it} + \sum_{m=1}^{n} \beta^{m} * Pbin_{it}^{m} + \sum_{n=1}^{7} \alpha^{n} * Tbin_{it}^{n} + sunshine_{it} + sunshine_{it}^{2} + X_{it} + c_i + \lambda_t + \varepsilon_{it}$$

$\boldsymbol{z_{it}}$: the variables of interest, which could be output value per hectare and energy consumption per hectare for agriculture.

$\boldsymbol{Pbin_{it}^{m}}$: number of days in the mth precipitation bin during the whole year in county i and year t, the baseline bin of the precipitation is $Pbin_{it}^{2}$ (10 to 25mm).

$\boldsymbol{Tbin_{it}^{N}}$: number of days the nth temperature bin during the whole year in county i and year t. The baseline temperature bin is $\boldsymbol{Tbin_{it}^{4}}$ (15~20℃).

$\boldsymbol{sunshine_{it}}$: sunshine duration in county i and year t.

$\boldsymbol{X_{it}}$: control variables, such as number of farmers per hectare.

$\boldsymbol{c_i}$ is county fixed effect; $\boldsymbol{\lambda_t}$ is year fixed effect; $\boldsymbol{\varepsilon_{it}}$ is error term.

D_{it}: take 1, if the number of days without precipitation in county i in year t is greater than the average number of days without precipitation in the province plus 2 standard deviations of the province.

[1] Graduate Student, Graduate School of Economics and Management, Tohoku University
〒980-8576 Japan, Sendai-Shi, Aoba-Ku, Kawauchi, 27-1, E-mail: chen.guang.r5@dc.tohoku.ac.jp
[2] Graduate School of Economics and Management, Tohoku University

The agriculture related data is obtained from the China County Statistical Yearbook, China Regional Economic Statistical Yearbook and city statistical yearbooks, they include county-level panel for 2545 counties from 2000 to 2020 in mainland China. The weather-related data is obtained from the China Meteorological Data Service Center (CMDC) affiliated with the National Meteorological Information Center of China.

Main results and conclusions

Figure 1 presents the estimation results of the bin variables. Our main findings are:

(1) the optimal precipitation bin (precipitation group) and temperature bin (temperature group) are 10 ~25mm ($Pbin_{it}^2$) 15~20℃ ($Tbin_{it}^4$) . The results indicate that there is inversed U-shaped relationship between weather variables and land productivity (value of agricultural production/ hectare).

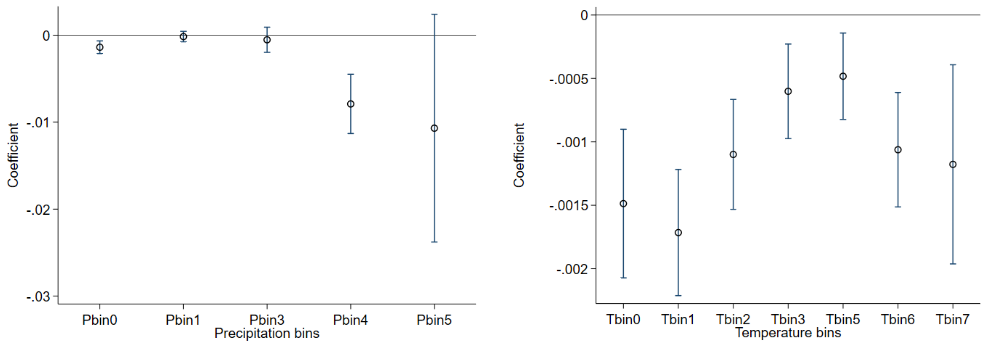

Figure 1: the impact of weather on agriculture output value per hectare

(2) temperature beyond the threshold temperature increases energy consumption which suggest energy use is likely to contribute to reduction in the negative impact of high temperature. (The results are not reported here)

(3) increase in the level of mechanization reduces the negative impact of extreme temperature.

References

Chen, S. and Gong, B.L., 2021. "Response and adaptation of agriculture to climate change: Evidence from China," Journal of Development Economics, vol. 148(C).

Burke, M. and Emerick K. 2016. “Adaptation to climate change: evidence from US agriculture”. American Economic Journal: Economic Policy 8 (3): 106–140.