

Supplementary Materials I

for

**Spatial-Temporal Evolution and Risk Assessment of Land
Finance: Evidence from China**

Table of Contents

Table S1. Pairwise comparison matrix of the land finance factors.

Table S2 Three subzones of land finance by the k-means clustering method.

Table S3 Land finance risks during 2009 - 2016.

Table S4 Four types of land finance risks during 2009 - 2016.

Table S5 Fixed-effect and random-effect models with year dummy variables.

Table S6 Comparison of the results using normalize vs. unnormalized data.

Table S1. Pairwise comparison matrix of the land finance factors.

		x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15
x1	Urbanization rate	1.0 0														
x2	Increase of developed land	5.0 0	1.0 0													
x3	Average housing price growth rate	7.0 0	5.0 0	1.0 0												
x4	The income disparity between urban and rural residents	0.1 0	0.2 0	0.1 4	1.0 0											
x5	Degree of development of land markets	7.0 0	7.0 0	3.0 0	9.0 0	1.0 0										
x6	Cultivated land per capita	0.3 3	0.1 1	0.1 1	0.2 0	0.1 1	1.0 0									
x7	Degree of land transfer dependence	9.0 0	9.0 0	5.0 0	9.0 0	3.0 0	9.0 0	1.0 0								
x8	Deficit ratio	0.3 3	0.1 4	0.1 4	0.3 3	0.1 1	3.0 0	0.1 1	1.0 0							
x9	Macro tax burden	0.3 3	0.1 4	0.1 4	0.3 3	0.1 1	3.0 0	0.1 1	1.0 0	1.0 0						
x10	The asset-liability ratio of real estate enterprises	7.0 0	3.0 0	0.3 3	7.0 0	0.3 3	7.0 0	0.2 0	7.0 0	7.0 0	1.0 0					
x11	Number of land violation cases	3.0 0	0.3 3	0.2 0	3.0 0	0.1 4	3.0 0	0.1 4	3.0 0	5.0 0	0.2 0	1.0 0				
x12	Number of illegal land occupation cases	5.0 0	0.3 3	0.2 0	3.0 0	0.2 0	5.0 0	0.1 4	5.0 0	5.0 0	0.2 0	3.0 0	1.0 0			
x13	Percentage of cultivated land in illegal occupation cases	5.0 0	0.3 3	0.2 0	3.0 0	0.2 0	5.0 0	0.1 4	5.0 0	5.0 0	0.2 0	3.0 0	1.0 0	1.0 0		
x14	Percentage of cultivated land area	5.0 0	1.0 0	0.3 3	5.0 0	0.2 0	5.0 0	0.2 0	5.0 0	7.0 0	0.3 3	3.0 0	3.0 0	3.0 0	1.0 0	
x15	Cultivated land decrease rate	5.0 0	1.0 0	0.3 3	5.0 0	0.2 0	5.0 0	0.2 0	5.0 0	7.0 0	0.3 3	3.0 0	3.0 0	3.0 0	1.0 0	1.0 0

Table S2. Three subzones of land finance by the k-means clustering method.

Zone 1 (Western area)	Zone 2 (Central area)	Zone 3 (Eastern coastal area)
Gansu	Anhui	Fujian
Guangxi	Beijing	Guangdong
Guizhou	Chongqing	Jiangsu
Hainan	Hebei	Shandong
Heilongjiang	Henan	Shanghai
Jilin	Hubei	Zhejiang
Neimenggu	Hunan	
Ningxia	Jiangxi	
Qinghai	Liaoning	
Shaanxi	Sichuan	
Shanxi	Tianjin	
Xinjiang		
Yunnan		

Table S3. Land finance risks during 2009 - 2016.

Areas	Province	2009	2010	2011	2012	2013	2014	2015	2016
Western	Gansu	40.78	39.02	37.49	35.38	34.41	32.21	32.61	32.88
	Guangxi	47.44	50.03	48.94	47.24	45.36	46.06	46.15	46.53
	Guizhou	38.65	41.07	39.87	38.16	37.99	35.45	32.65	31.20
	Hainan	40.96	48.10	32.73	32.44	33.19	32.25	29.01	30.45
	Heilongjiang	30.01	31.06	32.49	27.07	29.33	29.47	29.11	29.18
	Jilin	38.18	40.12	40.73	33.41	36.17	36.12	32.07	35.51
	Neimenggu	34.92	38.21	35.25	35.85	46.22	32.56	29.80	27.95
	Ningxia	34.60	32.72	31.96	29.63	32.57	24.45	26.71	24.20
	Qinghai	44.85	43.39	42.93	39.11	39.50	40.11	35.00	33.56
	Shaanxi	35.13	37.76	36.28	33.19	33.28	31.19	30.48	31.35
	Shanxi	27.88	31.34	28.87	28.20	30.17	27.90	27.89	28.84
	Xinjiang	43.96	40.71	39.08	33.28	33.02	32.11	30.90	33.64
	Yunnan	44.25	46.82	51.61	44.91	44.83	42.35	37.10	38.95
Central	Anhui	39.78	41.50	38.93	36.55	41.60	38.45	33.51	37.53
	Beijing	40.65	45.07	42.11	40.03	42.42	43.06	40.95	42.93
	Chongqing	34.92	38.21	35.25	35.85	46.22	32.56	29.80	27.95
	Hebei	37.31	40.34	36.91	34.86	40.84	36.68	37.00	35.03
	Henan	35.02	34.22	35.20	34.36	37.68	32.53	30.87	33.20
	Hubei	43.15	45.20	46.74	41.32	45.44	39.00	38.64	40.34
	Hunan	42.69	48.09	49.58	44.57	48.49	45.48	44.10	45.60
	Jiangxi	32.90	33.74	34.68	31.47	35.51	31.85	29.80	29.61
	Liaoning	36.91	43.27	45.47	34.73	35.19	32.51	29.29	30.55
	Sichuan	48.63	49.66	49.11	46.47	48.23	49.69	45.94	41.19
	Tianjin	39.67	41.15	34.28	28.00	30.43	31.40	34.00	37.96
Eastern coastal	Fujian	38.65	40.77	42.50	37.92	41.16	36.76	40.06	37.28
	Guangdong	48.44	45.76	44.49	50.44	52.25	51.70	49.23	58.42
	Jiangsu	43.17	41.44	38.73	35.34	41.54	34.28	33.20	37.86
	Shandong	42.04	41.09	37.38	36.74	43.34	38.56	33.54	34.56
	Shanghai	28.52	23.08	22.84	20.67	26.14	24.28	21.77	22.91
	Zhejiang	47.76	53.09	46.12	40.00	46.71	37.93	34.40	38.37

Table S4. Four types of land finance risks during 2009 - 2016.

Factor	Areas	Province	2009	2010	2011	2012	2013	2014	2015	2016
Social risk	Western	Gansu	42.43	39.84	38.32	37.15	35.86	35.53	29.67	32.63
		Guangxi	65.82	63.57	61.68	59.04	55.65	57.27	53.94	55.52
		Guizhou	45.62	46.11	42.79	34.72	30.39	27.92	26.78	25.65
		Hainan	41.65	54.17	26.34	24.50	26.24	29.54	20.30	21.47
		Heilongjiang	35.92	30.53	30.32	30.66	32.26	31.16	33.97	36.31
		Jilin	50.36	42.83	44.08	34.37	39.59	43.58	39.23	45.91
		Neimenggu	55.15	43.00	40.41	37.72	34.56	32.92	34.77	36.40
		Ningxia	30.53	27.10	24.48	23.97	28.03	18.29	23.20	19.88
		Qinghai	52.91	51.36	49.12	46.32	45.48	44.94	39.69	35.88
		Shaanxi	43.44	46.91	47.32	35.09	30.88	28.29	31.41	31.49
		Shanxi	29.31	33.55	27.97	27.69	27.19	25.27	26.00	25.50
		Xinjiang	62.71	51.24	50.61	34.13	30.27	29.92	27.49	31.94
		Yunnan	59.65	57.95	56.88	50.66	51.90	54.55	46.55	48.60
	Central	Anhui	35.75	32.68	32.39	28.69	26.85	26.94	23.66	27.54
		Beijing	50.09	54.05	47.97	55.90	51.58	50.52	49.45	60.90
		Chongqing	35.07	34.63	32.73	32.82	45.61	24.37	18.38	19.49
		Hebei	37.19	30.88	29.89	29.93	31.97	29.37	27.36	28.26
		Henan	41.84	37.17	35.77	35.86	34.22	27.77	26.54	27.30
		Hubei	59.57	51.90	55.43	47.88	49.87	42.93	41.13	46.84
		Hunan	54.51	57.57	61.37	56.47	58.78	56.45	55.80	59.13
		Jiangxi	30.83	23.66	27.48	24.45	25.53	25.47	23.27	23.51
		Liaoning	37.78	34.79	33.59	31.21	30.43	31.12	30.41	34.31
		Sichuan	61.25	57.22	61.25	54.96	54.89	63.52	58.78	49.21
		Tianjin	46.42	46.16	39.20	34.09	35.95	39.09	43.71	49.89
	Eastern coastal	Fujian	29.47	25.86	32.37	27.36	30.09	28.22	28.24	31.01
		Guangdong	66.52	64.02	61.97	72.95	66.72	67.33	62.21	75.66
		Jiangsu	42.40	39.27	35.39	35.82	39.80	34.31	34.35	37.47
		Shandong	43.14	35.64	35.82	35.22	39.93	33.37	32.44	33.11
		Shanghai	31.11	19.63	18.46	18.15	24.47	19.81	20.09	21.87
		Zhejiang	32.21	32.91	31.72	34.21	32.29	28.26	27.22	30.45
Economic risk	Western	Gansu	18.78	27.33	39.70	23.59	31.46	27.89	30.74	29.71
		Guangxi	27.92	36.59	35.66	34.13	36.40	35.03	33.82	36.29
		Guizhou	23.13	30.54	34.19	41.29	48.13	43.01	38.65	36.28
		Hainan	50.20	52.72	43.91	45.01	44.64	36.14	38.17	40.73
		Heilongjiang	22.26	32.36	38.25	21.34	25.33	25.67	21.76	20.53
		Jilin	27.47	44.04	44.50	36.87	36.87	32.49	26.15	28.16
		Neimenggu	22.80	36.40	34.46	31.30	31.64	28.72	27.56	27.77
		Ningxia	39.87	41.86	40.82	32.40	41.86	29.43	28.71	26.91
		Qinghai	33.38	34.81	32.65	27.01	30.69	31.76	25.59	24.87
		Shaanxi	21.48	23.47	19.56	28.64	33.03	29.74	24.14	26.16
		Shanxi	20.84	24.28	26.77	26.65	32.06	26.87	23.49	28.43
		Xinjiang	17.94	24.44	20.74	24.90	27.77	23.73	23.66	25.07
		Yunnan	30.20	38.22	55.62	43.11	42.06	29.68	24.41	26.58
	Central	Anhui	45.12	57.82	52.64	46.87	65.02	53.67	44.94	57.80
		Beijing	29.99	40.71	38.77	23.86	37.59	38.38	34.60	23.26
		Chongqing	35.83	45.50	40.40	43.33	58.17	45.03	45.27	36.92
		Hebei	33.74	50.98	42.37	39.70	49.38	38.25	37.09	38.04
		Henan	24.85	33.79	38.21	38.71	44.44	40.01	34.13	40.39
		Hubei	29.01	45.16	44.43	37.97	47.84	37.80	37.37	36.16
		Hunan	20.81	32.79	37.03	32.85	40.16	34.46	31.76	32.95
		Jiangxi	34.06	47.99	44.57	39.08	51.48	39.91	36.83	36.19
		Liaoning	42.05	60.16	72.13	46.25	47.12	35.42	29.62	28.00
		Sichuan	39.66	45.31	37.68	39.82	47.23	39.70	34.37	34.19

Factor	Areas	Province	2009	2010	2011	2012	2013	2014	2015	2016
	Eastern coastal	Tianjin	42.31	46.66	34.99	23.39	28.36	26.42	21.56	31.64
		Fujian	43.22	56.83	46.74	38.93	48.50	35.89	34.85	37.16
		Guangdong	28.61	26.55	24.79	25.04	35.78	32.78	29.95	30.57
		Jiangsu	48.86	54.87	52.78	42.88	55.34	41.46	39.36	48.64
		Shandong	47.30	56.53	48.71	45.22	51.55	42.61	34.20	36.96
		Shanghai	27.16	24.40	23.42	18.23	23.07	26.36	24.17	22.77
		Zhejiang	68.20	78.73	59.32	40.99	64.90	41.65	33.63	46.24
Legal risk	Western	Gansu	24.24	18.09	19.92	24.68	19.36	18.55	19.23	22.04
		Guangxi	27.34	33.14	33.70	33.75	26.28	29.05	43.15	35.09
		Guizhou	46.97	45.47	39.34	36.95	33.91	35.76	29.80	28.69
		Hainan	10.72	14.77	16.52	17.86	18.41	20.70	23.02	23.38
		Heilongjiang	22.54	26.73	23.87	23.63	25.17	28.92	26.35	22.13
		Jilin	24.99	26.77	25.99	23.40	25.94	22.84	22.95	20.92
		Neimenggu	16.75	14.52	16.49	17.60	20.16	16.75	16.27	12.43
		Ningxia	22.75	17.31	22.73	27.31	13.20	16.08	17.84	15.10
		Qinghai	24.70	16.81	25.79	20.90	17.89	21.52	16.60	20.44
		Shaanxi	28.58	31.23	28.46	25.27	29.34	30.56	28.43	29.60
		Shanxi	29.31	32.03	26.91	23.45	26.39	28.55	33.85	30.75
		Xinjiang	22.85	23.86	22.96	25.64	29.63	33.65	33.16	34.83
	Yunnan	17.93	23.19	20.28	21.93	19.79	22.33	23.29	24.70	
	Central	Anhui	47.89	40.87	35.62	44.01	43.68	47.25	43.24	29.42
		Beijing	22.18	15.70	18.73	12.87	11.95	18.02	15.29	18.42
		Chongqing	27.68	30.69	27.84	25.04	22.61	25.26	24.43	26.71
		Hebei	46.67	48.89	47.81	39.48	52.52	57.22	68.50	49.61
		Henan	46.38	35.51	36.65	29.28	44.65	39.31	45.04	44.54
		Hubei	21.28	24.22	25.38	26.39	26.17	26.33	30.50	26.81
		Hunan	46.79	48.04	36.61	26.83	30.16	29.63	28.23	25.32
		Jiangxi	23.08	20.73	22.87	22.72	19.11	20.20	20.02	19.36
		Liaoning	21.10	35.47	27.24	18.95	22.62	28.41	21.37	21.41
		Sichuan	19.26	27.43	28.16	24.94	20.52	20.34	21.53	19.37
		Tianjin	17.52	18.74	19.53	18.33	17.95	19.08	33.57	18.33
		Eastern coastal	Fujian	41.95	37.23	51.53	53.43	45.44	49.60	74.94
	Guangdong		28.31	21.45	23.32	29.31	37.36	38.47	44.05	63.84
	Jiangsu		44.19	28.00	26.17	23.71	25.84	24.33	21.47	22.82
	Shandong		40.64	36.97	28.34	33.70	50.25	58.25	45.37	43.96
	Shanghai		18.29	21.49	25.65	23.42	30.33	24.67	11.40	17.01
	Zhejiang		45.56	56.75	56.26	47.46	45.73	50.46	47.49	35.99
Ecological risk	Western	Gansu	71.08	68.56	68.60	68.62	68.64	68.65	68.66	68.67
		Guangxi	59.38	58.60	58.63	58.66	58.67	58.68	58.73	58.78
		Guizhou	48.48	48.20	48.21	48.27	48.32	48.37	48.41	48.45
		Hainan	54.73	54.68	54.75	54.82	54.82	54.84	54.85	54.92
		Heilongjiang	42.50	37.17	37.20	37.21	37.18	37.17	37.19	37.20
		Jilin	35.63	31.46	31.47	31.51	31.56	31.61	31.63	31.67
		Neimenggu	79.04	74.56	74.56	74.56	74.57	74.56	74.51	74.51
		Ningxia	60.24	57.69	57.73	57.77	57.81	57.79	57.69	57.65
		Qinghai	85.96	84.65	84.66	84.65	84.64	84.59	84.72	84.67
		Shaanxi	57.41	57.63	57.66	57.68	57.68	57.65	57.63	57.65
		Shanxi	48.11	48.08	48.10	48.10	48.11	48.15	48.16	48.16
		Xinjiang	85.15	81.35	81.38	81.37	81.36	81.34	81.35	81.35
	Yunnan	62.64	62.20	62.21	62.24	62.27	62.30	62.33	62.33	
	Central	Anhui	24.96	24.57	24.66	24.73	24.73	24.81	24.83	24.87
		Beijing	65.90	66.26	66.53	66.67	66.74	66.74	66.84	66.93
		Chongqing	44.26	42.79	42.68	42.62	42.56	42.54	42.82	43.51
		Hebei	35.71	35.16	35.11	35.11	35.17	35.27	35.36	35.41
		Henan	15.18	14.75	14.88	14.95	15.06	15.25	15.38	15.36

Factor	Areas	Province	2009	2010	2011	2012	2013	2014	2015	2016
		Hubei	46.50	44.33	44.42	44.50	44.58	44.70	44.79	44.86
		Hunan	58.93	57.49	57.48	57.45	57.41	57.40	57.40	57.40
		Jiangxi	60.44	59.00	59.02	59.03	59.02	59.01	59.03	59.05
		Liaoning	39.36	35.76	35.91	36.07	36.18	36.26	36.31	36.35
		Sichuan	67.61	65.57	65.56	65.53	65.54	65.53	65.53	65.54
		Tianjin	28.62	28.73	29.10	29.35	29.51	29.65	29.72	29.73
	Eastern coastal	Fujian	69.92	69.78	69.82	69.82	69.82	69.82	69.84	69.84
		Guangdong	63.76	65.35	65.05	64.83	64.74	64.69	64.70	64.76
		Jiangsu	20.09	20.78	20.92	20.98	21.02	21.11	21.13	21.17
		Shandong	13.80	13.56	13.66	13.77	13.81	13.91	14.00	14.05
		Shanghai	38.63	42.35	42.57	42.53	42.51	42.50	42.25	41.98
		Zhejiang	58.10	57.59	57.62	57.65	57.68	57.70	57.70	57.71

Table S5 Fixed-effect and random-effect models with year dummy variables.

Basic level indicators (X – normalized variable)		Fixed-effects	Random-effects	Random-effects
		[1]	[2]	[3]
X1	Urbanization rate	0.5806*** (3.4031)	0.2159** (2.2553)	0.2509*** (2.8621)
X2	Increase of developed land	0.1024*** (3.3565)	0.1310*** (3.9589)	0.1251*** (3.9632)
X3	Average housing price growth rate	0.0343 (1.2984)	0.0316 (1.1009)	
X4	The income disparity between urban & rural residents	0.1888*** (3.3023)	0.1607*** (2.8576)	0.1730*** (3.2061)
X5	Degree of land market development	-0.0658* (-1.8596)	-0.0799** (-2.4718)	-0.0792** (-2.5432)
X6	Per capita cultivated land	1.6478** (2.1116)	0.0087 (0.1085)	
X7	Degree of land transfer dependence	0.3279*** (10.0555)	0.3421*** (10.1188)	0.3566*** (10.7099)
X8	Deficit rate	-0.2526** (-2.0957)	-0.2453*** (-2.6910)	-0.2651*** (-3.2613)
X9	Macro tax burden	0.2505*** (2.7975)	0.0865 (1.1648)	
X10	The asset-liability ratio of real estate enterprises	-0.0033 (-0.0791)	0.0107 (0.2611)	
X11	Number of land violation cases	0.0034 (0.1219)	-0.0191 (-0.6270)	
X12	Number of illegal land occupation cases	0.0935*** (2.7452)	0.0987*** (2.7008)	0.0920*** (2.8650)
X13	Percentage of cultivated land in illegal occupation cases	-0.0257 (-1.1740)	-0.0164 (-0.6970)	
X14	Percentage of cultivated land area	-1.5907 (-1.2205)	0.0866 (1.1918)	
X15	Cultivated land decrease rate	-0.0853** (-2.1844)	-0.1020** (-2.4140)	-0.0987** (-2.3586)
2010.year		0.0086 (0.8080)	0.0199* (1.7747)	0.0190* (1.7357)
2011.year		0.0258** (2.0632)	0.0434*** (3.5833)	0.0432*** (3.7910)
2012.year		0.0370** (2.4551)	0.0623*** (4.6656)	0.0630*** (5.2301)
2013.year		0.0580*** (3.1675)	0.0871*** (5.2650)	0.0871*** (5.8570)
2014.year		0.0614*** (3.1260)	0.0962*** (5.7126)	0.0973*** (6.6693)

2015.year	0.0747*** (3.5216)	0.1142*** (6.4667)	0.1166*** (7.4444)
2016.year	0.0869*** (3.8907)	0.1247*** (6.8119)	0.1245*** (7.2992)
Constant		-0.1138 (-1.2085)	-0.0586 (-0.8232)
Spatial weights (ρ)	0.1689*** (2.7321)	0.1752*** (2.8091)	0.1834*** (3.1262)
R^2 or Adj. R^2	0.166	0.675	0.666

Table S6 Comparison of the results using normalize vs. unnormalized data.

Variables	Normalized		Unnormalized	
X1	0.4642*** (3.4856)	0.2159** (2.2553)	0.8419*** (3.4852)	0.3920** (2.2589)
X2	0.1483*** (4.4383)	0.1310*** (3.9589)	0.0005*** (4.4388)	0.0005*** (3.9591)
X3	-0.0111 (-0.3778)	0.0316 (1.1009)	-1.7614 (-0.3774)	5.0052 (1.1024)
X4	0.0520 (0.8732)	0.1607*** (2.8576)	2.3118 (0.8737)	7.1453*** (2.8593)
X5	-0.0928*** (-2.6519)	-0.0799** (-2.4718)	-12.5483*** (-2.6527)	-10.8053** (-2.4715)
X6	0.0906 (0.8169)	0.0087 (0.1085)	2.3919 (0.8162)	0.2272 (0.1069)
X7	0.2669*** (8.8540)	0.3421*** (10.1188)	21.2641*** (8.8550)	27.2451*** (10.1192)
X8	-0.0305 (-0.3144)	-0.2453*** (-2.6910)	-6.6031 (-0.3159)	-52.8708*** (-2.6909)
X9	0.2264*** (2.8354)	0.0865 (1.1648)	155.6181*** (2.8361)	59.2373 (1.1613)
X10	0.0745* (1.6478)	0.0107 (0.2611)	0.2890* (1.6482)	0.0416 (0.2607)
X11	0.0038 (0.1212)	-0.0191 (-0.6270)	0.0001 (0.1223)	-0.0003 (-0.6264)
X12	0.0864** (2.2771)	0.0987*** (2.7008)	0.0019** (2.2782)	0.0022*** (2.7022)
X13	-0.0338 (-1.3608)	-0.0164 (-0.6970)	-3.6543 (-1.3610)	-1.7760 (-0.6975)
X14	0.1231 (1.2962)	0.0866 (1.1918)	27.0788 (1.2921)	19.0537 (1.1891)
X15	-0.0419 (-1.0392)	-0.1020** (-2.4140)	-8.0761 (-1.0414)	-19.6223** (-2.4168)
2010.year		0.0199* (1.7747)		2.6952* (1.7769)
2011.year		0.0434*** (3.5833)		5.8726*** (3.5858)
2012.year		0.0623*** (4.6656)		8.4282*** (4.6691)
2013.year		0.0871*** (5.2650)		11.7909*** (5.2685)
2014.year		0.0962***		13.0140***

		(5.7126)		(5.7154)
2015.year		0.1142***		15.4510***
		(6.4667)		(6.4687)
2016.year		0.1247***		16.8784***
		(6.8119)		(6.8131)
Constant	-0.3173***	-0.1138	-93.2512***	-56.2585***
	(-2.7230)	(-1.2085)	(-4.0189)	(-2.8407)
Spatial weights (ρ)	0.3211***	0.1752***	0.3210***	0.1751***
	(5.6324)	(2.8091)	(5.6300)	(2.8074)
Adj R^2	0.461	0.675	0.461	0.675

Notes: ***, **, and * mean the significance level of 0.001, 0.01, and 0.05, respectively; the values in parentheses are t values. N means the number of observations.