

***Changes in Cropland during 1980-2011 in China
with spatial and temporal analysis***

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Motivation

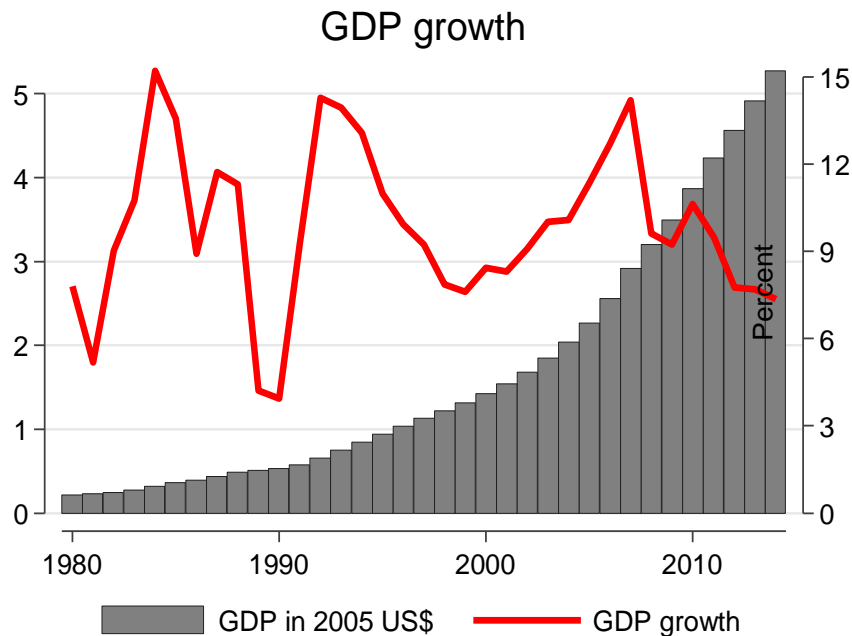


Research questions

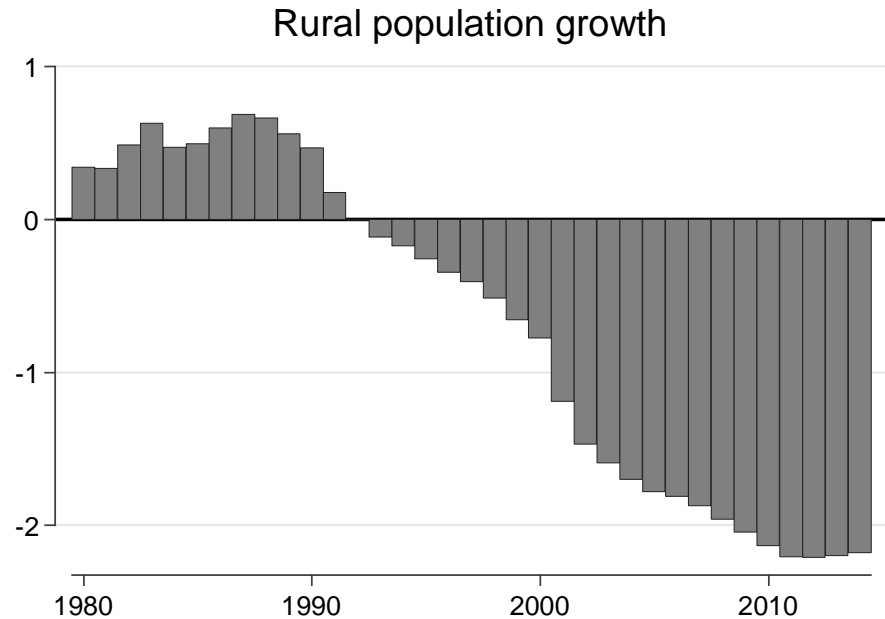


Conclusions

- China observed rapid development during last three decades
 - Average GDP growth rate 9%, economic restructuring
- Rural-urban migration

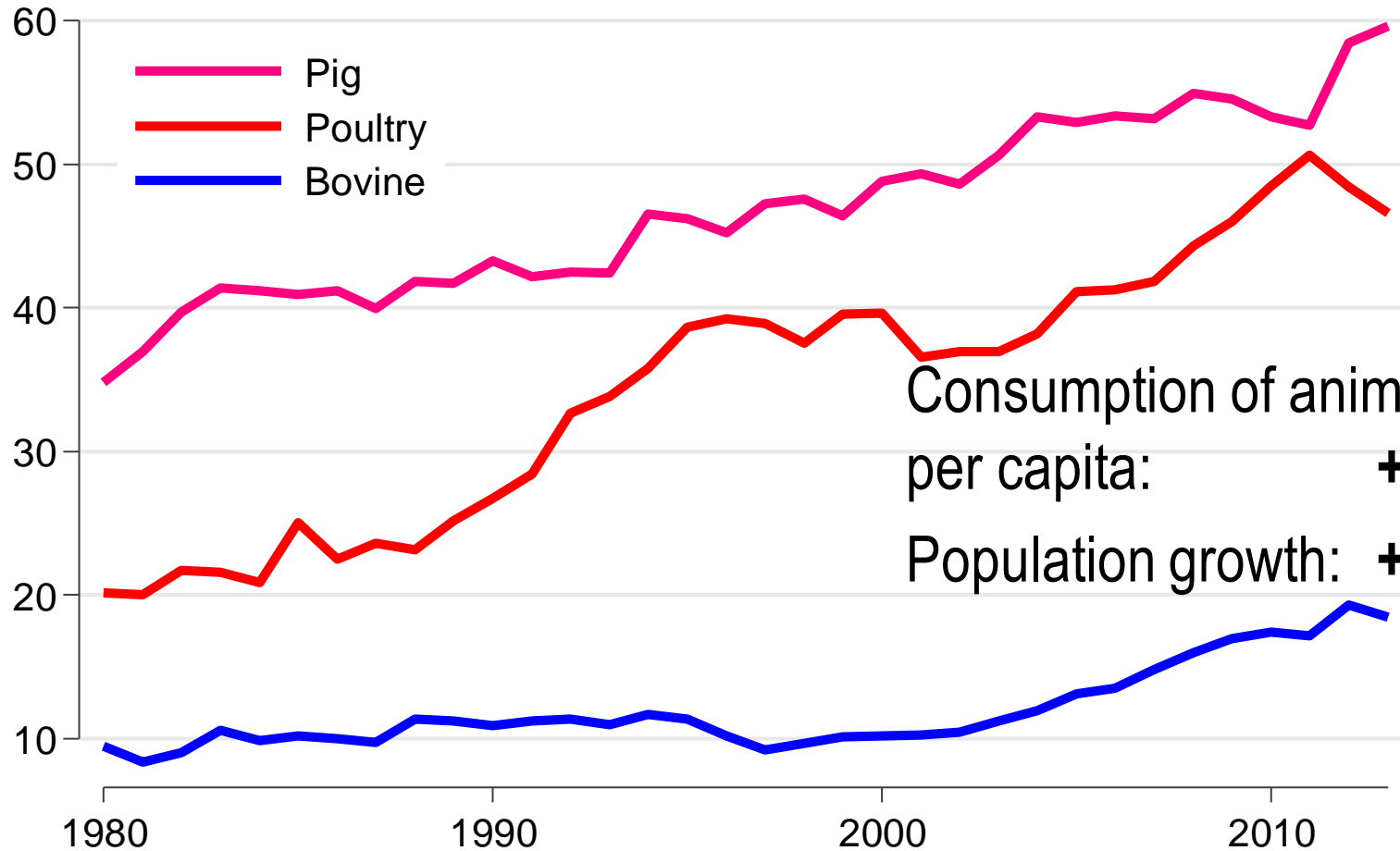


Source: World Development Indicators 2015



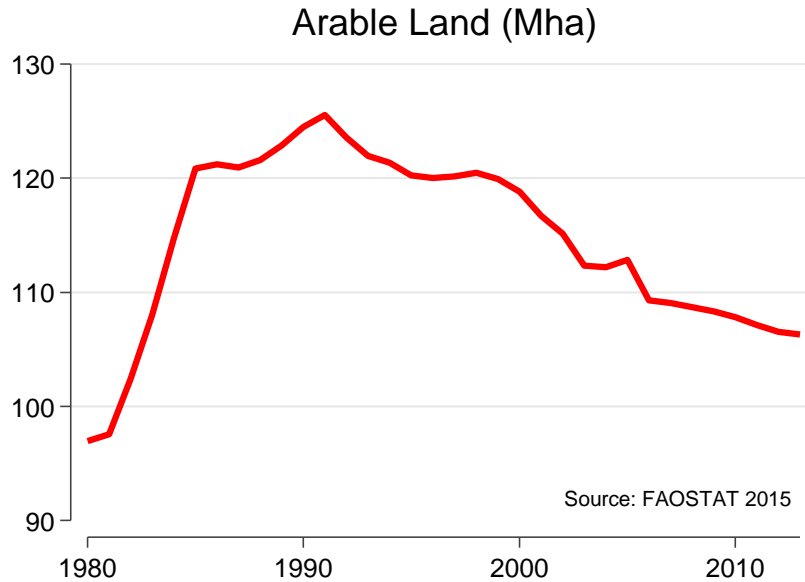
Source: World Development Indicators 2015

Protein supply



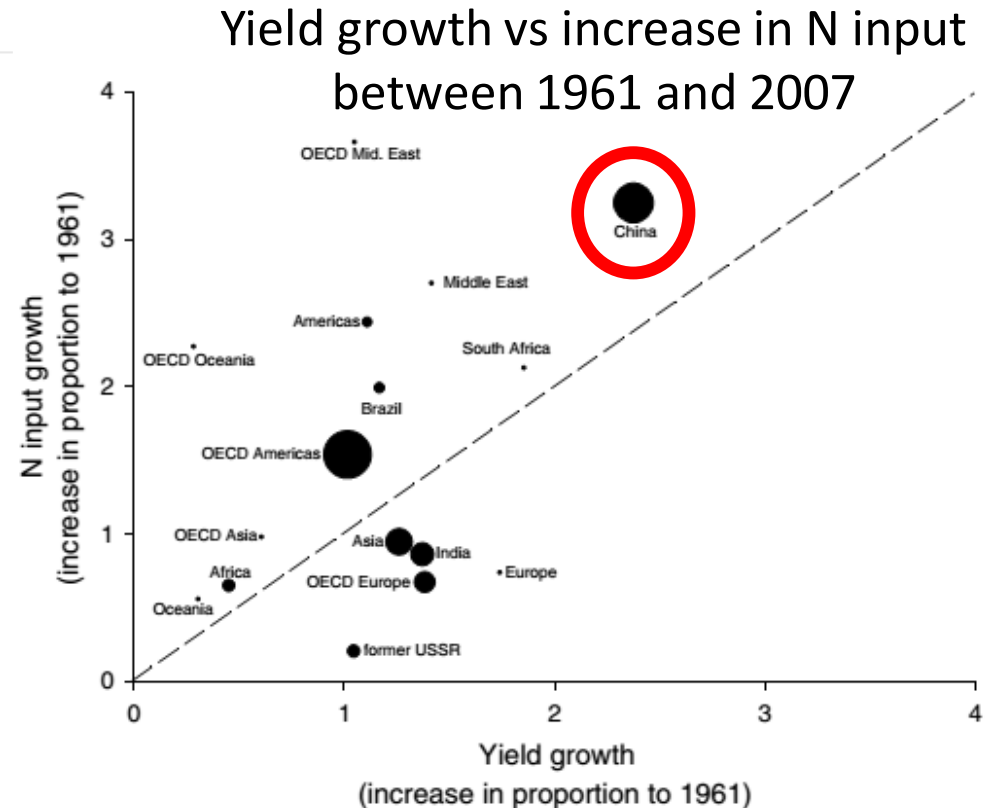
Source: FAOSTAT 2015

Decreasing area and efficiency



→ Decrease of arable land
(urbanization; conservation)

→ Decreasing efficiency of
nitrogen use (more N input
than yield growth)





Motivation



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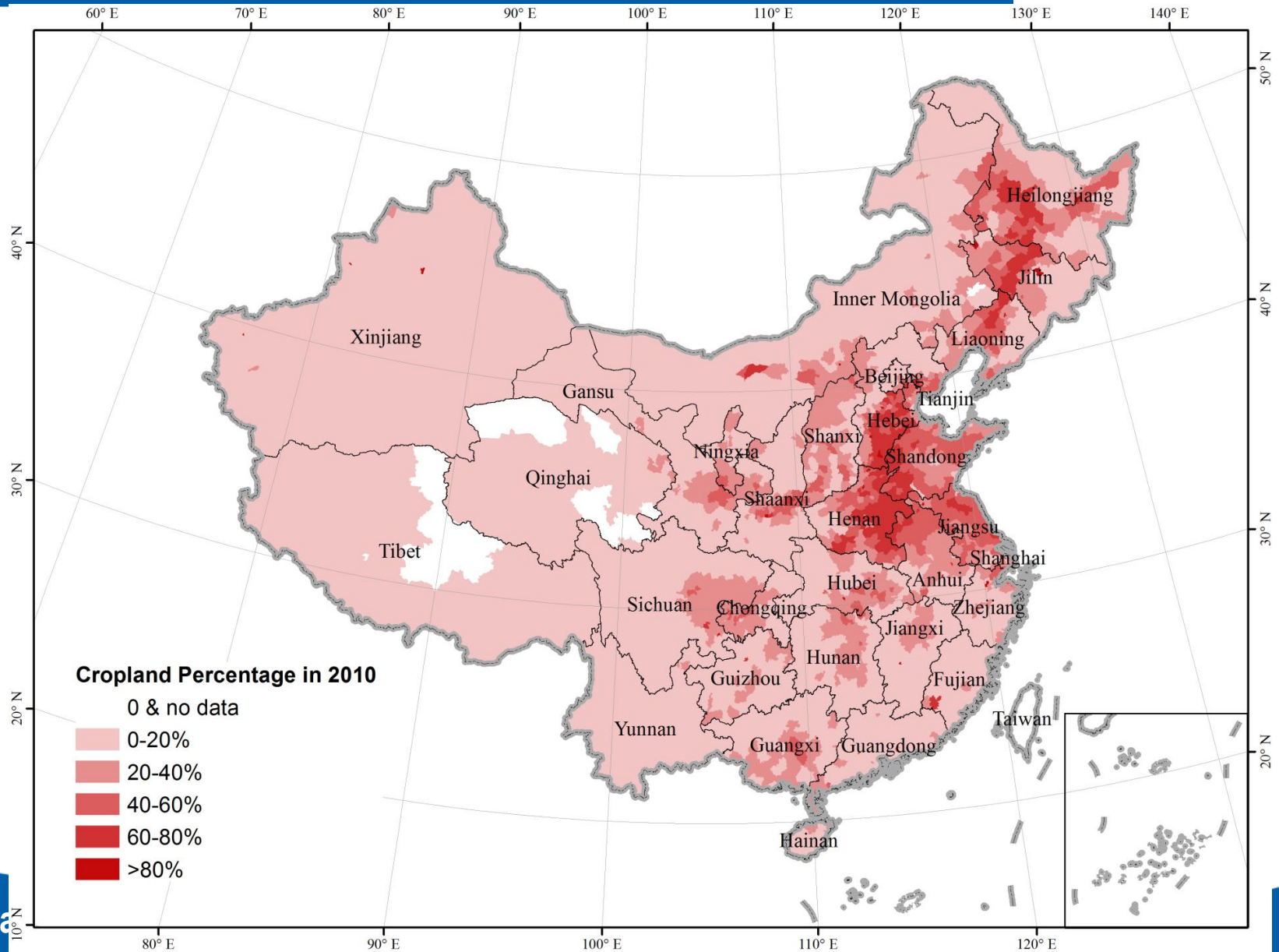
→ To develop a solid quantitative understanding of spatial patterns and determinants of cropland change across all of China from 1980 to 2011.

Research questions

1. How did the spatial patterns of cropland change?
2. What are the spatiotemporal determinants of cropland change?

- Agricultural statistics at county level (N = 2,354)
- Every year from 1980 to 2011
- Topography and soil suitability
- Temperature and precipitation
- Road accessibility

Percent cropland per county in 2010

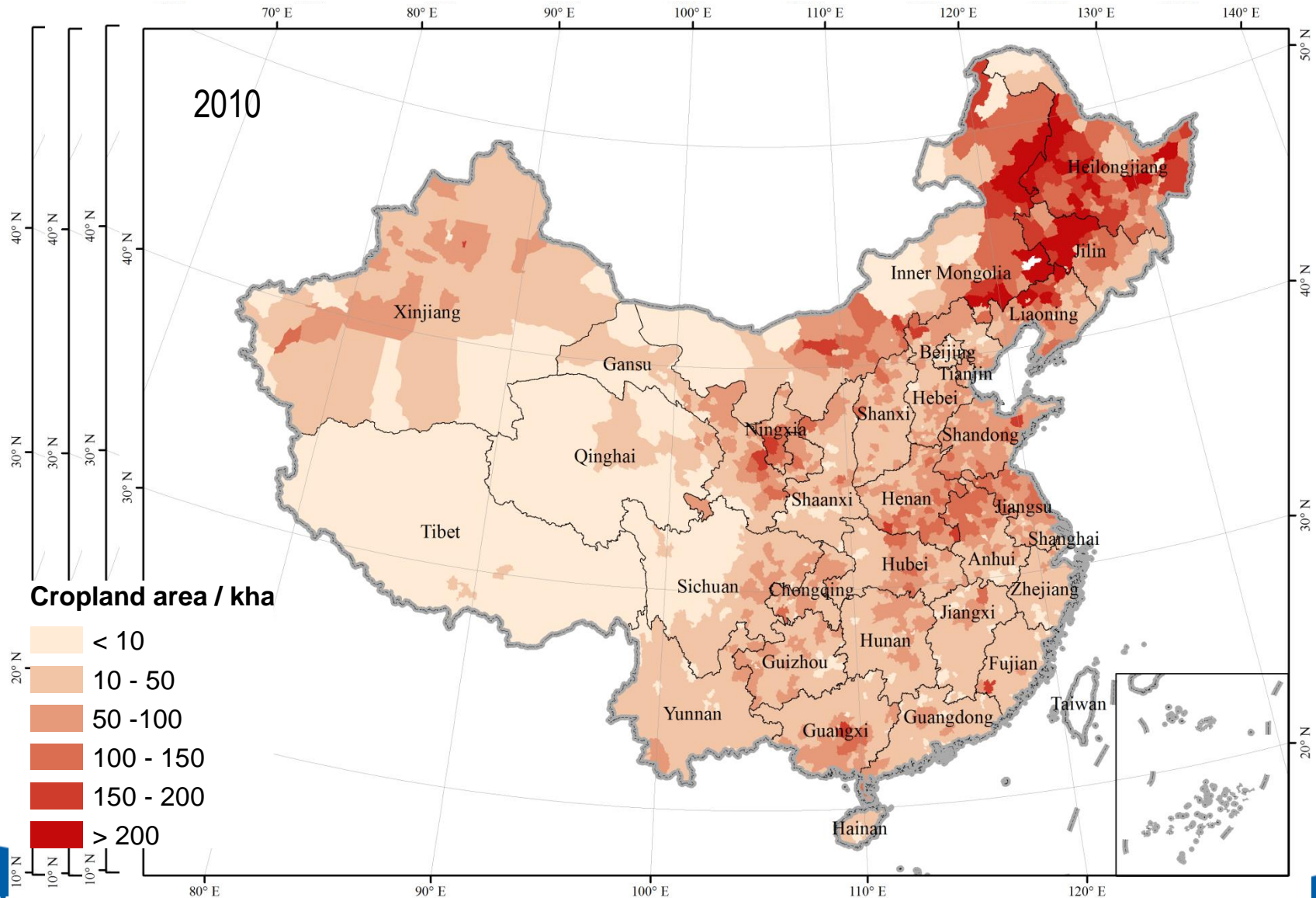




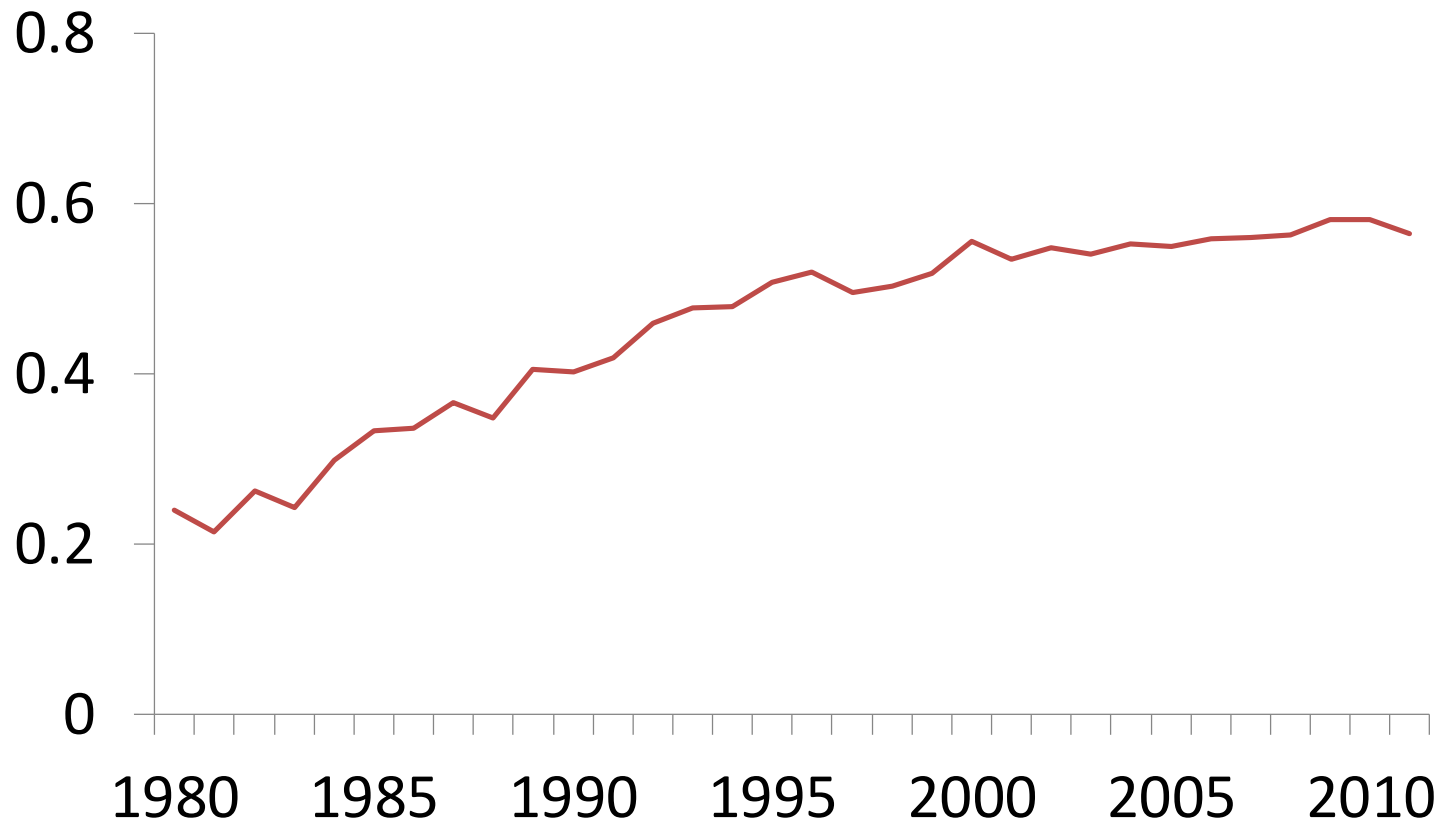
Research question 1: Spatial patterns

- Exploratory spatial data analysis
 - Moran's I
 - Local indicators of spatial association (LISA)

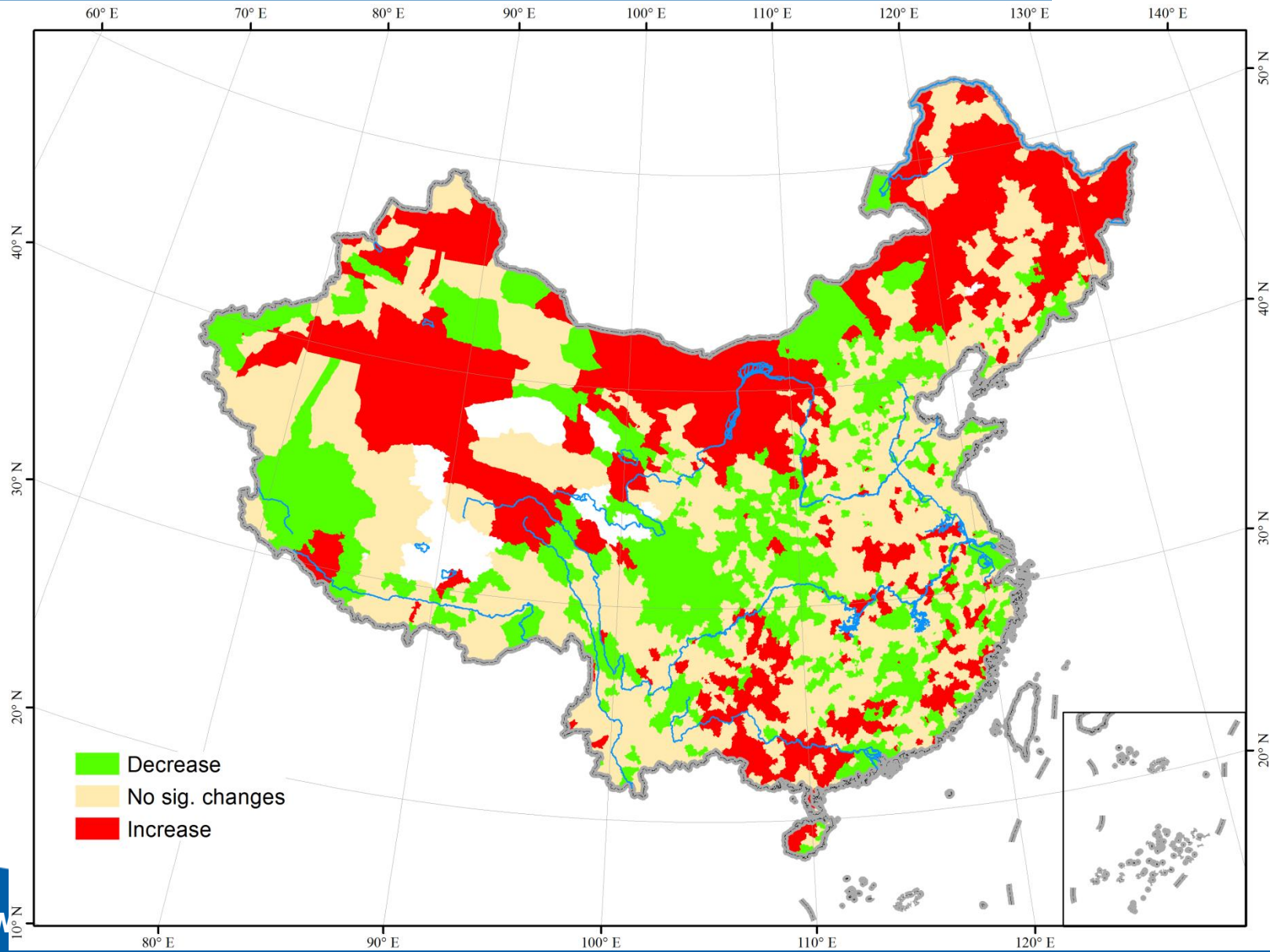
County patterns of cropland area



Moran's I of cropland

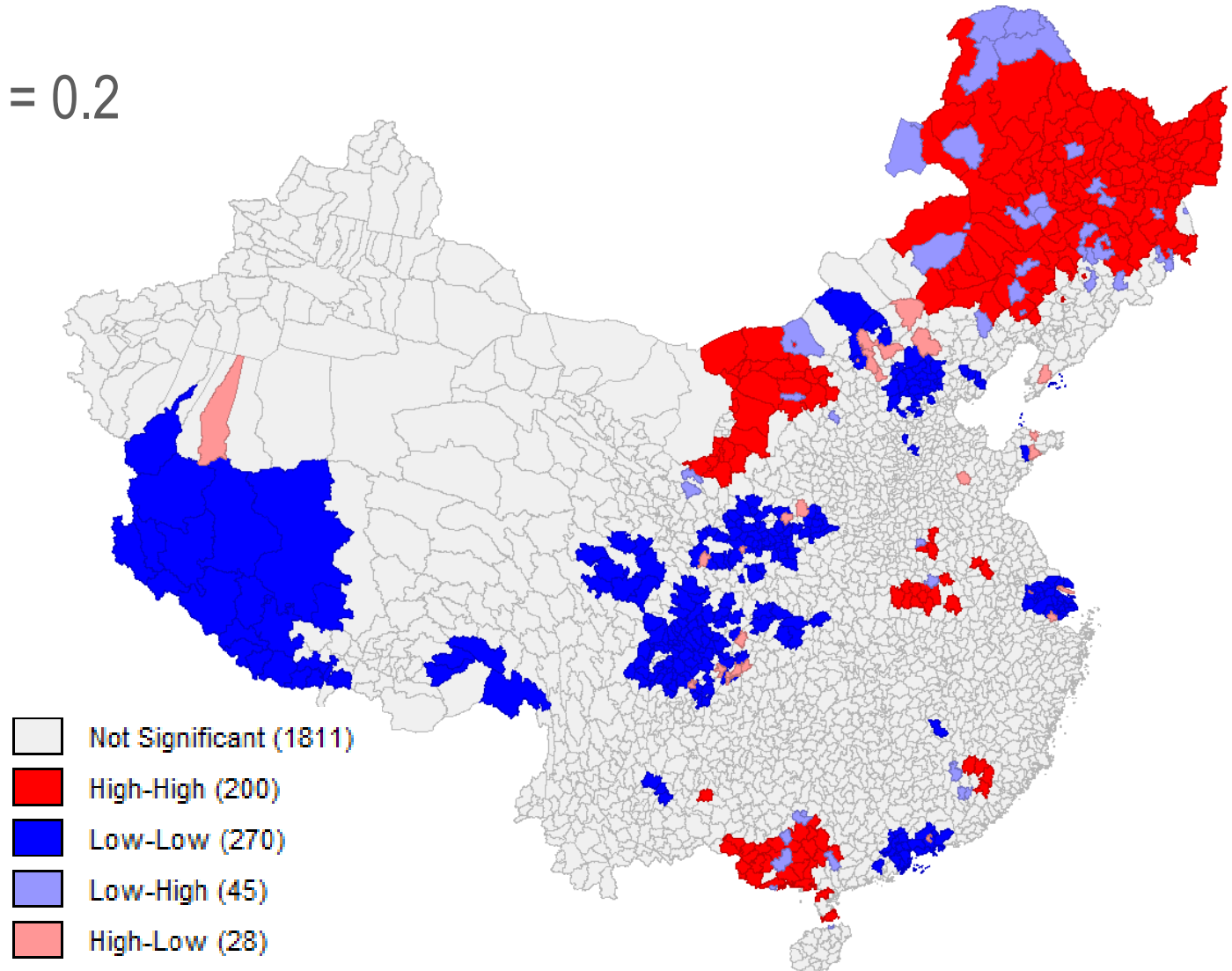


Changes in area of cropland (2007/11 - 1980/84)



Spatial clusters of cropland change

→ Moran's $I = 0.2$





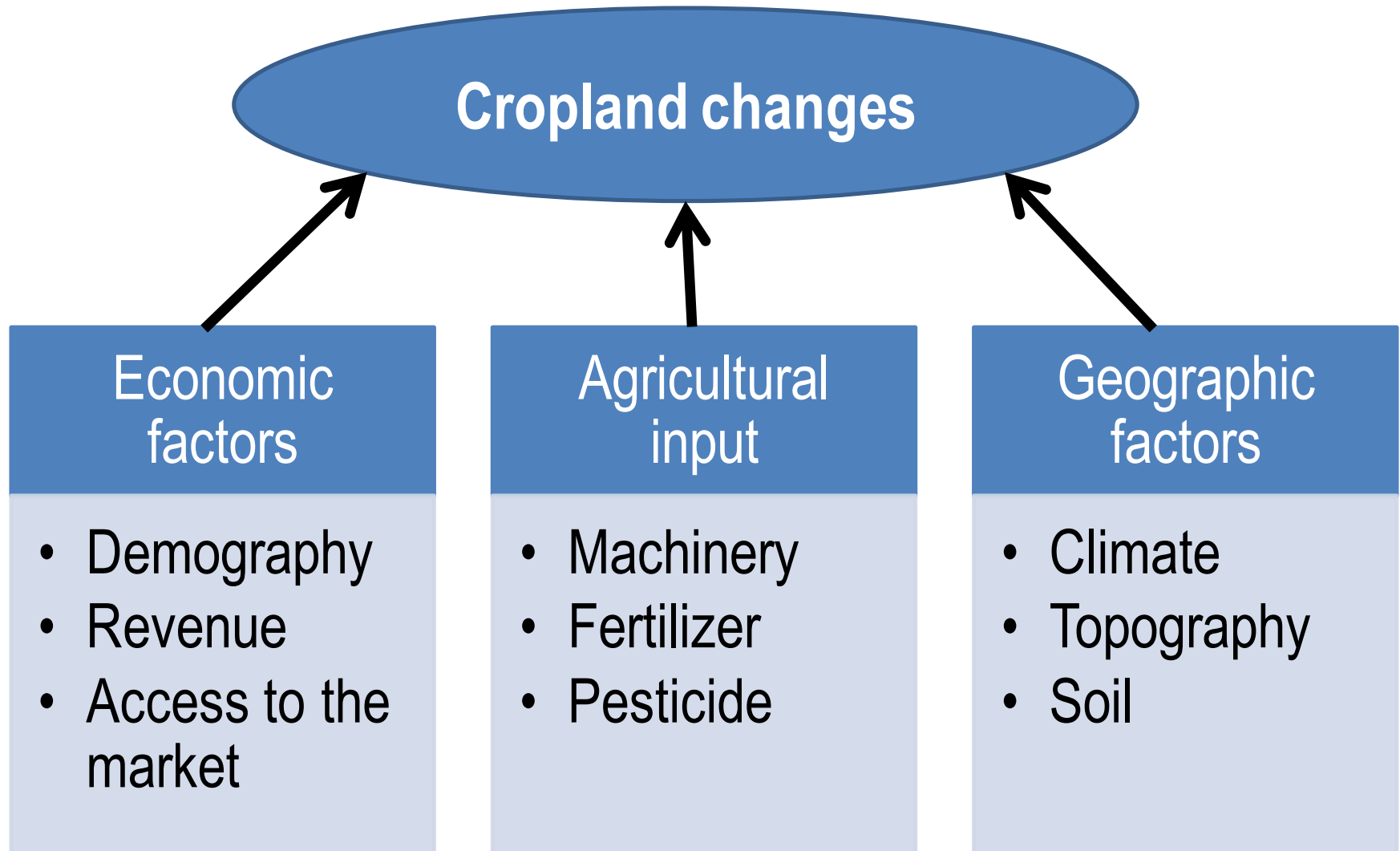
Research question 2: Determinants of changes

- Spatial panel regressions:

$$y_{it} = \alpha + \tau y_{it-1} + \rho \sum_{k=1}^K w_{ij} y_{it} + \sum_{k=1}^K x_{itk} \beta_k + \sum_{k=1}^K \sum_{j=1}^n w_{ij} x_{itk} \theta_k + \mu_i + \gamma_t + v_{it}$$

Spatial lag

Time lag



Economic factors

- Population & rural population (+)
- **Household (-)**
- **Revenue & agricultural revenue (-)**
- Pig, sheep and cow (+)
- National way (+)
- Railway (-)

Agricultural input

- Machinery power (+)
- Fertilizer (+)
 - N (+)
 - P (+)
- Pesticide (+)

Geographic factors

- Precipitation (-)
- **Temperature (-)**
- Accumulated temperature of growing days (+)
- Soil suitability (+)
- **Elevation (-)**



Motivation



Research questions



Conclusions

- Cropland increases clustered towards northeast of China, and expansion also appears clustered in Northeast Plain
- At the warm and fertile plain, increasing using agricultural machines will significantly maintain and even increase the cropland area

Thank you for your attention!

Fang Yin

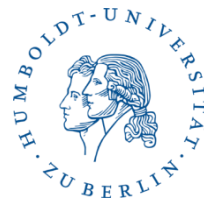
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Variable description

Variable	description	unit	Mean	
Cropland	cropland area	hectare	41192.61	Economic factors
Household	Households		125841.6	
Population	Population		486613.4	
Rural_Population	Rural population		386293.7	
Revenue	Revenue	10 000 Yuan	307278.2	
Agri_Revenue	Revenue from agriculture	10 000 Yuan	62054.51	
Agri_Electricity	electricity usage in rural area	10 000 kwh	9148.678	
Big_Livestock	Pigs, cows and sheep	head	62171.52	
nationway	length of national way	m	55193.95	
railway	length of railway	m	36275.65	
Mach_Area	cultivated by machines area		23847.9	Agricultural input
Agri_Power	agricultural machinery	kw	188163.7	
Fertilizer	Fertilizer	ton	14694.15	
N_Fertilizer	nitrogen fertilizer	ton	8367.708	
P_Fertilizer	phosphorus fertilizer	ton	2565.112	
Pesticide	Pesticide	ton	846.0397	
Rain	Precipitation	0.1mm	9165.326	Geographic factors
STDRain	standard deviation of precipitation		308.9698	
Temperature	Temperature	0.1°C	132.3007	
STDta	standard deviation of temperature		3.705405	
GDD	accumulated temperature over 10°C	0.1°C	47184.22	
STDGDD			1168.472	
DEM	elevation	m	854.576	
DEMstd	standard deviation of DEM		204.474	
DEMvariety	variety of DEM		658.2426	
Soil_area	area with good soil suitable for cropland	km ²	1021.957	

Variables	Main	Wx	Variables	Main	Wx
Household	-0.003	-0.023 ^{***}	Precipitation	-0.094 [*]	0.168 ^{***}
Population	0.001 ^{**}	-0.011 ^{***}	STD of prec	0.986 ^{**}	0.626
Rural Population	0.028 ^{***}	-0.008 ^{**}	Temperature	-78.478 ^{***}	-42.452 [*]
Revenue	-0.001 ^{***}	0.002 ^{***}	STD of ta	120.958	-1342.521 ^{***}
Agri_Revenue	-0.006 ^{***}	-0.014 ^{***}	GDD	0.336 ^{***}	-0.098
Agri_Electricity	-0.018 ^{***}	0.073 ^{***}	STD of GDD	-0.944 ^{**}	7.210 ^{***}
Big Livestock	0.010 ^{***}	-0.015 ^{**}	DEM	-6.009 ^{***}	-2.778
National way	0.027 ^{***}	-0.282 ^{***}	STD of DEM	-9.164	-241.779 ^{***}
railway	-0.001	-0.326 ^{***}	Soil_area	0.934 ^{***}	27.872 ^{***}
Mach_Area	0.124 ^{***}	0.331 ^{***}	<u>_cons</u>	16902.980 ^{***}	
Agri_Power	0.006 ^{***}	-0.012 ^{***}	Spatial rho	0.293 ^{***}	
Fertilizer	0.005	-0.101 ^{**}	sigma2_e	2.37e+08 ^{***}	
N_Fertilizer	0.157 ^{***}	1.112 ^{***}	lgt_theta	-2.000 ^{***}	
P_Fertilizer	0.377 ^{***}	-0.384	N	75328	
Pesticide	0.001	-0.090 [*]	r2	0.329	