What Constrains Mechanization in Chinese Agriculture? Roles of Farm Size and Fragmentation

Xiaobing Wang[1], Futoshi Yamauchi[2], Jikun Huang[1], Scott Rozelle[3]

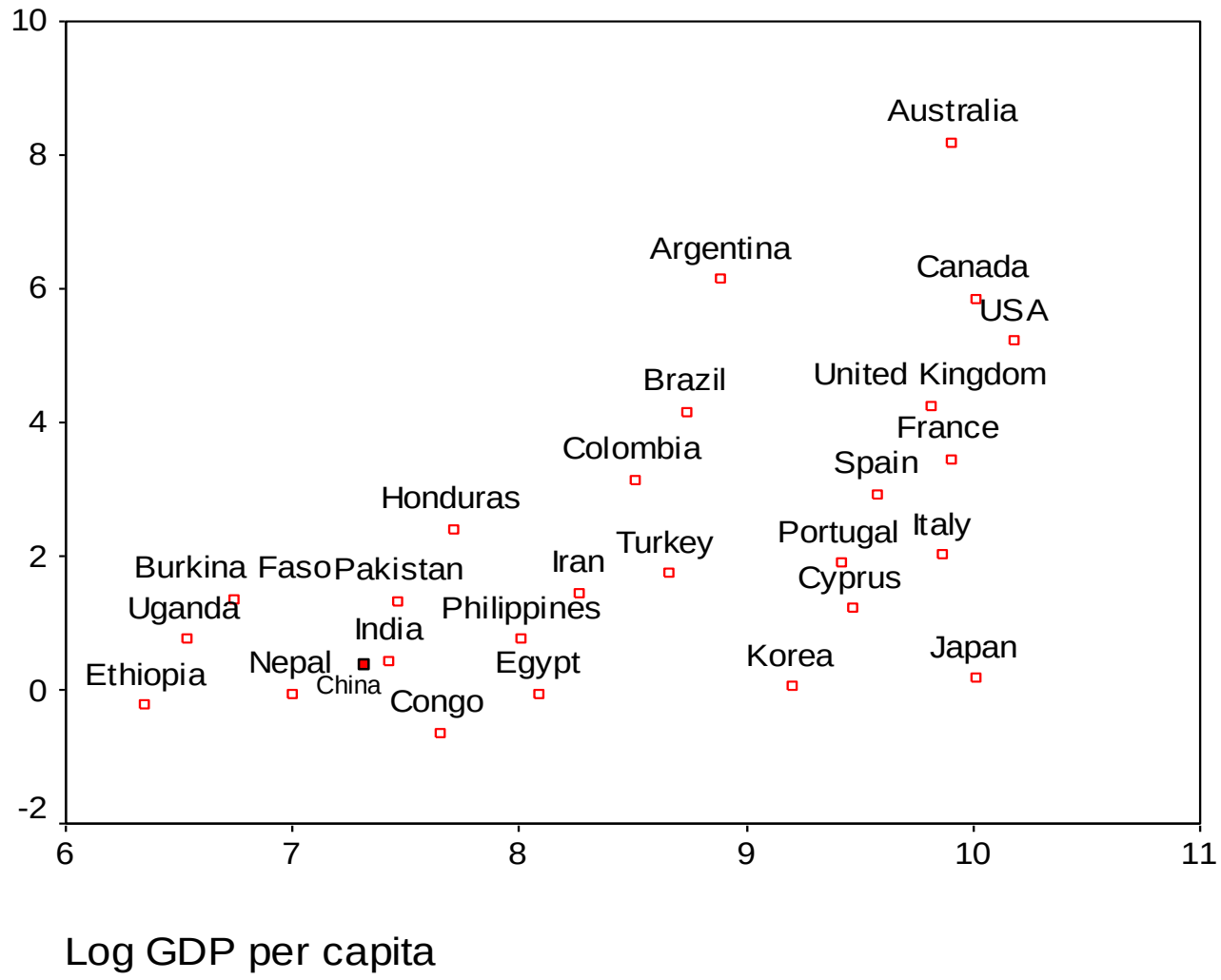
China Center for Agricultural Policy, Peking Univ.

World Bank

Stanford University

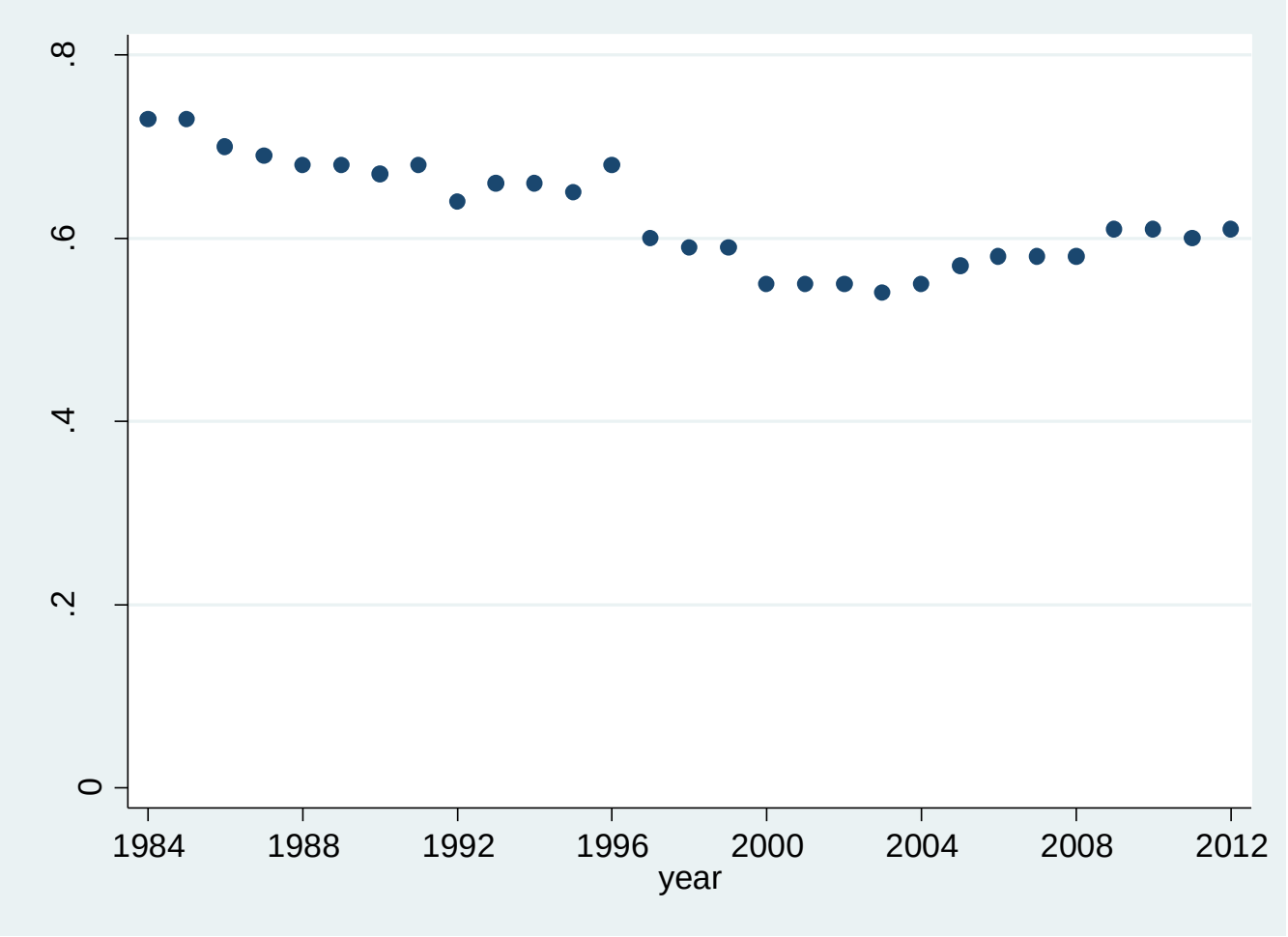
IAMO, June 22, 2017

Farm size and GDP per capita in the 1990s



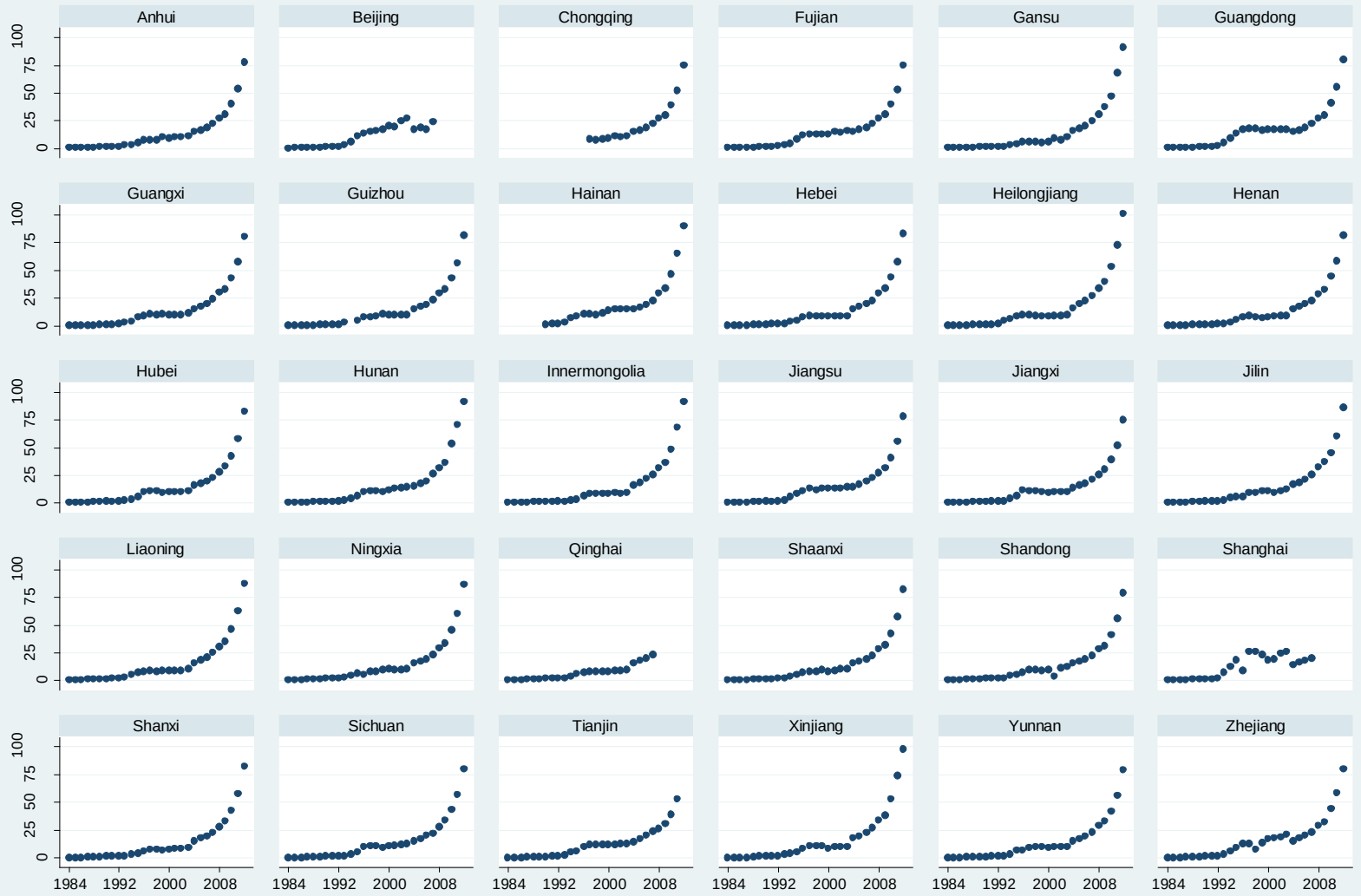
Source: Eastwood et al. (2006)

What motivate us? Farm size in China



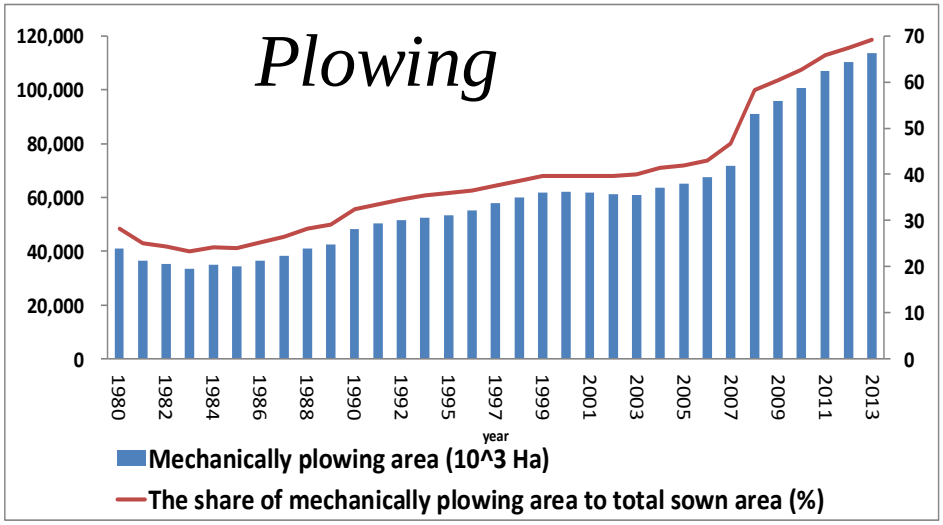
Source: *Yearbook of Rural Household Survey, China* (NBSC, various issues)

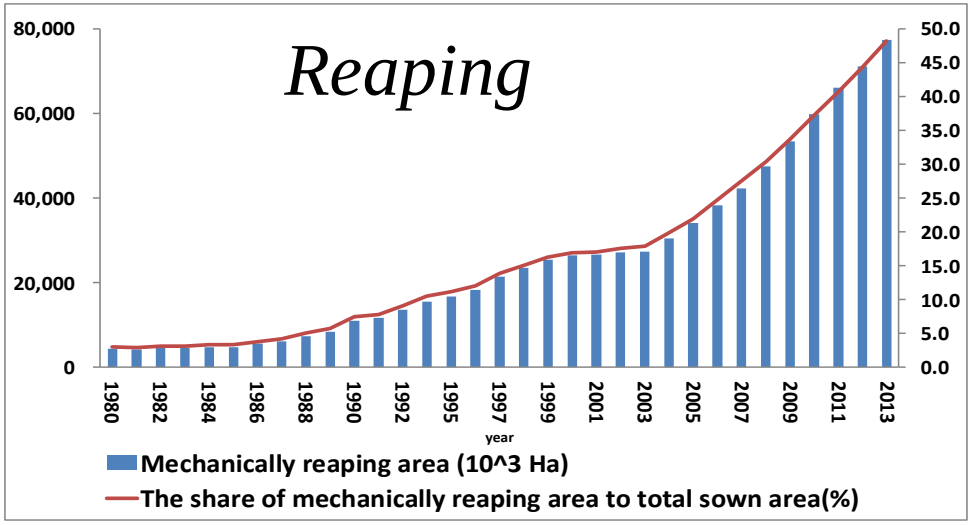
Average daily cost of on-farm labor has been increasing rapidly in agricultural production



Graphs by p

Machine operation in China's agricultural production





Questions

China provides an interesting setting. The prohibition of land sales gives us an ideal experimental ground to know whether or not machine services are accessible affects the decision to rent in land to increase farm size?

Whether land fragmentation is a constraint of accessing to machine service when real wage increases?

Survey Data

Collected data from a nationally representative sample of households in late 2000 and in 2008

- 6 provinces - 1 in each of China's "major zones"
  - Hebei, Shaanxi, Liaoning, Zhejiang, Sichuan, Hubei
- 5 counties per province-- one randomly selected from each income quintile
- 2 villages / county
- 20 households randomly selected in each village

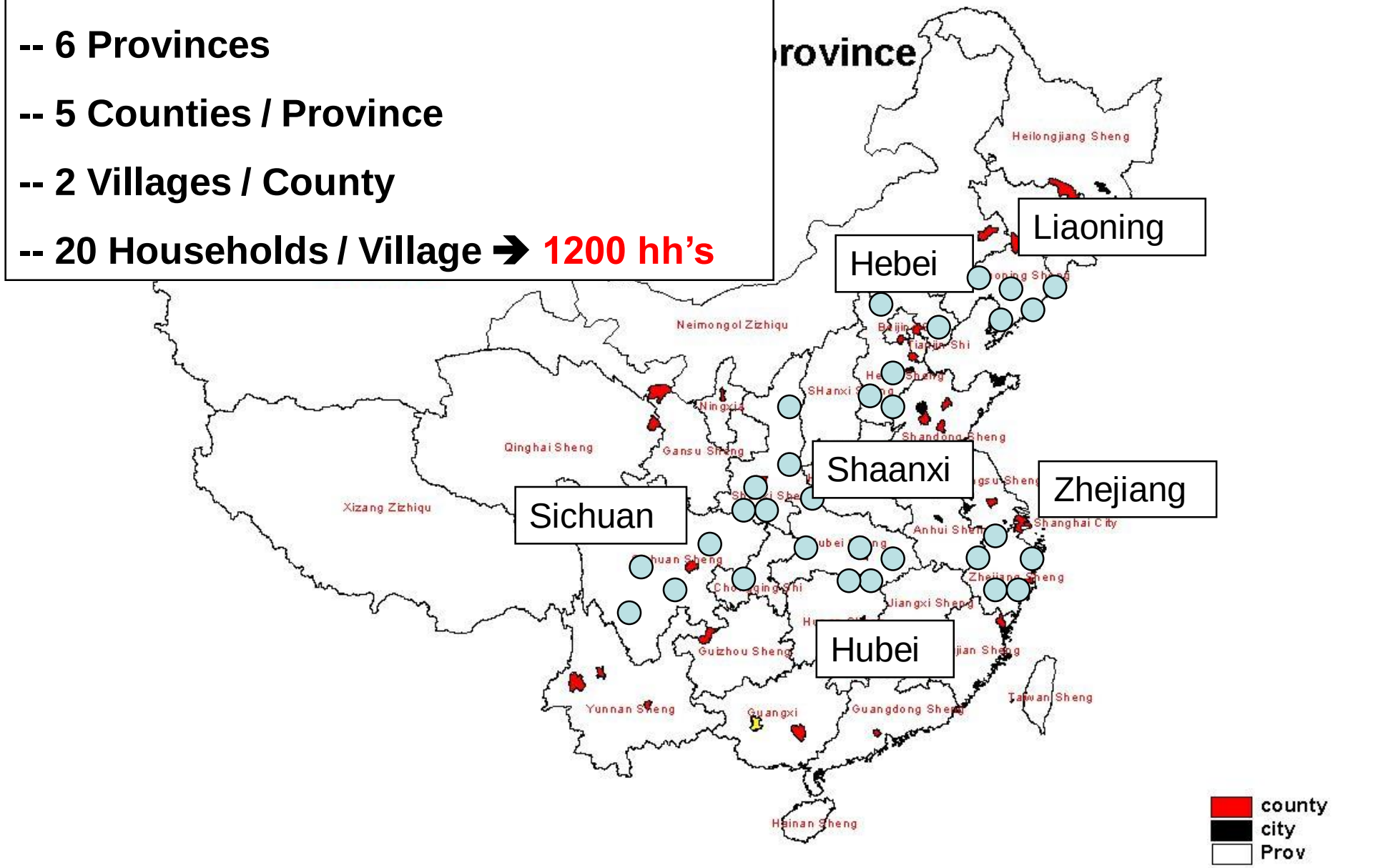
2000 China National Land and Labor Survey (First Wave)

-- 6 Provinces

-- 5 Counties / Province

-- 2 Villages / County

-- 20 Households / Village ➔ 1200 hh's



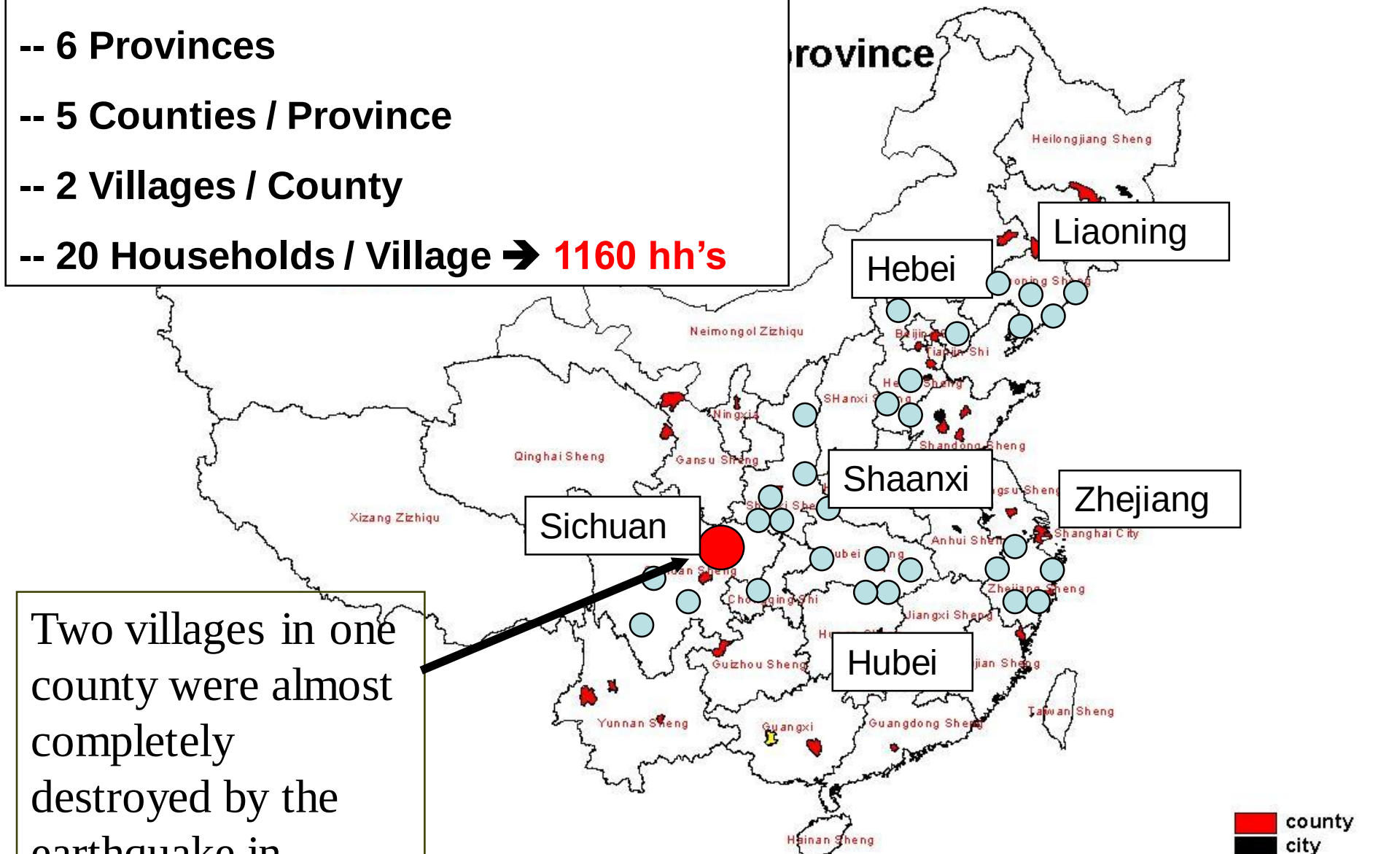
2008 China National Land and Labor Survey (Second Wave)

-- 6 Provinces

-- 5 Counties / Province

-- 2 Villages / County

-- 20 Households / Village ➔ 1160 hh's



Two villages in one county were almost completely destroyed by the earthquake in Sichuan

Surveyed: May 2009

Survey Data

- Demographic information
- Farmland
- Agriculture
- Self-run enterprise
- Consumer durables
- Other income

Analysis: (i) net rent-in/out (iv) machine service

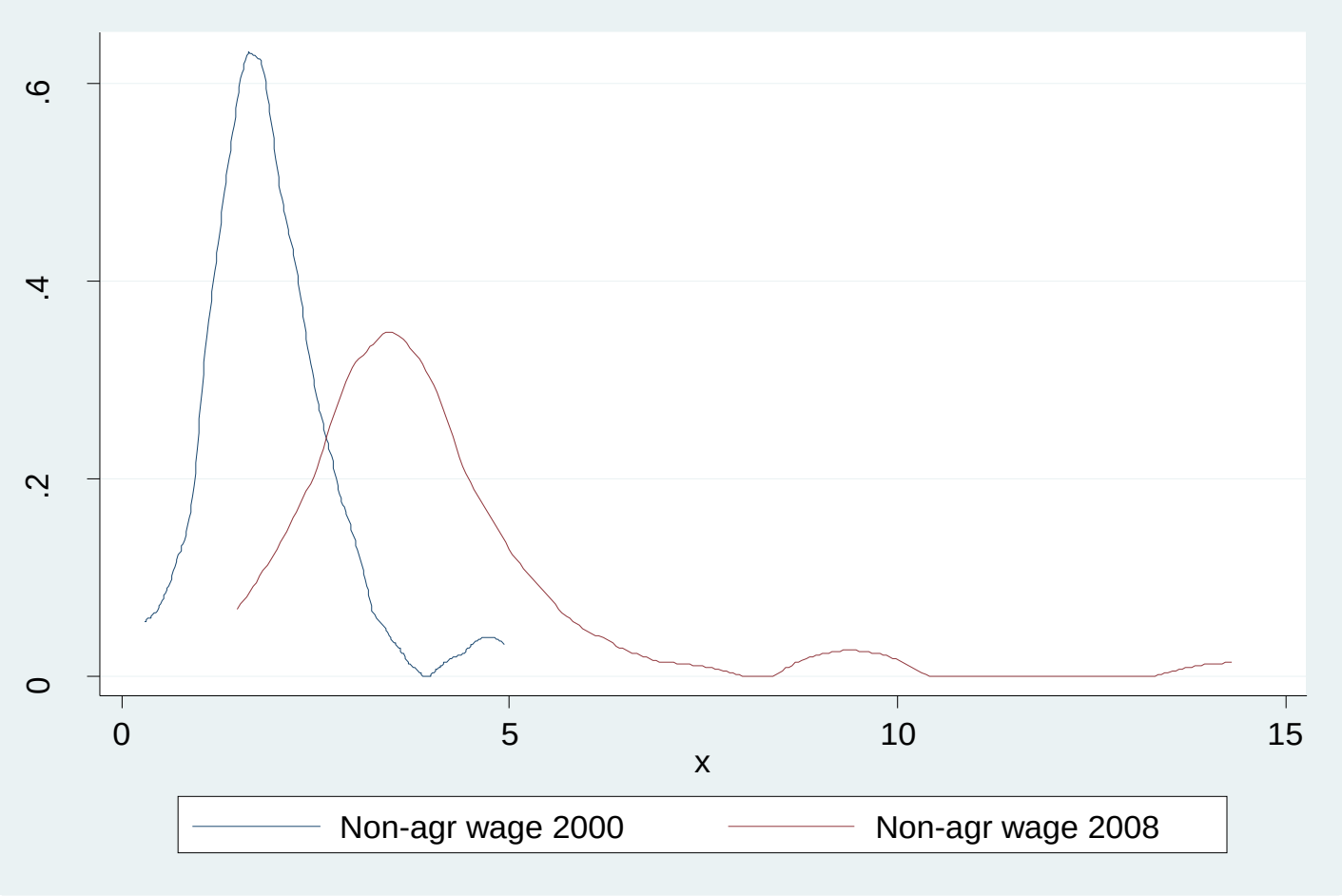
Survey Data: Willingness to pay for renting in and out land

Plot code	If you don't need to bear any agricultural tax and fee and rent out for one year, are you willing to contract "out" the plot for the price listed below? (start from 300 yuan/mu, if not willing, continue with 400-600 yuan/mu; if willing, continue with 200-0 yuan/mu).						
	0	100	200	300	400	500	600
Plot code	For the neighbored plot, If you don't need to bear any agri tax and fee and rent in for one year, are you willing to contract "in" the plot for the price listed below? (start from 300 yuan/mu, if willing, continue with 400-500 yuan/mu; if not willing, continue with 200-0 yuan/mu).						
	0	100	200	300	400	500	600

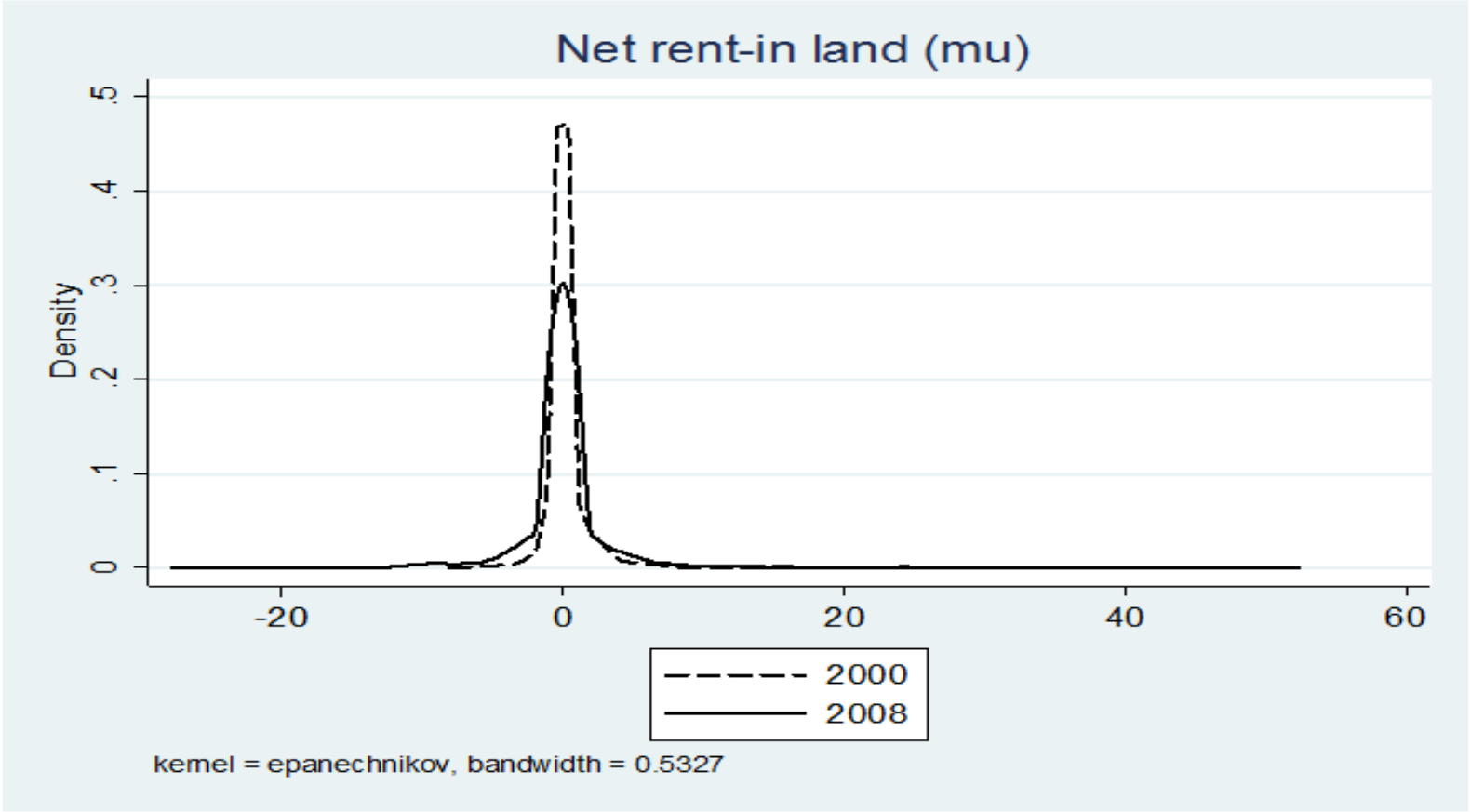
In our sample, farm size and no of plot

	Farm size		No. of plot
Year 2000	Mean (Mu)	Mean (Ha)	Mean
All provinces	6.38	0.43	4.61
Hebei	10.82	0.72	4.47
Shaanxi	5.63	0.38	3.98
Liaoning	9.97	0.66	5.18
Zhejiang	3.39	0.23	4.23
Sichuan	3.65	0.24	5.44
Hubei	4.31	0.29	4.33

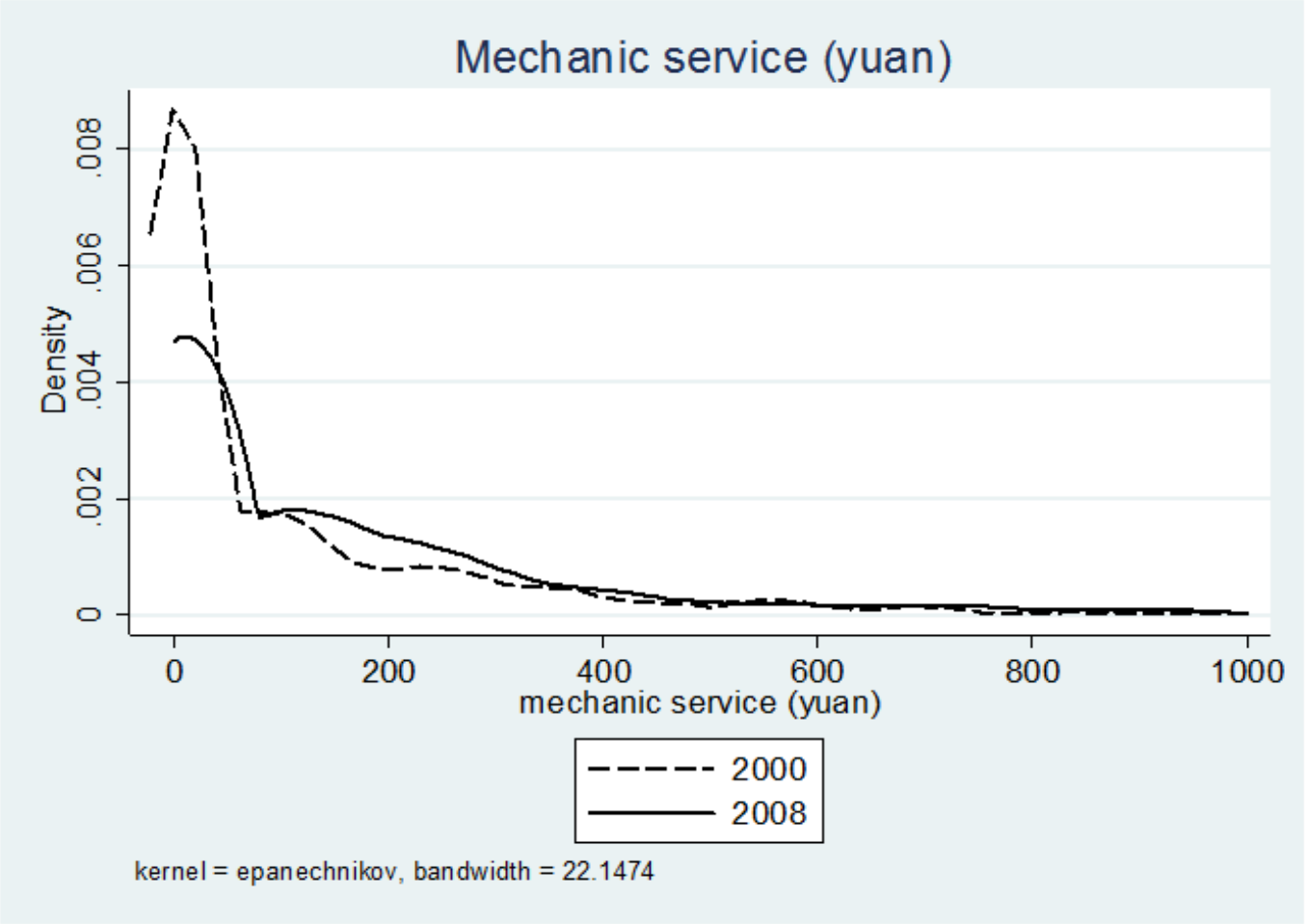
Kernel density estimations of real non-agricultural wages (yuan/hour)



Variance of net rent-in land has increased, which implies that land rental markets become more active.



In our sample, we also observe the expansion of machine services (from the providers)



Analysis (1): Land and Machine

$$\Delta y_{ij} = \beta_0 \Delta w_j + \beta_1 \Delta w_j * land_{ij} + \gamma X_{ij} + \sum prov + \Delta \varepsilon_{ij}$$

Δy_{ij} : Change in self-cultivated land, Change in rent-in land, Expense on machine service between 2000 and 2008

Δw_j changes: wage growth rate (agr and non-agr) at village level

Control variables: family and farm characteristics at 2000

Analysis (2): Change of rent in/out Land and machine service

$\Delta y_{ij} = \beta_0 land_j + \beta_1 plot_j + \gamma land_j * plot_j + \sum Prov + \Delta\varepsilon_{ij}$

Δy_{ij} : Change in rent-in/out land; expense on machine service

Land: Operational land at 2000

Plot: no of plot at 2000

Note: Opportunity cost of labor; ΔWTP_j changes

Change in net rent-in/out land in 2000-08

	Change in rent-in land		Change in rent-out land	
Change in willing to pay for renting in land (hh deviations)	0.0014	**0.0011***		
	(1.70)	**(2.10)**		
Change in willing to pay for renting out land (hh deviations)			**-0.0008*** **	**-0.0008*** **
			(4.24)	(4.21)
Control variables		yes		yes
Village dummies	yes	yes	yes	yes

Change in machine services 2000-08 when opportunity cost of rural labor increases

	Change in machine service (yuan)				
Operational land	**5.4149****	16.4347*	20.5932**	21.8368***	19.8839**
	(3.94)	(2.36)	(3.08)	(4.08)	(3.84)
Operational land ^2			-0.0951	-0.0760	-0.0292
			(1.41)	(1.24)	(0.79)
Number of plot	-9.8793	-0.1083	-21.3429	-24.3778	-18.4668
	(0.95)	(0.02)	(1.78)	(1.85)	(0.95)
Number of plot ^2			1.8808	2.4170*	2.1027
			(1.86)	(2.21)	(1.89)
Operational land*Number of plot		**-1.7127***	**-1.5371****	**-1.8650*****	**-2.0421****
		(1.96)	(3.21)	(4.49)	(3.23)
HH control variables				yes	yes
Road+topography					yes

Change in machine services 2000-08 when opportunity cost of rural labor is stagnant

	Change in machine service (yuan)				
Operational land	6.0105**	7.1012	9.0157	12.4123	3.5885
	(3.10)	(0.84)	(1.11)	(1.55)	(0.43)
Operational land ^2			-0.0098	-0.0181	0.0122
			(0.24)	(0.41)	(0.51)
Number of plot	-7.5396*	-6.6644	-28.3736	-14.7037	-7.8976
	(2.26)	(1.15)	(1.77)	(1.29)	(0.55)
Number of plot ^2			2.4884	1.3779	1.1256
			(1.38)	(0.85)	(0.63)
Operational land*Number of plot		-0.1723	-0.3595	-0.6259	0.0291
		(0.16)	(0.42)	(0.84)	(0.03)
HH control variables				yes	yes
Road+topography					yes

Change in machine services 2000-08 when farmers are willing to pay for rent in land

	Change in machine service (yuan)				
Operational land	5.2682***	11.7489	14.5192**	17.2171**	16.0404**
	(4.26)	(2.01)	(2.82)	(3.26)	(3.59)
Operational land ^2			0.0025	0.0047	0.0179
			(0.08)	(0.13)	(0.58)
Number of plot	-8.8819	-3.6549	-26.8402	-17.4942	-14.3354
	(1.14)	(0.56)	(1.52)	(1.03)	(0.77)
Number of plot ^2			2.9306	2.3395	2.0724
			(1.66)	(1.18)	(1.00)
Operational land*Number of plot		-0.9953	**-1.4593****	**-1.7759****	**-1.7919*****
		(1.42)	(3.09)	(3.93)	(4.42)
HH control variables				yes	yes
Road+topography					yes

Change in machine services 2000-08 when farmers arenot willing to pay for rent in land

	Change in machine service (yuan)				
Operational land	8.0194	9.9837	9.5760	12.0220	7.6880
	(1.80)	(1.21)	(0.80)	(0.83)	(0.52)
Operational land ^2			0.0604	-0.0022	0.0973
			(0.22)	(0.01)	(0.26)
Number of plot	-9.9323*	-7.4776	-14.6412	-15.7814	-9.8603
	(2.24)	(0.92)	(0.83)	(0.81)	(0.55)
Number of plot ^2			0.8680	1.0612	0.6451
			(0.56)	(0.57)	(0.36)
Operational land*Number of plot		-0.4025	-0.5910	-0.7489	-0.3928
		(0.32)	(0.54)	(0.69)	(0.44)
HH control variables				yes	yes
Road+topography					yes

Major findings from China

- Whether or not machine services are accessible affects the decision to rent in land to increase farm size.

- When real wages rapidly increase, farm size becomes a critical factor to determine mechanization but fragmented lands significantly penalize the scale merit.

Major findings from China

- Large farmers tend to rent in more land when real wages rapidly increase and machine services are available.
- The availability of machine services does not affect rent-out behaviors.
- Farmers who operate relatively small land tend to rent out their land.