Estimates on Hubei's Agricultural Production during 2007–2017, using county-level panel data

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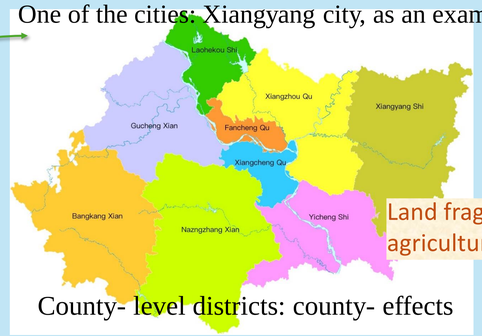
Before we start

Hubei province:17 cities

City- level districts: city-effects

One of the cities: Xiangyang city, as an example



County- level districts: county- effects

Land fragmentation and agricultural mechanization?

Target	Commonly used machinery type and equipment in agricultural production
cultivating	Cultivator, ploughing boat, tractor plow, rotary tiller, tractor-propelled harrow, field straw chopper.
sowing	Power rice-transplanter, rice drill, seed-sowing machine.
harvest	Corn combine harvester, swather, motorized threshing machine, automatic harvesting-thrashing machine, harvesters used for harvesting vegetables, cotton, peanut and other crops.
irrigating	Saving water irrigation equipment, mechanical facilities of irrigation and drainage, agricultural water pump.
protection	Plastic mulch laying machine, machined jet-dust sprayer.

Temporal section:
11th five-year plan period: 2007–10
12th five-year plan period: 2011–15
13th five-year plan period: 2016–17
Cross section:
17 cities; 127 counties

AOP: agricultural output value panel dataset
AAP: agricultural added value panel dataset
FOP: farming output value panel dataset
FAP: farming added value panel dataset

The cultivated land area per farming organization in Japan is 2.32 hectares, the average paddy field area is 1.52 hectares, and the average cultivated land area is 1.33 hectares.

comparison with Japan

The annual average food-crop planting area per household in each county is 0.44 hectares, the average cash-crop plating area per household is 0.33 hectares, the average total sowing area per household is 0.79 hectares, and the total sowing area per capita is 0.86 hectares.

Conclusions:
Comprehensive mechanization has a positive effect, about 20%.
Despite the fragmentation of cultivated land, the promotion of mechanization has improved the agricultural efficiency by enhancing the BC technology

Part 2 Agricultural machinery and BC technology:
Simultaneous equation system and the GMM-3SLS method

dealing with endogeneity

BC(biological and chemical) technology

$$lnQ_{it}=\alpha_0+\alpha_1{}^k lnV_{it}+\alpha_2{}^k lnS_{it}+\alpha_3{}^k ln(machinery\_rate_{it})+\mu_{1it}$$

$$lnS_{it}=\beta_0+\beta_1{}^k lnK_{it}+\beta_2{}^k lnL_{it}+\mu_{2it}$$

M (mechanical) technology

Table 2 Estimates results of the effects of agricultural mechanization, using AOP

VARIABLES	lnoutput	lnoutput	lnoutput	lnoutput	lnoutput
Sowing machinery ($\alpha_3{}^1$)	0.115***				
	(0.0282)				
cultivating machinery ($\alpha_3{}^2$)		0.201***			
		(0.0749)			
Protecting machinery ($\alpha_3{}^3$)			0.162***		
			(0.0591)		
Harvest machinery ($\alpha_3{}^4$)				0.0633**	
				(0.0301)	
irrigation machinery ($\alpha_3{}^5$)					0.160***
					(0.0491)

Note: Cluster robust standard errors in parentheses are *** p<0.01, ** p<0.05, and * p<0.1.

Part 1 Productive elasticities and comprehensive machinery:
TWFE and HDFE under the CRS constraint

$$\ln\left(\frac{Y}{S}\right)_{it}=\ln A_{it}+\alpha_L\ln\left(\frac{L}{S}\right)_{it}+\alpha_K\ln\left(\frac{K}{S}\right)_{it}+\alpha_M machinery_{it}+\mu_i+\lambda_t+\nu_{it}$$

Basic Model

$$Y=AL^{\alpha_L}S^{\alpha_S}K^{\alpha_K}V^{\alpha_V}$$

L: labor; S: land; K: capital; V: fertilizer

Table 1 Regression results of Hubei's agricultural production during 2007–17 using AAP

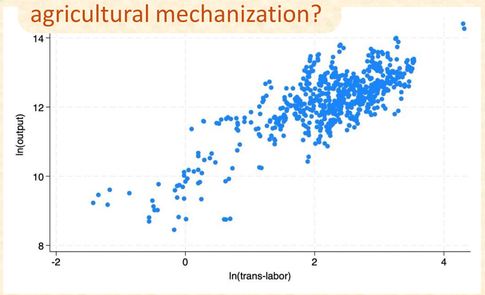
Note: Cluster robust standard errors in parentheses are *** p<0.01, ** p<0.05, and * p<0.1.

	Time	Fixed	TWFE	HDFE
VARIABLES	ln(Y/S)	ln(Y/S)	ln(Y/S)	ln(Y/S)
Ln(K/S) (α_K)	0.260***	0.293***	0.159*	0.153*
	(0.0771)	(0.0792)	(0.0850)	(0.0872)
Ln(L/S) (α_L)	0.445***	0.399***	0.652***	0.653***
	(0.0490)	(0.0458)	(0.0798)	(0.0757)
S (α_S)	0.295	0.308	0.189	0.194
com-mech3 (α_M)	0.238***	0.264***	0.145***	0.155***
	(0.0574)	(0.0566)	(0.0481)	(0.0457)
Constant	6.635***	6.467***	7.975***	8.032***
				4)
Year	Yes	No	Yes	Yes
County	Yes	Yes	Yes	Yes
City#peirod	No	No	No	Yes
Reset test	0.6542	0.6003	0.1804	0.3541
Observations	791	791	790	790
R-squared	0.694	0.666	0.957	0.970

High dimensional effects can be controlled to eliminated influence of heterogeneity.

Conclusions:
Hubei's agriculture depends on labor force most.
Controlling for the city-effects and policy-effects reduces the effectiveness of agricultural machinery from 0.26 to 0.15, which may reduce the exaggerated part of agricultural mechanization.

Labor force quality, transferred labor and agricultural mechanization?



The rural agricultural labor force decreases from 10.48 million in 2007 to 8.70 million in 2017, and the number of agricultural labor force who works in state-owned enterprises also decreases from 365.1 thousand to 290.8 thousand.

Part 3 Interaction effect of agricultural mechanization and the five-year plan policies:
Fixed effect model with policy dummy variables

$$lnA_{it}=\beta_{xj}x_{j,it}+\beta_{D2}*D_2+\beta_{D3}*D_3$$

Time effects are controlled by absorbing the policy dummy variables.

$$lnA_{it}=\beta_{xj}x_{j,it}+\beta_{D2}*D_2+\beta_{D3}*D_{3t}+\beta_{D2xj}*D_2x_{j,it}+\beta_{D3xj}*D_3\,x_{j,it}$$

Conclusions:
Hubei's agriculture is a labor- intensive industry.
The implement of 12th five-year plan policy has brought positive effects while the negative effects are more obvious after implementing the 13th five-year plan policy.
Farming is more easily affected by the application of agricultural machines.

the effects of 12th five-year plan policy= 12-plan policy effects+ the interaction effects

the effects of 13th five-year plan policy= 13-plan policy effects+ the interaction effects

	coefficient	FAP	FOP	AAP	AOP
Sowing	$\beta_{D2}+\beta_{D2x1}$	0.7234	0.1091	0.3338	0.2819
	$\beta_{D3}+\beta_{D3x1}$	-0.0316	-0.1454	-0.1013	-0.0045
Cultivating	$\beta_{D2}+\beta_{D2x2}$	0.1578	0.1711	0.0036*	0.0499
	$\beta_{D3}+\beta_{D3x2}$	-0.149	0.0707	-0.1705*	-0.0753*
Protection	$\beta_{D2}+\beta_{D2x3}$	0.0119	0.0236	-0.0061*	0.0016*
	$\beta_{D3}+\beta_{D3x3}$	0.27	0.1875	0.2079*	0.1021*
Harvest	$\beta_{D2}+\beta_{D2x4}$	-0.1331	0.1822	0.0956	0.047
	$\beta_{D3}+\beta_{D3x4}$	0.1059	-0.0547	0.0448	-0.0856
Irrigating	$\beta_{D2}+\beta_{D2x5}$	-0.0323	-0.0354	-0.0878*	-0.0807*
	$\beta_{D3}+\beta_{D3x5}$	0.218	0.0415	-0.0041	-0.0238*

Table 3 Estimation results of agricultural machinery effects during each period.
Note: *means both coefficients of β_{D2} and β_{D2xj} *(or* β_{D3} and β_{D3xj}*)* are significant at levels above 90%.