

Supplementary Materials

The substitution effect of grass-fed livestock products on grain-fed livestock products from the perspective of supply-side reform in China

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Supplementary Tables

Table S1. Statistical description of agricultural land among grassland ecological-economic regions

Region	Grassland ($\times 10^7$ hm ²)	Arable land ($\times 10^7$ hm ²)	Agricultural land ($\times 10^7$ hm ²)
Mengning	7.78	0.65	8.43
Northwest	4.53	0.80	5.32
Qinghai-Tibet	13.53	0.07	13.61
Northeast	2.48	3.64	6.13
Huanghuaihai	2.99	5.10	8.09
Southwest	6.69	0.49	7.18
Southeast	6.01	1.48	7.48

Table S2. Estimated results of fixed effects

Period	Parameter	Grain-fed livestock products	Grass-fed livestock products
2000-2015	α_i	147.1843*** ¹	-3.1884**
	β_i	0.0374***	0.0098**
2000-2003	α_i	14.8541***	-3.2184***
	β_i	0.0653***	0.0031***
2004-2006	α_i	57.1894	1.1779**
	β_i	0.0458	0.0074**
2007-2009	α_i	144.1896***	-4.1859***
	β_i	0.0417***	0.0109***
2010-2012	α_i	247.0493***	11.4938***
	β_i	0.0294***	0.0098***
2013-2015	α_i	317.1547***	27.1548***
	β_i	0.0157***	0.0214***

¹ "****" "***" "**" means significant at the levels of 1%, 5%, and 10%, respectively.

Table S3. Meat cross-price elasticity in Mengning Region from 2006 to 2015

Province	County or city	Grain-fed livestock products		Grass-fed livestock products	
		2006-2010	2011-2015	2006-2010	2011-2015
Ningxia	Yinchuan	0.64	0.37	0.51	0.54
	Shizuishan	0.81	-0.51	0.75	0.62
	Wuzhong	0.65	0.71	0.81	1.88
	Guyuan	1.24	0.87	0.69	-0.76
	Zhongwei	0.94	0.82	0.82	0.69
Inner Mongolia	Bayannur	1.21	0.61	0.45	1.53
Inner Mongolia	ErDOS	1.17	0.93	1.28	0.54
	Hohhot	0.86	0.58	1.29	1.95
	Baotou	0.61	0.74	-1.21	-0.54
	Ulanqab	0.74	-0.65	1.31	0.39
	Xilingol	0.78	0.88	0.85	0.65
	Chifeng	0.39	0.59	0.87	0.63
	Tongliao	0.63	0.34	1.41	0.54
	Erguna	1.13	0.67	1.35	0.67
	Hulun Buir	0.57	0.82	1.48	0.74
	Xing'an	0.31	0.32	1.13	0.68
Hebei	Weichang	0.99	0.81	0.51	0.97
	Guyuan	0.99	0.72	0.91	0.95
	Zhangbei	0.93	0.85	0.77	0.87

Table S4. Meat cross-price elasticity in Northwest Region from 2006 to 2015

Province	City	Grain-fed livestock products		Grass-fed livestock products	
		2006-2010	2011-2015	2006-2010	2011-2015
Xinjiang	Urumchi	0.93	0.51	1.35	1.19
	Changji	0.67	0.73	0.97	0.75
	Turpan	0.44	-0.27	1.25	0.87
	Hami	0.51	0.82	1.71	0.54
	Tacheng	1.14	0.75	2.54	0.44
	Yili	0.75	-0.32	0.94	0.51
	Aksu	0.81	0.18	0.51	0.99
	Kashi	0.44	0.88	0.88	0.85
	Hetian	0.98	0.71	0.71	0.73
	Kezhou	0.82	0.47	0.97	0.83
	Bozhou	0.97	0.66	0.84	0.93
	Bazhou	0.91	-0.51	0.95	0.58
	Altay	0.84	0.77	0.64	-0.34
	Gansu	Jiuquan	0.59	0.56	1.74
Zhangye		-0.97	0.67	0.74	0.54
Inner Mongolia	Alxa	0.58	0.59	-0.54	-0.17

Table S5. Meat cross-price elasticity in Qinghai-Tibet Region from 2006 to 2015

Province	City	Grain-fed livestock products		Grass-fed livestock products	
		2006-2010	2011-2015	2006-2010	2011-2015
Qinghai	Xining	0.71	0.84	0.54	0.97
	Haibei	0.93	-0.87	0.71	0.41
	Huangnan	-0.91	0.98	0.77	0.86
	Hainan	0.93	-0.89	0.66	0.97
	Haixi	0.87	0.76	0.81	-0.88
	Haibei	0.78	-0.66	0.61	0.81
	Guoluo	0	0	0	0
	Yushu	0	0	0	0
Tibet	Lhasa	-0.67	0.85	0.87	1.99
	Ali	0.84	-0.78	0.75	1.15
	Xigaze	-0.85	0.81	0.97	0.79
	Naqu	0.99	0.82	0.88	0.81
	Shannan	0.98	0.68	0.72	0.73
	Linzhi	0.89	-0.66	0.77	-0.77
	Changdu	0.79	0.76	0.61	0.85
Sichuan	Aba	0.97	0.77	0.77	0.94
	Ganzi	-0.79	0.78	0.84	0.93
Yunnan	Nujiang	0.54	0.83	0.66	0.97
	Diqing	0.93	0.81	0.85	0.85

Table S6. Meat cross-price elasticity in Northeast Region from 2006 to 2015

Province	City	Grain-fed livestock products		Grass-fed livestock products	
		2006-2010	2011-2015	2006-2010	2011-2015
Heilongjia ng	Great Khingan	0.84	0.64	0.87	0.4
	Heihe	0.54	0.98	0.65	0.34
	Qiqihar	0.38	-0.84	1.61	0.17
	Suihua	0.32	0.78	1.24	0.18
	Daqing	0.54	0.69	2.17	0.38
	Yichun	0.25	0.65	1.09	0.14
	Hegang	0.64	0.97	0.98	0.43
	Kiamusze	0.65	0.74	0.37	0.41
Jilin	Mudanjiang	0.41	0.58	0.51	0.51
	Baishan	0.56	0.38	0.62	0.93
	Songyuan	0.89	0.81	0.67	0.51
	Changchun	0.67	0.77	0.75	0.69
	Siping	0.88	-0.68	0.88	0.87
	Jilin	-.54	0.81	0.79	0.75
	Liaoyuan	0.55	0.69	0.65	0.56
	Tonghua	0.85	0.98	0.77	0.77
	Baishan	0.58	0.57	0.68	0.67
	Yanbian	-0.97	0.57	0.51	0.84
Liaoning	Shenyang	0.29	0.68	0.42	0.74
	Dalian	0.64	-0.78	0.87	0.98
	Benxi	0.69	0.84	0.86	0.58
	Dandong	0.47	0.77	0.72	0.83
	Panjin	1.15	0.88	0.63	0.94
	Anshan	1.28	-0.85	0.72	0.63
	Jinzhou	-0.78	0.75	0.33	0.83
	Fushun	0.61	0.65	0.84	0.71
	Tieling	0.85	-0.67	0.68	0.74
	Yingkou	-0.77	0.54	0.79	0.79
	Huludao	0.63	0.47	0.89	0.88
Liaoyang	0.44	-0.41	0.67	0.98	
Inner Mongolia	Oroqen	0.82	0.64	0.58	0.54

Table S7. Meat cross-price elasticity in Huanghuahai Region from 2006 to 2015

Province	City	Grain-fed livestock products		Grass-fed livestock products		
		2006-2010	2011-2015	2006-2010	2011-2015	
Gansu	Qingyang	-0.07	0.54	1.27	0.87	
	Longnan	0.91	0.68	0.64	0.83	
Shaanxi	Xi'an	0.53	0.66	0.71	0.71	
	Baoji	0.39	0.84	-0.81	0.69	
	Xianyang	0.58	0.86	0.83	0.85	
	Hanzhong	0.31	0.95	0.57	0.46	
	Ankang	0.69	0.95	0.84	-0.99	
	Shangluo	0.83	0.97	0.83	0.68	
	Weinan	0.94	0.91	0.65	0.53	
	Tongchuan	-0.97	0.94	0.52	-0.97	
	Yan'an	-0.95	0.94	-0.91	0.88	
Shanxi	Taiyuan	0.97	0.95	0.54	0.92	
	Shuozhou	0.96	-0.54	0.81	0.58	
	Xinzhou	0.97	0.83	0.71	0.96	
	Yangquan	0.93	0.61	0.94	0.88	
	Lvliang	0.91	-0.75	-0.65	0.46	
	Linfen	0.81	0.77	0.54	0.87	
	Yuncheng	0.92	0.66	0.17	0.63	
	Jincheng	0.84	0.91	0.86	-0.89	
	Linfen	0.97	0.57	0.96	0.68	
	Changzhi	0.67	-0.76	0.87	0.84	
	Jinzhou	-0.79	1.66	0.88	0.76	
	Datong	0.84	1.71	-0.35	0.68	
	Hebei	Langfang	0.85	0.84	-0.74	0.67
		Baoding	0.63	0.87	0.66	0.83
Shijiazhuang		0.96	0.78	0.48	0.58	
Xingtai		0.81	0.78	-0.95	0.44	
Hengshui		0.87	-0.66	0.96	0.63	
Cangzhou		0.87	0.57	0.87	0.76	
Henan	Zhengzhou	0.54	-0.93	0.56	0.77	
	Kaifeng	0.67	0.84	0.99	0.92	
	Shangqiu	0.72	-0.41	1.16	-0.26	
	Zhoukou	0.66	-0.64	0.94	0.87	
	Xuchang	0.77	0.91	1.25	0.54	
	Pingdingshan	0.84	0.82	1.18	0.65	
	Luoyang	0.44	0.87	0.89	0.76	
Sanmenxia	0.81	0.63	0.84	-1.23		

	Nanyang	0.63	-0.89	0.74	0.76
	Zhumadian	0.87	0.57	0.73	0.85
	Xinyang	0.51	0.98	0.65	0.66
	Xinxiang	0.66	0.86	-0.84	0.56
	Puyang	0.77	0.47	0.69	0.86
	Anyang	0.96	0.56	0.81	0.96
Beijing		0.78	0.67	0.65	-0.77
Tianjin		0.73	0.83	0.83	0.66
Anhui	Huaibei	0.86	0.98	0.68	0.62
	Bozhou	0.88	-0.27	0.86	0.41
	Suzhou	0.66	0.83	0.66	0.88
Jiangsu	Xuzhou	0.51	0.51	0.88	0.89
	Lianyungang	0.83	0.82	0.75	0.63

Table S8. Meat cross-price elasticity in Southwest Region from 2006 to 2015

Province	City	Grain-fed livestock products		Grass-fed livestock products	
		2006-2010	2011-2015	2006-2010	2011-2015
Chongqing		0.57	0.81	0.94	0.87
Guizhou	Guiyang	0.74	0.94	0.35	0.93
	Bijie	0.72	0.84	1.91	0.81
	Zunyi	0.29	0.78	0.86	0.84
	Tongren	0.84	0.76	0.83	0.75
	Liupanshui	0.65	0.58	0.67	-0.61
	QianDongnan	0.76	0.67	0.43	1.47
	Qianxinan	0.19	0.66	0.51	1.28
	Anshun	0.61	0.87	0.91	0.95
	Sichuan	Liangshan	0.52	-0.66	0.84
Panzhihua		0.44	0.35	0.50	0.57
Leshan		0.55	0.84	0.48	0.98
Zigong		0.66	0.86	0.96	0.87
Yibin		0.72	0.57	0.27	0.65
Luzhou		0.74	0.63	0.33	0.96
Yunnan	Kunming	0.57	0.66	0.41	0.65
	Lijiang	0.65	0.87	0.87	0.74
	Dali	0.96	0.93	-0.36	0.75
	Chuxiong	0.87	0.66	0.86	0.57
	Qujing	0.56	0.86	0.85	0.94
	Wenshan	0.69	0.61	0.51	0.57
	Honghe	-0.73	0.86	0.63	0.96
	Pu'er	0.68	0.34	0.67	-0.87
	Xishuangbanna	0.65	0.82	0.57	0.85
	Lincang	0.52	0.38	1.54	0.71
Baoshan	0.53	0.57	-0.64	0.67	
Hunan		0.63	0.61	0.98	0.93
Hubei		0.87	0.87	0.57	0.59

Table S9. Meat cross-price elasticity in Southeast Region from 2006 to 2015

Province	City	Grain-fed livestock products		Grass-fed livestock products	
		2006-2010	2011-2015	2006-2010	2011-2015
Hunan	Shanghai	0.17	0.88	0.92	0.01
	Changsha	0.85	0.74	0.83	0.84
	Changde	0.84	0.63	0.61	0.97
	Yiyang	0.87	0.51	0.73	0.91
	Loudi	0.64	0.81	0.78	0.59
	Huaihua	0.79	0.69	0.89	0.62
	Shaoyang	0.81	-0.88	0.94	0.66
	Xiangtan	0.22	0.76	0.77	0.54
	Zhuzhou	0.81	0.86	0.67	0.78
	Yueyang	0.90	0.88	0.71	0.88
	Hengyang	0.93	0.95	0.85	0.79
	Yongzhou	0.85	0.64	0.63	0.68
	Chenzhou	0.74	0.73	0.77	0.59
Hubei	Wuhan	0.83	0.57	-0.64	0.61
	Huangshi	0.66	-0.75	0.41	0.78
	Shiyan	0.66	0.72	0.42	0.45
	Yichang	0.87	0.84	0.11	0.39
	Xiangyang	0.85	0.66	0.24	0.63
	Ezhou	-0.85	0.98	0.24	0.64
	Jingmen	0.77	0.07	-0.25	0.71
	Xiaogan	0.81	-0.71	0.47	0.24
	Huanggang	0.65	0.88	0.09	0.27
	Xianning	0.89	0.51	0.38	0.86
	Suizhou	0.74	0.52	0.35	0.65
	Xiantao	0.77	0.69	0.38	0.77
	Qianjiang	0.69	0.87	0.17	0.92
Tianmen	0.98	0.77	0.39	0.81	
Anhui	Hefei	0.84	-0.62	0.23	0.88
	Wuhu	0.71	0.51	0.36	1.76
	Bengbu	0.64	0.74	0.69	0.95
	Huainan	0.87	0.69	0.32	0.96
	Maanshan	0.88	0.58	0.85	0.91
	Tongling	0.65	0.77	0.39	0.86
	Anqing	-0.83	0.74	0.24	1.36
	Huangshan	0.67	0.42	0.66	1.14
	Fuyang	0.66	0.58	0.79	1.17
Liuan	0.88	0.47	0.88	1.15	

	Chizhou	0.69	0.68	0.61	1.22
Jiangxi	Nanchang	0.88	0.85	0.53	0.31
	Jiujiang	0.65	0.67	0.77	0.48
	Shangrao	0.87	-0.35	-0.99	0.39
	Fuzhou	0.82	0.38	0.81	0.64
	Yichun	0.91	0.68	0.63	0.66
	Ji'an	0.94	0.81	0.88	0.84
	Ganzhou	0.68	-0.59	0.95	0.61
	Jingdezhen	0.58	0.68	0.91	-0.96
	Pingxiang	0.74	0.87	0.52	0.93
	Xinyu	0.47	0.68	0.84	1.16
	Yingtang	0.81	0.87	1.14	-0.61
Jiangsu		0.95	0.64	0.71	0.96
Fujian		0.86	0.84	1.25	0.36
Zhejiang		0.85	0.71	0.57	0.89
Guangdong		0.45	-0.19	0.89	0.84
Hainan		0.87	0.68	0.67	0.66

Table S10. Agricultural land required for production of grass-fed livestock products in grassland and grain farming models

Region	Province or City	Consumption of grass-fed livestock products		Grain farming areas ($\times 10^3$ hm ²)	Grassland agriculture areas ($\times 10^3$ hm ²)
		($\times 10^3$ FEU _a)	ALEU		
Mengning	Inner Mongolia	9752.4	5167.82	12.61	2.59
	Ningxia	3030.75	1606.01	3.92	0.81
Northwest	Xinjiang	17937.04	9504.88	28.81	4.76
	Jiuquan	71.54	37.905	0.10	0.02
	Zhangye	178.21	94.43	0.28	0.04
	Alashan	345.58	183.12	0.52	0.07
Qinghai-Tibet	Qinghai	2484.67	1316.63	3.57	0.66
	Tibet	1237.94	655.97	1.78	0.31
Northeast	Liaoning	20051.24	10625.2	23.63	5.32
	Jilin	11259.96	5966.66	13.27	2.97
	Heilongjiang	15803.84	8374.485	18.62	4.20
Huanghuaihai	Beijing	11908.04	6310.08	10.71	3.15
	Tianjing	5607.58	2971.465	5.04	1.47
	Hebei	31224.6	16545.97	28.03	8.26
	Shanxi	11598.3	6145.965	10.43	3.08
	Shandong	44562.56	23613.77	40.04	11.80
	Henan	44323.8	23487.24	39.79	11.76
	Shaanxi	18836.22	9981.335	16.90	5.00
	Gansu	9526.5	5048.12	8.54	2.52
Southwest	Guangxi	16884.62	8947.19	15.15	2.31
	Chongqing	14782.8	7833.42	13.26	1.99
	Sichuan	35196.12	18650.49	31.60	4.79
	Guizhou	16210.8	8590.12	14.56	2.20
	Yunnan	18988.58	10062.08	17.04	2.59
Southeast	Shanghai	17278.8	9156.07	9.625	3.22
	Jiangsu	33435.82	17717.7	18.65	6.26
	Zhejiang	19509.1	10337.92	10.88	3.64
	Fujian	17704.18	9381.47	9.87	3.32
	Jiangxi	16255.68	8613.92	9.06	3.04
	Hubei	22598.4	11974.94	12.60	4.23
	Hunan	23740.56	12580.16	13.23	4.44
	Guangdong	45645.85	24187.8	25.45	8.54
	Hainan	4291.56	2274.09	2.38	0.80