Online Appendix

“Assessing market (dis)integration in early modern China and Europe”

Daniel Bernhofen[a] Markus Eberhardt[b,c] Jianan Li[d] Stephen Morgan[e,f]

[a] *School of International Service, American University, Washington DC, USA*

[b] *School of Economics, University of Nottingham, UK*

[c] *Centre for Economic Policy Research, UK*

[d] *School of Economics, Xiamen University, PR China*

[e] *Nottingham University Business School, University of Nottingham, UK*

[f] *Provost Office, University of Nottingham, Ningbo, PR China*

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Contents:

A. Qing China: Maps and Related Material

Figure A-1: Skinner Macro-Regions of China

Source: Skinner, G. W., Henderson, M. and Yue, Z. (no date). "A note regarding the Physiographic and Socioeconomic Macroregions of China" (http://tinyurl.com/qexyu96).

Figure A-2: Agro-Climatic Regions of China

Source: Buck (1937, p. 27).

Skinner Macro-Regions

Below are the macro-regions defined by William Skinner (1977a) and presented in Figure A-1 above. Our sample does not contain prefectures in Manchuria (ID: 10) or Yunnan (parts of 90). Since the former is typically not seen as part of the '18 provinces of China proper', the literature typically talks of the *eight* Skinner macro-regions. The cross-section averages as well as the averages for the convergence to Skinner macro-regions is based on the larger groupings indicated in the ID column. Overleaf we indicate the allocation of each prefecture to a Skinner macro-region.

ID	**Macro-region**	**Chinese Name**	**Geographical Area**
10	Northeast China (Manchuria)	东北区	not reported
20	North China	华北区	746,460 km^2
30	Northwest China	西北区	771,300 km^2
	31 Wei-Fen Basins	渭汾流域分区	
	32 Upper Huang Basin	黄河上游分区	
	33 Gansu (Hexi) Corridor	河西(甘肃)走廊分区	
40	Upper Yangzi	长江上游区	423,950 km^2
50	Middle Yangzi	长江中游区	699,700 km^2
	51 Middle Yangzi proper	长江中游分区	
	52 Gan Basin	赣江流域分区	
	53 Yuan Basin	沅江流域分区	
	54 Upper Han Basin	汉江上游分区	
60	Lower Yangzi	长江下游区	192,740 km^2
70	Southeast Coast	东南沿海区	226,670 km^2
	71 Ou-Ling Basins	瓯灵流域分区	
	72 Min Basin	闽江流域分区	
	73 Zhang-Quan	漳泉分区	
	74 Han Basin	韩江流域分区	
	75 Taiwan	台湾分区	
80	Lingnan	岭南区	424,900 km^2
90	Yungui	云贵区	470,570 km^2

Source: Skinner, G. W., Henderson, M. and Yue, Z. (no date). "A note regarding the Physiographic and Socioeconomic Macroregions of China" (http://tinyurl.com/qexyu96); the geographical areas, Skinner, 1977a: 213.

Table A-1 Prefectural Makeup of Skinner Macro-Regions (South China)

Prefecture	Pref	Pro	Province	ID	Prefecture	Pref	Pro	Province	ID
Sizhou	33	1	Anhui	20	Taiping	36	1	Anhui	60
Chuzhou	34	1	Anhui	20	Hezhou	37	1	Anhui	60
Fengyang	35	1	Anhui	20	Luzhou	38	1	Anhui	60
Liu'an	39	1	Anhui	20	Guangde	41	1	Anhui	60
Yingzhou	40	1	Anhui	20	Ningguo	42	1	Anhui	60
Haizhou	1	2	Jiangsu	20	Huizhou	43	1	Anhui	60
Huai'an	2	2	Jiangsu	20	Chizhou	44	1	Anhui	60
Kuizhou	108	10	Sichuan	40	Anqing	45	1	Anhui	60
Baoning	109	10	Sichuan	40	Yangzhou	3	2	Jiangsu	60
Shunqing	110	10	Sichuan	40	Tongzhou	4	2	Jiangsu	60
Zhongqing	111	10	Sichuan	40	Taicang	5	2	Jiangsu	60
Long'an	112	10	Sichuan	40	Songjiang	6	2	Jiangsu	60
Tongchuan	113	10	Sichuan	40	Suzhou	7	2	Jiangsu	60
Chengdu	114	10	Sichuan	40	Changzhou	8	2	Jiangsu	60
Jiading	115	10	Sichuan	40	Zhenjiang	9	2	Jiangsu	60
Xuzhou	116	10	Sichuan	40	Jiangning	10	2	Jiangsu	60
Mingyuan	117	10	Sichuan	40	Ningbo	11	11	Zhejiang	60
Yazhou	118	10	Sichuan	40	Jiaxing	12	11	Zhejiang	60
Huangzhou	73	8	Hubei	51	Hangzhou	13	11	Zhejiang	60
Wuchang	74	8	Hubei	51	Shaoxing	14	11	Zhejiang	60
Hanyang	75	8	Hubei	51	Jinhua	15	11	Zhejiang	60
De'an	76	8	Hubei	51	Huzhou	17	11	Zhejiang	60
Anlu	77	8	Hubei	51	Yanzhou	18	11	Zhejiang	60
Jingzhou fu	78	8	Hubei	51	Quzhou	19	11	Zhejiang	60
Xiangyang	79	8	Hubei	51	Taizhou	16	11	Zhejiang	71
Yichang	80	8	Hubei	51	Wenzhou	20	11	Zhejiang	71
Yunyang	81	8	Hubei	51	Funing	21	4	Fujian	72
Shinan	82	8	Hubei	51	Fuzhou	22	4	Fujian	72
Yuezhou	83	9	Hunan	51	Jianning	26	4	Fujian	72
Changsha	84	9	Hunan	51	Yanping	27	4	Fujian	72
Changde	85	9	Hunan	51	Shaowu	31	4	Fujian	72
Lizhou	86	9	Hunan	51	Xinghua	23	4	Fujian	73
Hengzhou	87	9	Hunan	51	Quanzhou	24	4	Fujian	73
Baoqing	88	9	Hunan	51	Zhangzhou	25	4	Fujian	73
Chenzhou	91	9	Hunan	51	Yongchun	28	4	Fujian	73
Guiyang	92	9	Hunan	51	Longyan	29	4	Fujian	73
Yongzhou	93	9	Hunan	51	Tingzhou	30	4	Fujian	74
Raozhou	46	3	Jiangxi	52	Chaozhou	60	5	Guangdong	74
Guangxin	47	3	Jiangxi	52	Jiayingzhou	61	5	Guangdong	74
Fuzhou	48	3	Jiangxi	52	Taiwan	32	4	Fujian	75
Nanchang	49	3	Jiangxi	52	Huizhou	62	5	Guangdong	80
Nankang	50	3	Jiangxi	52	Hanxiong	63	5	Guangdong	80
Jiujiang	51	3	Jiangxi	52	Shaozhou	64	5	Guangdong	80
Jianchang	52	3	Jiangxi	52	Guangzhou	65	5	Guangdong	80
Ningdu	53	3	Jiangxi	52	Lianzhou	66	5	Guangdong	80
Ji'an	54	3	Jiangxi	52	Zhaoqing	67	5	Guangdong	80
Linjiang	55	3	Jiangxi	52	Luoding	68	5	Guangdong	80
Ruizhou	56	3	Jiangxi	52	Gaozhou	69	5	Guangdong	80
Ganzhou	57	3	Jiangxi	52	Leizhou	70	5	Guangdong	80
Nan'an	58	3	Jiangxi	52	Lianzhou fu	71	5	Guangdong	80
Yuanzhou	59	3	Jiangxi	52	Qiongzhou	72	5	Guangdong	80
Tongren	119	6	Guizhou	53	Guilin	96	7	Guangxi	80
Sizhou	122	6	Guizhou	53	Wuzhou	97	7	Guangxi	80
Zhenyuan	123	6	Guizhou	53	Pingle	98	7	Guangxi	80
Liping	124	6	Guizhou	53	Liuzhou	99	7	Guangxi	80
Duyun	125	6	Guizhou	53	Xunzhou	100	7	Guangxi	80
Pingyue	126	6	Guizhou	53	Yulin	101	7	Guangxi	80
Chenzhou fu	89	9	Hunan	53	Nanning	102	7	Guangxi	80
Yongshun	90	9	Hunan	53	Si'en	103	7	Guangxi	80
Jingzhou	94	9	Hunan	53	Qingyuan	104	7	Guangxi	80
Yuanzhou	95	9	Hunan	53	Taiping fu	105	7	Guangxi	80

Table continued overleaf

Prefecture	Pref	Pro	Province	ID	Prefecture	Pref	Pro	Province	ID
Zhen'an	106	7	Guangxi	80	Anshun	128	6	Guizhou	90
Sicheng	107	7	Guangxi	80	Xingyi	129	6	Guizhou	90
Sinan	120	6	Guizhou	90	Guiyang	130	6	Guizhou	90
Shiqian	121	6	Guizhou	90	Dading	131	6	Guizhou	90
Zunyi	127	6	Guizhou	90					

Notes: South China prefectures by Skinner macro region (final column, marked ID) and province (Pro), in order of prefecture identifier (Pref). The latter is the numbering maintained in the map of our sample in Figure 1 of the main text.

Table A-2 Prefectural Makeup of Skinner Macro-Regions (North China)

Prefecture	Pref	Pro	Province	ID	Prefecture	Pref	Pro	Province	ID
Zhangde	175	12	Henan	20	Daming	138	16	Zhili	20
Weihui	176	12	Henan	20	Baoding	139	16	Zhili	20
Huaiqing	177	12	Henan	20	Dingzhou	140	16	Zhili	20
Guide	178	12	Henan	20	Zhaozhou	141	16	Zhili	20
Kaifeng	179	12	Henan	20	Shenzhou	142	16	Zhili	20
Henan fu	180	12	Henan	20	Shunde	143	16	Zhili	20
Shanzhou	181	12	Henan	20	Xuanhua	144	16	Zhili	20
Chenzhou	182	12	Henan	20	Yizhou	145	16	Zhili	20
Xuzhou	183	12	Henan	20	Zhengding	146	16	Zhili	20
Ruzhou	184	12	Henan	20	Qingyang	200	11	Gansu	31
Guangzhou	185	12	Henan	20	Pingliang	202	11	Gansu	31
Runing	186	12	Henan	20	Qinzhou	203	11	Gansu	31
Nanyang	187	12	Henan	20	Gongchang	205	11	Gansu	31
Shangzhou	193	13	Shaanxi	20	Yulin	188	13	Shaanxi	31
Xing'an	198	13	Shaanxi	20	Suide	189	13	Shaanxi	31
Dengzhou	147	14	Shandong	20	Yan'an	190	13	Shaanxi	31
Laizhou	148	14	Shandong	20	Tongzhou	191	13	Shaanxi	31
Qingzhou	149	14	Shandong	20	Fuzhou	192	13	Shaanxi	31
Wuding	150	14	Shandong	20	Xi'an	194	13	Shaanxi	31
Yizhou	151	14	Shandong	20	Qianzhou	195	13	Shaanxi	31
Jinan	152	14	Shandong	20	Binzhou	196	13	Shaanxi	31
Tai'an	153	14	Shandong	20	Fengxiang	197	13	Shaanxi	31
Yanzhou	154	14	Shandong	20	Taiyuan	165	15	Shanxi	31
Dongchang	155	14	Shandong	20	Fenzhou	168	15	Shanxi	31
Caozhou	156	14	Shandong	20	Pingyang	170	15	Shanxi	31
Datong	157	15	Shanxi	20	Xizhou	171	15	Shanxi	31
Daizhou	159	15	Shanxi	20	Jiangzhou	172	15	Shanxi	31
Liaozhou	160	15	Shanxi	20	Jiezhou	173	15	Shanxi	31
Pingding	161	15	Shanxi	20	Puzhou	174	15	Shanxi	31
Xinzhou	162	15	Shanxi	20	Ningxia	201	11	Gansu	32
Ningwu	163	15	Shanxi	20	Lanzhou	206	11	Gansu	32
Lu'an	166	15	Shanxi	20	Xining	207	11	Gansu	32
Qinzhou	167	15	Shanxi	20	Shuoping	158	15	Shanxi	32
Zezhou	169	15	Shanxi	20	Baode	164	15	Shanxi	32
Yongping	132	16	Zhili	20	Liangzhou	208	11	Gansu	33
Zunhuazhou	133	16	Zhili	20	Ganzhou	209	11	Gansu	33
Tianjin	134	16	Zhili	20	Suzhou	210	11	Gansu	33
Hejian	135	16	Zhili	20	Anxi	211	11	Gansu	33
Jizhou	136	16	Zhili	20	Jiezhou	204	11	Gansu	40
Guangping fu	137	16	Zhili	20	Hanzhong	199	13	Shaanxi	54

Notes: North China prefectures by Skinner macro region (final column, marked ID) and province (Pro), in order of prefecture identifier (Pref). Prefecture numbering corresponds with the map of our sample in Figure 1 of the main paper.

B. Qing China: Data, Descriptive Statistics and Sample Makeup

Our Chinese price data (1740-1820) come from the rich records of the Qing state, which took a keen interest in grain prices. An elaborate grain price reporting system was progressively implemented during the reign of Emperor Kangxi (1662-1723) and became a nation-wide system at the start of the reign of the Emperor Qianlong (1736-1795). This system aggregated reports from the county into prefecture-level summaries of high and low prices for up to 20 commodities, though not all grains were produced in every region, which the provincial governor or governor general would convey in monthly reports to the emperor in Beijing (Chuan and Kraus, 1975; Wang, 1978, 1992; Marks, 1991). These reports survive in archives in Beijing and Taipei. We use the subset of rice and wheat prices compiled by the late Professor Wang Yejian [Yeh-Chien] and collaborators.[1]

Several technical issues have long concerned scholars working with these data, in particular the comparability of the units used for price, volume and weight, and the reliability of the reports. Units of account in China during this period varied widely.[2] According to Chuan and Kraus (1975) and Wang (1978) the evidence overwhelmingly supports the view that officials were competent in converting the many local units into the imperial standards. After all, the Qing state from the emperor downwards used these reports to monitor grain prices and supply across the country, and they were hardly ignorant of the problems of comparability if money and weight units were inconsistent between distant locations. At times the accuracy of the reports might be questionable, and we sometimes see the same price repeated for several months. But sources suggest the Emperor Qianlong and senior officials scrutinised the reports, querying anomalies, which combined with a system of irregular independent reports, ensured lower-level officials were "on their toes" (Marks, 1991). There is a general consensus in the literature that over the long-run there was a high degree of veracity in these data series (Chuan and Kraus, 1975; Marks, 1991, 1998; Shiue, 2002, 2004, 2015; Shiue and Keller, 2007).

[1] The Qing Dynasty Grain Price Database (*Qing dai liangjia ziliao ku*) is hosted at the Institute of Modern History, Academia Sinica, Taiwan. The database is available online at http://mhdb.mh.sinica.edu.tw/foodprice/.

[2] The grain prices were reported in taels (*liang*; ounces of silver) per granary bushel (*cang shi*, about 104 litres). Yet the purchases in retail markets were made in copper currency (*qian*), of which the exchange rate with silver differed from place to place, as did the measures of sales unit, which could be either volume or weight measures.

Table B-1: Geographic Distribution of the Sample by Province

South China (rice)			North China (wheat)		
Province	No. of Prefectures	Obs.	Province	No. of Prefectures	Obs.
Anhui	13	10,583	Gansu	12	9,977
Jiangsu	10	8,296	Henan	13	10,111
Jiangxi	14	8,146	Shaanxi	12	9,924
Fujian	12	9,842	Shandong	10	8,097
Guangdong	13	10,678	Shanxi	18	15,234
Guizhou	13	10,463	Zhili	15	9,490
Guangxi	12	10,339			
Hubei	10	7,872			
Hunan	13	10,985			
Sichuan	11	7,551			
Zhejiang	10	8,492			
Total	131	103,247	Total	80	62,833

Table B-2: Descriptive Statistics (raw price series) by Province. 1740-1820

South China (rice)				North China (wheat)			
Province	Mean	Min	Max	Province	Mean	Min	Max
Anhui	167.83	78.5	439	Gansu	109.76	41	448
Jiangsu	196.33	107	430	Henan	121.05	52	390
Jiangxi	140.89	86	276.5	Shannxi	144.53	41	829.5
Fujian	177.21	79.5	350	Shandong	165.46	77.5	524
Guangdong	152.56	65.5	297.5	Shanxi	195.03	84	398
Guizhou	96.16	58.5	247.5	Zhili	202.76	91	725
Guangxi	115.74	53.5	188				
Hubei	153.89	76.5	374				
Hunan	134.07	69.5	325				
Sichuan	151.43	49	565.5				
Zhejiang	180.08	96	351.5				

Notes: The data are grain prices reported in silver taels (*liang*) *x 100* per granary bushel (*cang shi*).

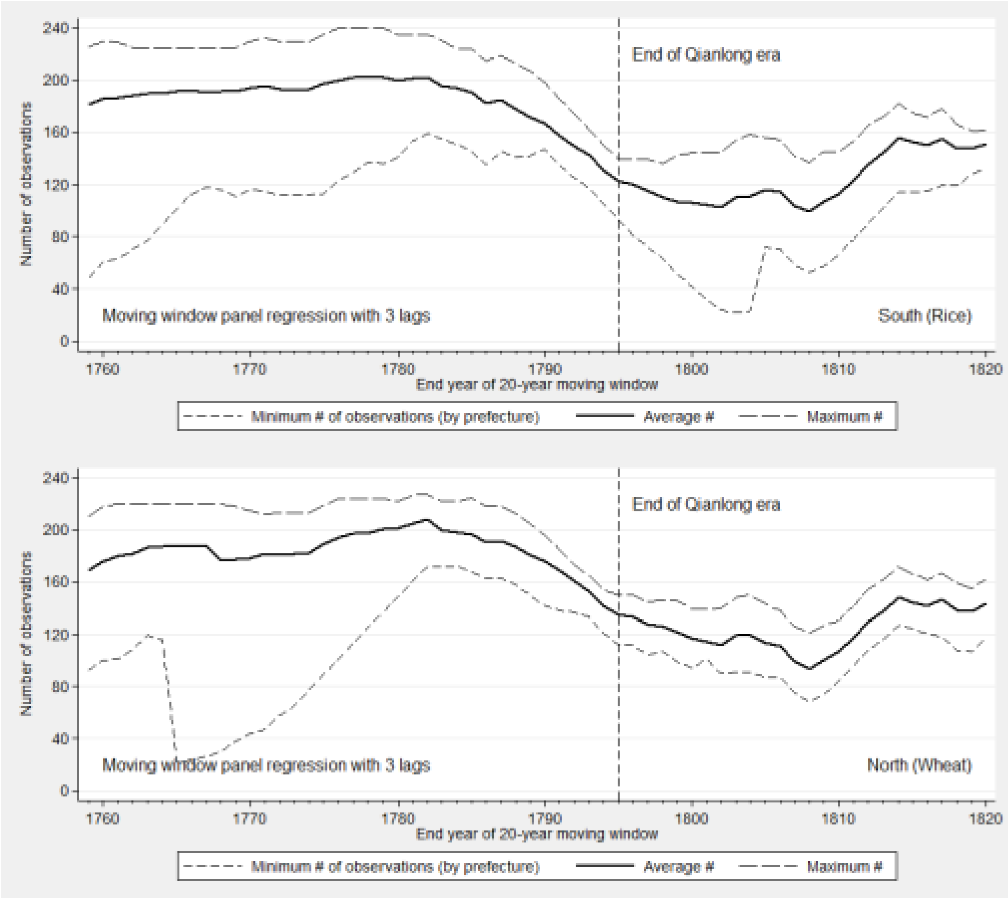
Table B-3: Coefficients of Variation (raw price series) by Province

South China (rice)		North China (wheat)	
Province	Coefficient of Variation	Province	Coefficient of Variation
Anhui	0.271	Gansu	0.342
Jiangsu	0.295	Henan	0.246
Jiangxi	0.146	Shannxi	0.454
Fujian	0.215	Shandong	0.348
Guangdong	0.211	Shanxi	0.243
Guizhou	0.195	Zhili	0.296
Guangxi	0.166		
Hubei	0.330		
Hunan	0.256		
Sichuan	0.333		
Zhejiang	0.218		

Table B-4: Planting and Harvest Time

	South China (rice)			North China (wheat)	
	Single-crop	Double-crop (early)	Double-crop (late)	Spring Wheat	Winter Wheat
Planting	Mar to June	Feb to Apr	Aug	Mar to Apr	Sep to Oct
Harvest	Oct and Nov	June and July	Oct and Nov	July to Aug	May and June

Figure B-1: Sample size for moving window analysis



Note: These plots show the number of observations in the 20-year moving window regressions for South (top panel) and North (bottom panel) China. We indicate the average number of observations by prefecture (in bold) from a dynamic regression with three lags (average lag length for South China: 1.162; for North China: 1.125) as well as the minimum (short dashes) and maximum (long dashes) numbers. The theoretical maximum is 240. In both the North and South samples exactly one window (Start year 1789, End year 1808) had less than an average of 100 observations.

Table B-2a: Price Change Frequency (South China)

		(1) 1740-1820	(2) 1740-1759	(3) 1760-1779	(4) 1780-1799	(5) 1800-1820
Jan	MC	0.554	*0.662*	0.573	0.488	0.468
	Obs.	7,465	1,973	2,174	1,743	1,575
Feb	MC	*0.546*	0.688	*0.549*	*0.472*	*0.443*
	Obs.	7,418	1,955	2,208	1,660	1,595
Mar	MC	0.647	0.760	0.683	0.548	0.562
	Obs.	7,574	1,998	2,262	1,641	1,673
Apr	MC	0.741	0.822	0.767	0.670	0.669
	Obs.	7,453	2,015	2,266	1,499	1,673
May	MC	0.751	0.829	0.770	0.712	0.682
	Obs.	7,375	1,982	2,222	1,512	1,659
Jun	MC	0.721	0.811	0.725	0.625	**0.692**
	Obs.	7,311	2,013	2,187	1,527	1,584
Jul	MC	0.699	0.782	0.723	0.587	0.658
	Obs.	7,263	2,041	2,207	1,410	1,605
Aug	MC	0.762	0.842	0.816	0.725	0.619
	Obs.	7,160	2,028	2,212	1,322	1,598
Sep	MC	**0.794**	**0.857**	**0.836**	**0.773**	0.676
	Obs.	7,226	1,997	2,180	1,434	1,615
Oct	MC	0.751	0.831	0.786	0.709	0.649
	Obs.	7,341	2,045	2,106	1,494	1,696
Nov	MC	0.684	0.788	0.734	0.583	0.591
	Obs.	7,479	2,104	2,088	1,648	1,639
Dec	MC	0.618	0.732	0.635	0.524	0.547
	Obs.	7,639	2,128	2,164	1,810	1,537

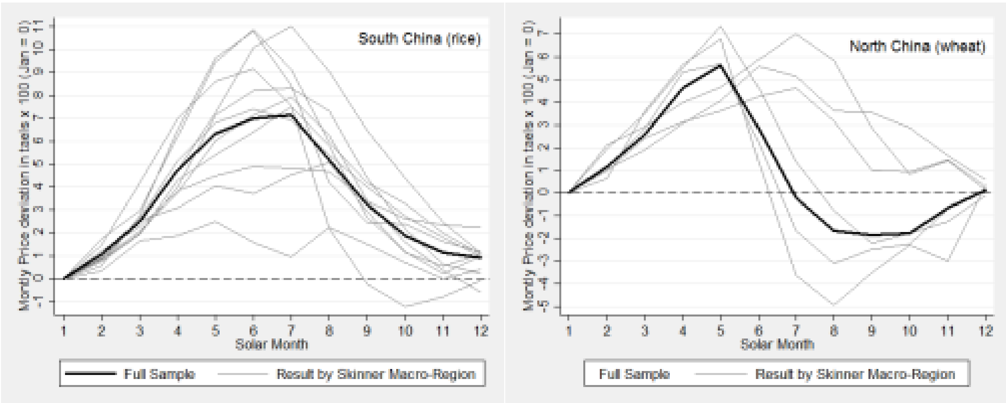
Notes: MC is the percentage of prefectures that experienced a price change in a given month; Obs is the number of monthly observations. Column (1) presents the results for the full 81 year time period, columns (2) to (5) for 20/21-year subsample periods. We highlight the month with the highest proportion of price changes over the previous month in bold.

Table B-2b: Price Change Frequency (North China)

		(1) 1740-1820	(2) 1740-1759	(3) 1760-1779	(4) 1780-1799	(5) 1800-1820
Jan	MC	0.597	0.789	0.670	0.445	0.471
	Obs.	4,774	1,111	1,426	1,218	939
Feb	MC	0.605	0.766	0.630	0.539	0.493
	Obs.	4,909	1,122	1,414	1,227	1,066
Mar	MC	0.671	0.805	0.714	0.570	0.608
	Obs.	4,957	1,141	1,432	1,225	1,079
Apr	MC	0.704	0.815	0.737	0.626	0.644
	Obs.	5,090	1,211	1,436	1,197	1,166
May	MC	0.695	0.829	0.713	0.624	0.615
	Obs.	5,047	1,187	1,483	1,124	1,173
Jun	MC	0.772	0.886	0.803	0.687	0.724
	Obs.	4,852	1,123	1,480	1,098	1,071
Jul	MC	**0.806**	**0.934**	**0.868**	**0.750**	**0.669**
	Obs.	4,750	1,101	1,456	1,019	1,094
Aug	MC	0.749	0.905	0.822	0.610	0.621
	Obs.	4,679	1,145	1,459	934	1,061
Sep	MC	0.668	0.812	0.754	0.514	0.554
	Obs.	4,730	1,148	1,470	945	1,087
Oct	MC	0.627	0.830	0.701	0.496	0.469
	Obs.	4,826	1,130	1,436	1,012	1,168
Nov	MC	0.612	0.789	0.687	0.433	0.522
	Obs.	4,868	1,123	1,465	1,068	1,132
Dec	MC	0.595	0.788	0.657	0.444	0.485
	Obs.	4,981	1,191	1,452	1,183	1,075

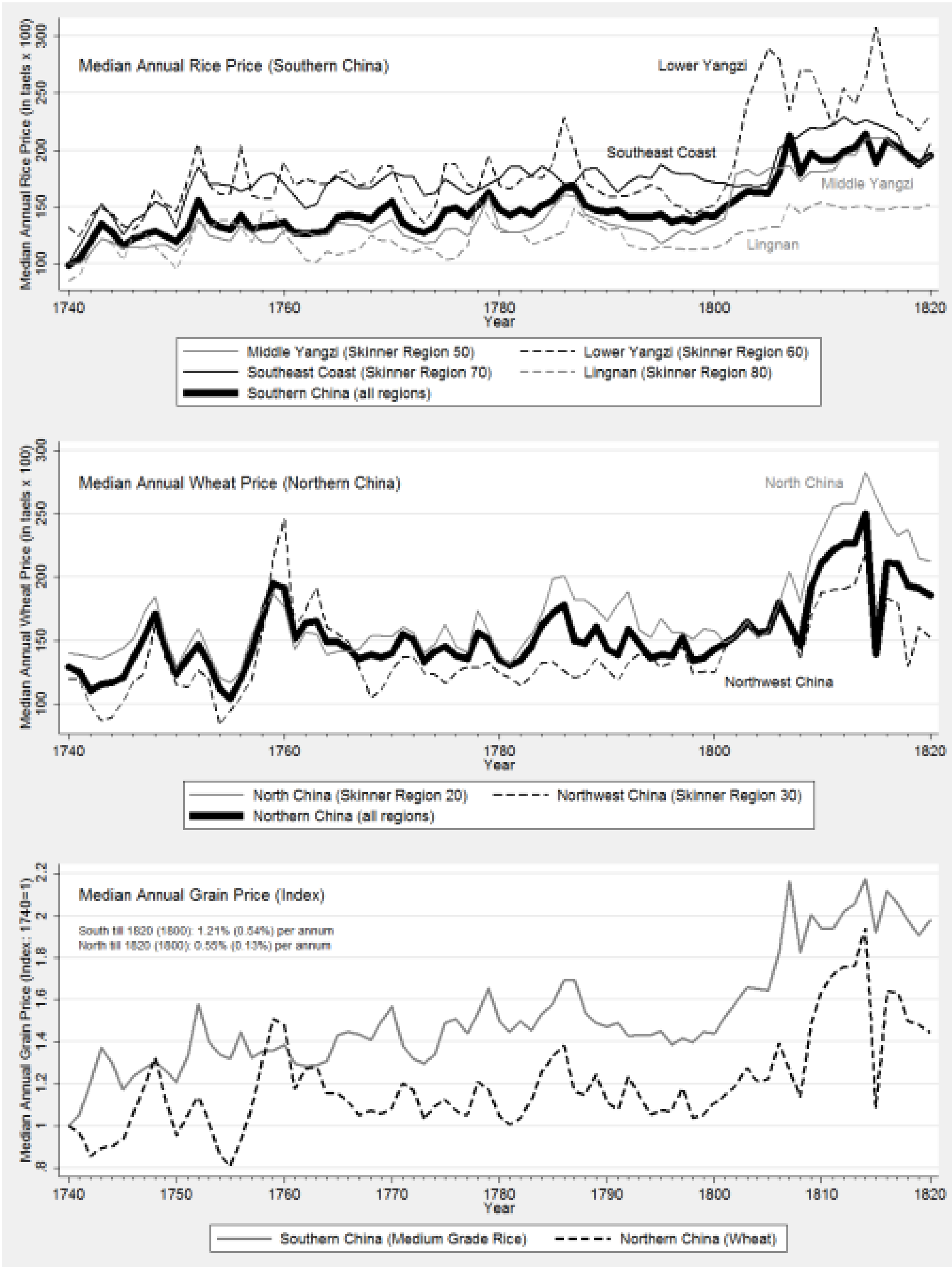
Notes: MC is the percentage of prefectures that experienced a price change in a given month; Obs is the number of monthly observations. Column (1) presents the results for the full 81-year time period, columns (2) to (5) for 20/21-year subsample periods. We highlight the month with the highest proportion of price changes over the previous month in bold.

Figure B-2: Seasonality in Price Behaviour



Notes: We plot the deviations from January prices in South (left panel) and North China, derived from prefectural fixed effects regressions of monthly grain prices (in taels *x100* per *shi*) on dummies for the solar month (January is the omitted category) and year fixed effects. For both plots we chart the result for all 131 Southern (80 Northern) prefectures using a thick black line, as well as results estimated by Skinner (1977a) macro-region using thin grey lines (two prefectures in Northern sample are dropped since these are Skinner 'isolates'). There are 11 sub-macroregions in the south (40, 51-53, 60, 71-74, 80 and 90) and five in the north (20, 31-33 and 54), where the numbers refer to the sub-macroregions shown in Figure A-1; note that in the other analysis presented in the main section of the paper and below we use the main macro-region classification only. The average rice (wheat) price in January of the base year 1740 is 0.99 (1.24) taels for the respective full sample, and the average maximum price deviation is 0.07 (0.06) taels, thus around 7% (5%). In the Southern sample, the Skinner macro-region for which the pattern deviates somewhat is that for prefectures in Jiangxi province, which account for 14 of the 131 prefectures. In the Northern sample the prefectures for the three Skinner regions in which the pattern is distinctly different (seemingly closer to the seasonal price behaviour displayed by millet; see Li, 2007: Figure 4.4) are located in Western and Central Gansu (#204 in Figure 1 of the main paper; #208-11; #201, #206-7) and Northern Shanxi (#158 and #164). These account for 10 of the 80 prefectures in the full Northern sample. Below in Section E we present price convergence analysis for individual months (i.e. treating February price as the 'annual' price) for February (trough) and July (peak) in the South, and May (peak) and August (trough) in the North.

Figure B-3: Median Price Movement



Notes: We plot the median annual price movement (in taels *x 100* in the top and middle plots) of grain prices in South and North China (thick solid line), alongside median prices computed by Skinner (1977a) macro-region (we exclude the Upper Yangzi region (top plot) and two isolated prefectures in the Upper and Middle Yangzi regions (middle plot) to aid illustration). The bottom plot shows price indices for the median regional grain price (full sample of prefectures in each case) with reference to the base year 1740.

Sample Prefectures

Table B-3a: Sample Prefectures in South China (rice prices)

Province	Prefecture
Anhui	Anqing, Chizhou, Chuzhou, Fengyang, Guangde, Hezhou, Huizhou, Liu'an, Luzhou, Ningguo, Sizhou, Taiping, Yingzhou;
Fujian	Fuzhou, Funing, Jianning, Longyan, Quanzhou, Shaowu, Tingzhou, Xinghua, Yanping, Yongchun, Zhangzhou, Taiwan;
Guangdong	Chaozhou, Gaozhou, Guangzhou, Huizhou, Jiayingzhou, Leizhou, Lianzhou, Lianzhou Fu, Luoding, Nanxiong, Qiongzhou, Shaozhou, Zhaoqing;
Guizhou	Anshan, Duyun, Guiyang, Liping, Pingyue, Shiqian, Sinan, Sizhou, Dading, Tongren, Xingyi, Zhenyuan, Zunyi;
Guangxi	Guilin, Liuzhou, Nanning, Pingle, Qingyuan, Sicheng, Si'en, Taiping Fu, Wuzhou, Xunzhou, Yulin, Zhen'an;
Hubei	Anlu, De'an, Hanyang, Huangzhou, Jingzhou Fu, Shinan, Wuchang, Xiangyang, Yichang, Yunyang;
Hunan	Baoqing, Changde, Changsha, Chenzhou, Chenzhou Fu, Guiyang, Hengzhou, Jingzhou, Lizhou, Yongshun, Yongzhou, Yuezhou, Yuanzhou
Jiangsu	Changzhou, Haizhou, Huai'an, Jiangning, Songjiang, Suzhou, Taicang, Tongzhou, Yangzhou, Zhenjiang
Jiangxi	Ganzhou, Guangxin, Ji'an, Jianchang, Jiujiang, Linjiang, Nan'an, Nanchang, Nankang, Ningdu, Raozhou, Ruizhou, Yuanzhou
Sichuan	Baoning, Chengdu, Chongqing, Jiading, Kuizhou, Long'an, Ningyuan, Shunqing, Tongchuan, Xuzhou, Yazhou
Zhejiang	Hangzhou, Huzhou, Jiaxing, Jinhua, Quzhou, Ningbo, Shaoxing, Taizhou, Wenzhou, Yanzhou

Table B-3b: Sample Prefectures in North China (wheat prices)

Province	Prefecture
Gansu	Anxi, Ganzhou, Gongchang, Jiezhou, Lanzhou, Liangzhou, Ningxia, Pingliang, Qinzhou, Qingyang, Suzhou, Xi'ning
Henan	Chenzhou, Guangzhou, Guide, Henan Fu, Huaiqing, Kaifeng, Nanyang, Ruzhou, Runing, Shanzhou, Weihui, Xuzhou, Zhangde
Shaanxi	Binzhou, Fengxiang, Fuzhou, Hanzhong, Qianzhou, Shangzhou, Suide, Tongzhou, Xi'an, Xing'an, Yan'an, Yulin
Shandong	Binzhou, Fengxiang, Fuzhou, Hanzhong, Qianzhou, Shangzhou, Suide, Tongzhou, Xi'an, Xing'an, Yan'an, Yulin
Shanxi	Baode, Daizhou, Datong, Fenzhou, Jiangzhou, Jiezhou, Liaozhou, Lu'an, Ningwu, Pingding, Pingyang, Puzhou, Qinzhou, Shuoping, Taiyuan, Xizhou, Xinzhou, Zezhou
Zheli	Baoding, Daming, Dingzhou, Hejian, Jizhou, Guangping Fu, Shenzhou, Shunde, Tianjin, Xuanhua, Yizhou, Yongping, Zhaozhou, Zhengding, Zunhuazhou

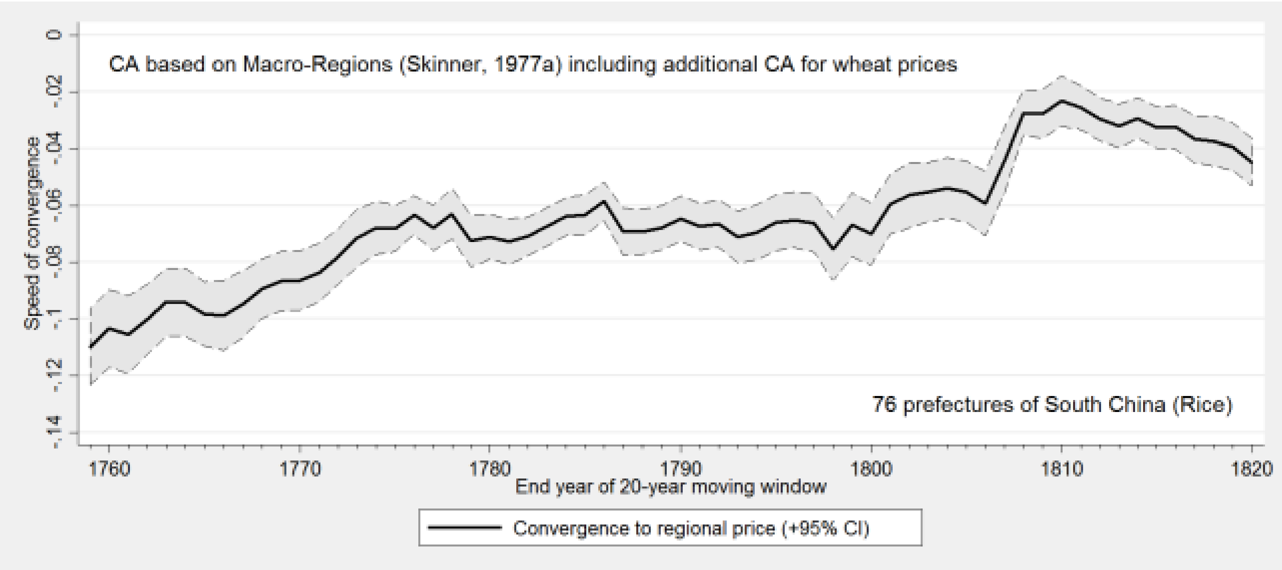
Southern Prefectures with both Rice and Wheat Prices

Table B-3c: Southern Prefectures with Both Rice and Wheat Prices

Province	Prefecture
Anhui	Anqing, Chizhou, Chuzhou, Fengyang, Guangde, Hezhou, Huizhou, Liu'an, Luzhou, Ningguo, Sizhou, Taiping, Yingzhou
Jiangsu	Changzhou, Haizhou, Huai'an, Jiangning, Songjiang, Suzhou, Taicang, Tongzhou, Yangzhou, Zhenjiang
Jiangxi	Ganzhou, Guangxin, Ji'an, Jianchang, Jiujiang, Linjiang, Nan'an, Nanchang, Nankang, Ningdu, Raozhou, Ruizhou, Yuanzhou
Fujian	Fuzhou, Funing, Jianning, Longyan, Quanzhou, Shaowu, Tingzhou, Xinghua, Yanping, Yongchun, Zhangzhou, Taiwan
Guangdong	Chaozhou, Gaozhou, Guangzhou, Huizhou, Jiayingzhou, Leizhou, Lianzhou, Lianzhou Fu, Luoding, Nanxiong, Qiongzhou, Shaozhou, Zhaoqing
Hubei	Anlu, De'an, Hanyang, Huangzhou, Jingzhou Fu, Shinan, Wuchang, Xiangyang, Yichang, Yunyang;
Hunan	Baoqing, Changde, Changsha, Chenzhou, Chenzhou Fu, Guiyang, Hengzhou, Jingzhou, Lizhou, Yongshun, Yongzhou, Yuezhou, Yuanzhou
Sichuan	Baoning, Chengdu, Chongqing, Jiading, Kuizhou, Long'an, Ningyuan, Shunqing, Tongchuan, Xuzhou, Yazhou
Zhejiang	Hangzhou, Huzhou, Jiaxing, Jinhua, Quzhou, Ningbo, Shaoxing, Taizhou, Wenzhou, Yanzhou

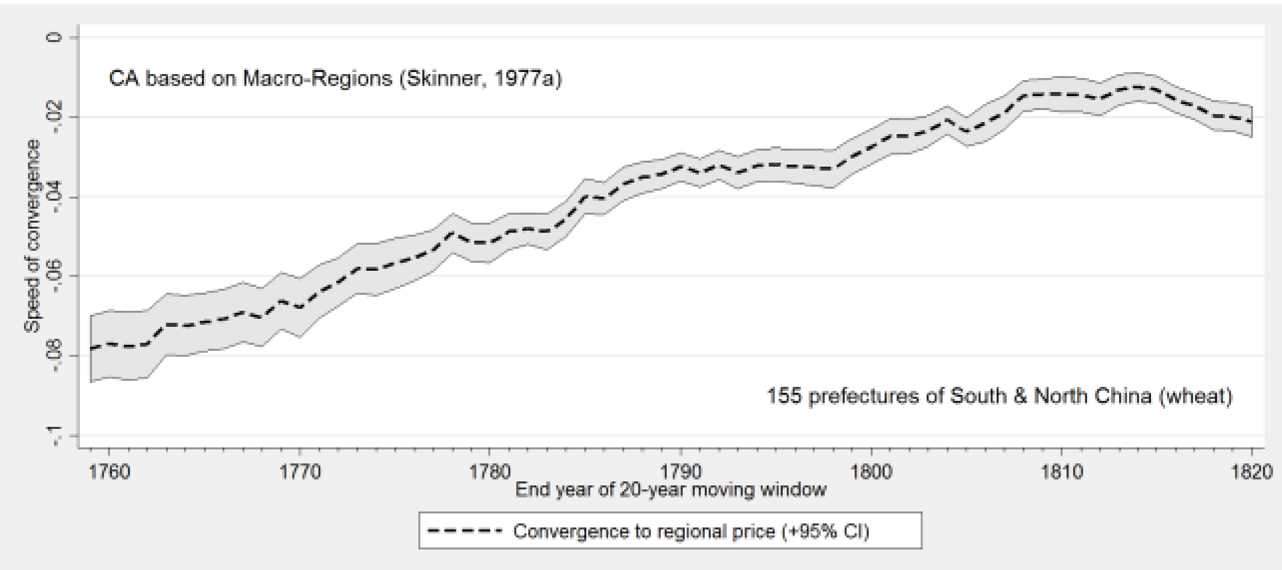
C. Qing China: Convergence Analysis – Additional Plots

Figure C-1: Convergence Analysis in a Model with an Additional Common Factor (South China)



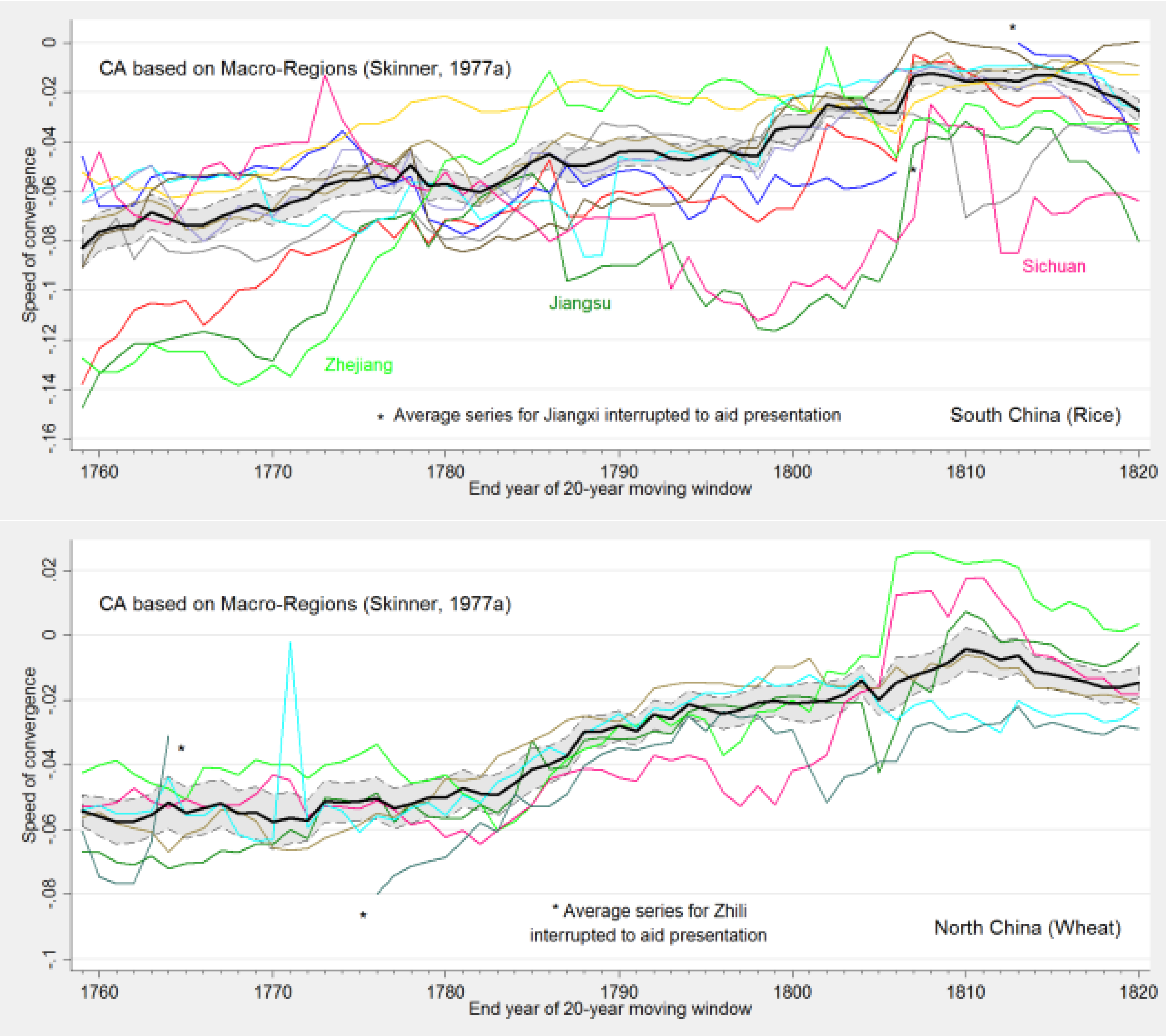
Notes: We plot the convergence coefficients from analysis of South China *rice* prices from 76 prefectures (listed in Section B above) using a 20-year rolling window as described in the text. The cross-section averages (CA) are computed from the rice prices within the Southern region but *additionally* include CA of *wheat* prices in Southern prefectures (hence the reduced number of prefectures). The solid line indicates convergence to the regional (South China) average. 95% confidence intervals are also marked.

Figure C-2: Convergence of Wheat Prices in a Large Sample
Incorporating South and North China



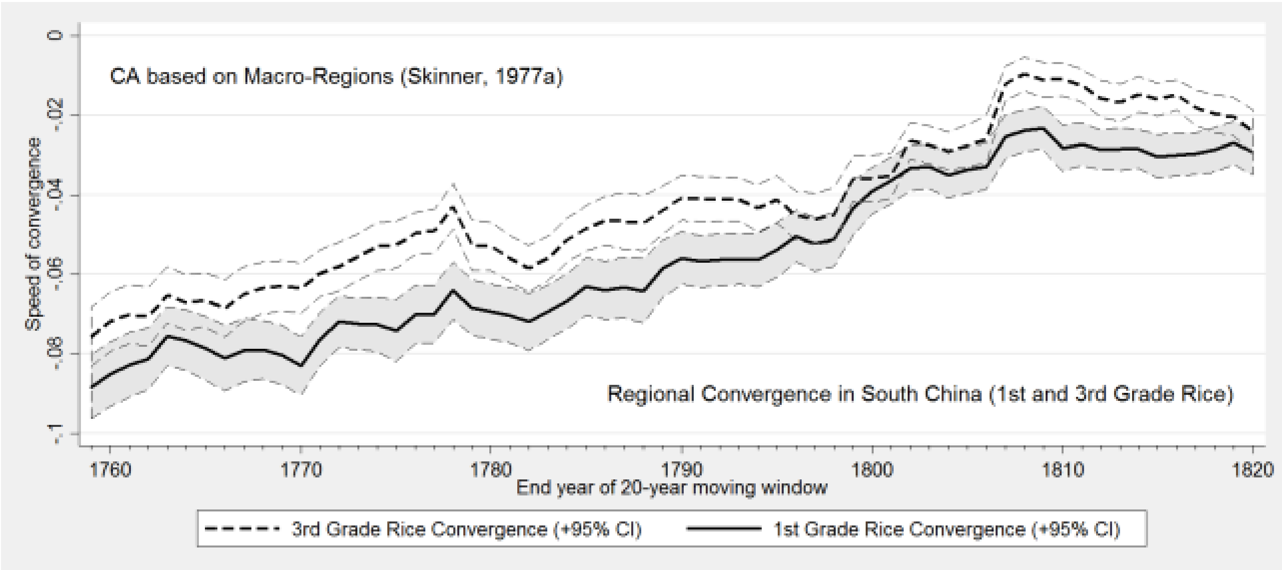
Note: We plot convergence to the provincial and regional average price series for wheat in a sample of 155 North and South China prefectures, respectively. Cross-section averages are computed by Skinner (1977a) macro-regions.

Figure C-3: Grain Price Convergence by Province



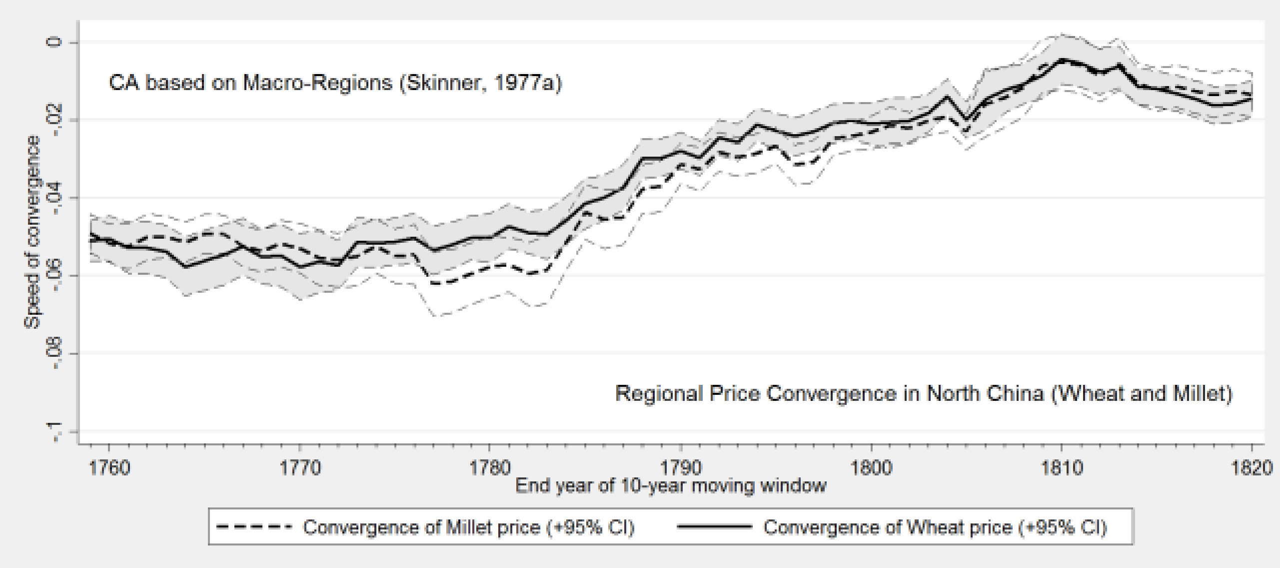
Note: These plots indicate the average prefectural price convergence to the regional average price (a) across all prefectures (solid black line and 95% confidence interval in grey – these are the plots from the main section of the paper), and (b) for each province. Estimation is based on 20-year rolling windows, with 1759 (1820) the first (last) end year. The number of prefectures per province varies. On a number of occasions we interrupted provincial plots to aid presentation. Across the two regions only the average convergence plot for *one* province (Sichuan) indicates a higher speed of convergence at the end of the sample period than at its start. Cross-section averages are computed by Skinner (1977a) macro-regions.

Figure C-4: Convergence of 1st and 3rd Grade Rice Prices (South China)



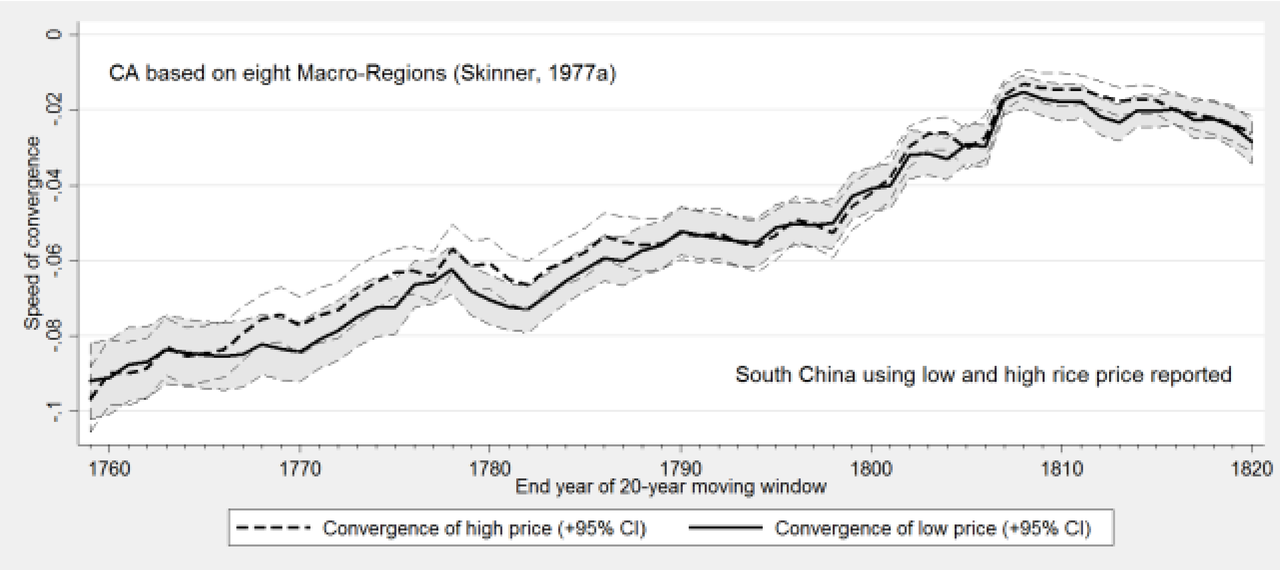
Notes: The plots indicate the prefectural price convergence to the regional average price in 131 Southern prefectures. Cross-section averages are computed by Skinner (1977a) macro-regions. We adopt superior (1st grade, solid line) and common (3rd grade, dashed line) grade rice. This provides the theoretically intuitive result that (regional) convergence in the higher-value commodity is faster. Note that over the 1740-1820 period 1st grade rice mean (median) price is 1.21 (1.12) times that of 3rd grade rice, 5th and 95th percentiles of this relative price are 1.04 and 1.87, respectively.

Figure C-5: Convergence of Millet Prices (North China)



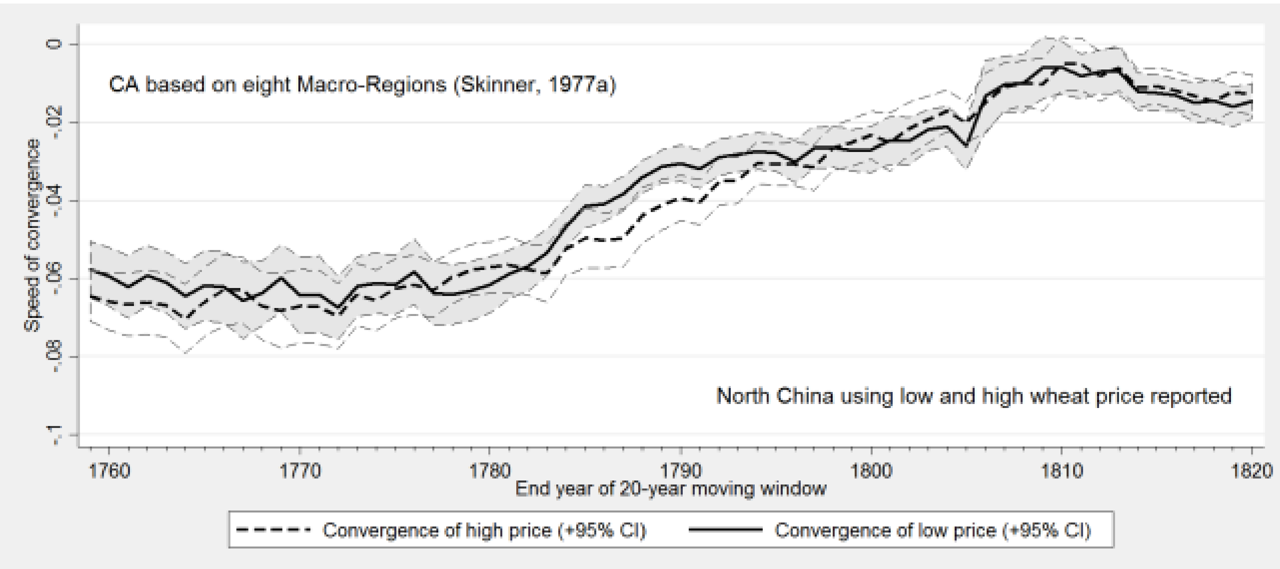
Note: The plot indicates the prefectural price convergence to the regional average price in Northern prefectures for wheat and millet. Cross-section averages are computed by Skinner (1977a) macro-regions. We adopt millet (available in 72 prefectures) instead of wheat prices. These price series are made up of unhusked/unhulled (*sugu*) and husked/hulled (*sumi*) millet ("husked *gu* becomes *mi*", Li, 2008: 93); confusingly, the data also refer to *xiaomi*, a modern colloquial term for unhusked millet, and *sugumi*, which conflates the terms of husked and unhusked. For millet husked grain is the quantity-equivalent of half of unhusked grain (Will and Wong, 1991: 239), and in our data we cannot identify which price series are for one or the other. This does not influence our convergence analysis, since the specification adopted accounts for (time-invariant) price gaps (via a prefecture-specific intercept term) and focuses on the relative price movements over time: the husked-unhusked ratio always remains 0.5. The rationale for directly comparing wheat and millet is as follows: if wheat really is a luxury good compared with millet (Li, 2007), then its price convergence should be faster. Our results do not support this view. Descriptive statistics suggest the mean (median) relative price (wheat/millet) is 1.01 (0.99) with 5th and 95th percentiles 0.71 and 1.35, respectively, noticeably centred around unity, which suggests that the price of millet and wheat were similar and not differentiated like 1st and 3rd grade rice in Southern China.

Figure C-6: Convergence of Reported High and Low Prices, South China



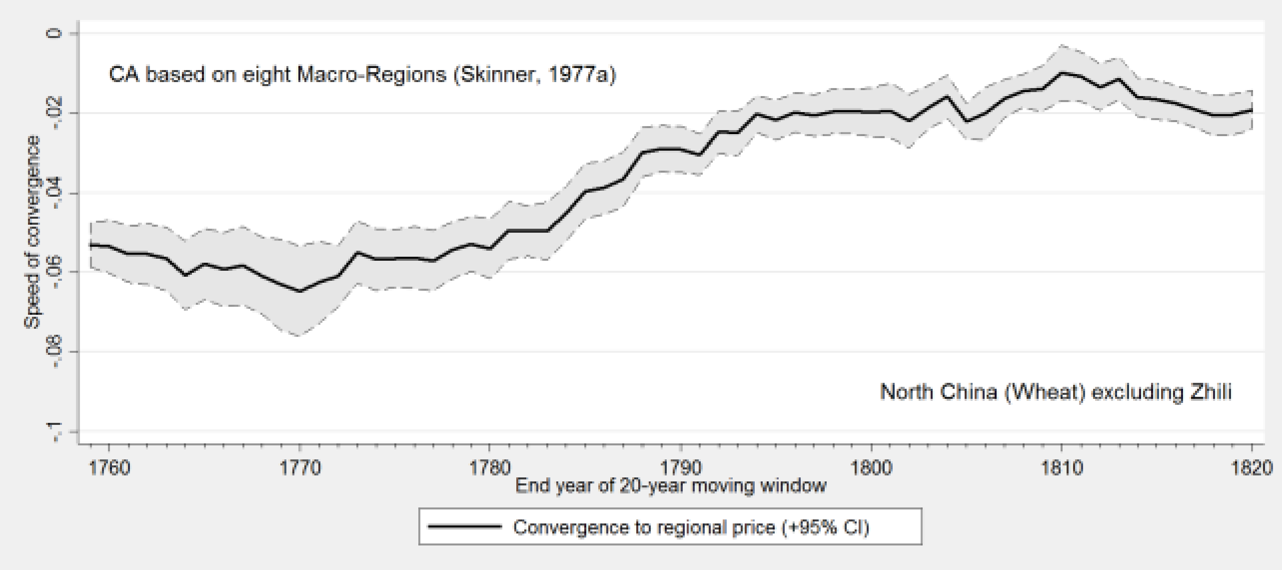
Note: The plot shows prefectural price convergence to the regional average price in 131 Southern prefectures. Instead of using the *average* of the high and low price report in the original data source, our convergence analysis uses the actual high (dashed line) and low price series (solid line), respectively. Cross-section averages are computed by Skinner (1977a) macro-regions.

Figure C-7: Convergence of Reported High and Low Prices, North China



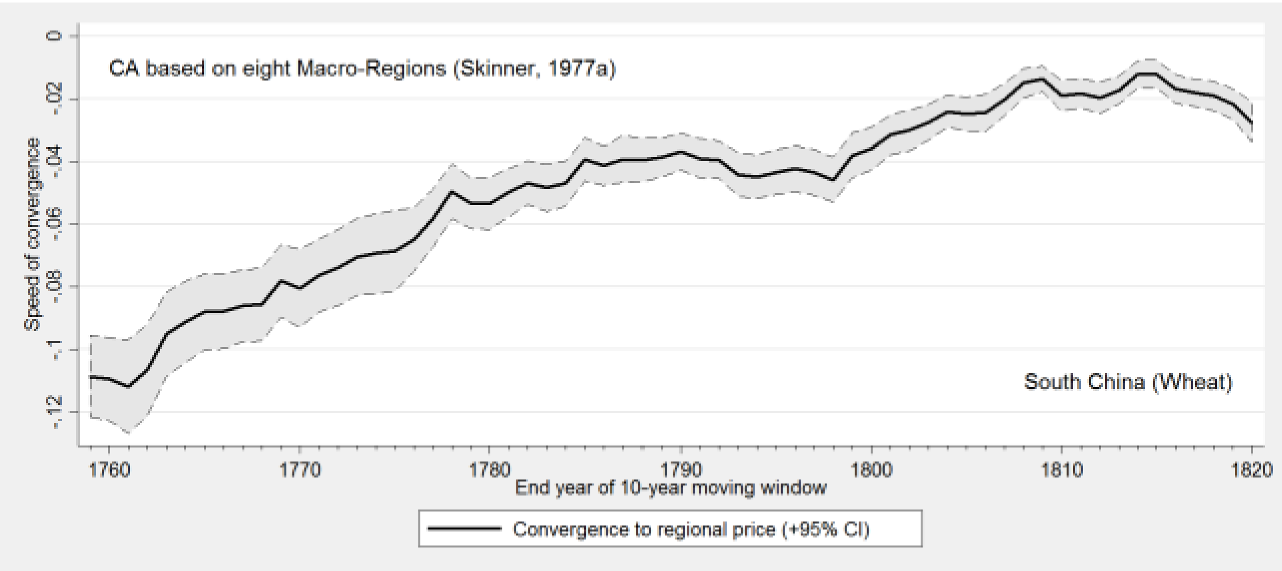
Note: The plot shows prefectural price convergence to the regional average price in 78 Northern prefectures. Instead of using the *average* of the high and low price reported in the original data source, our convergence analysis uses the actual high (dashed line) and low price series (solid line), respectively. Cross-section averages are computed by Skinner (1977a) macro-regions.

Figure C-8: Convergence in North China excluding Zhili



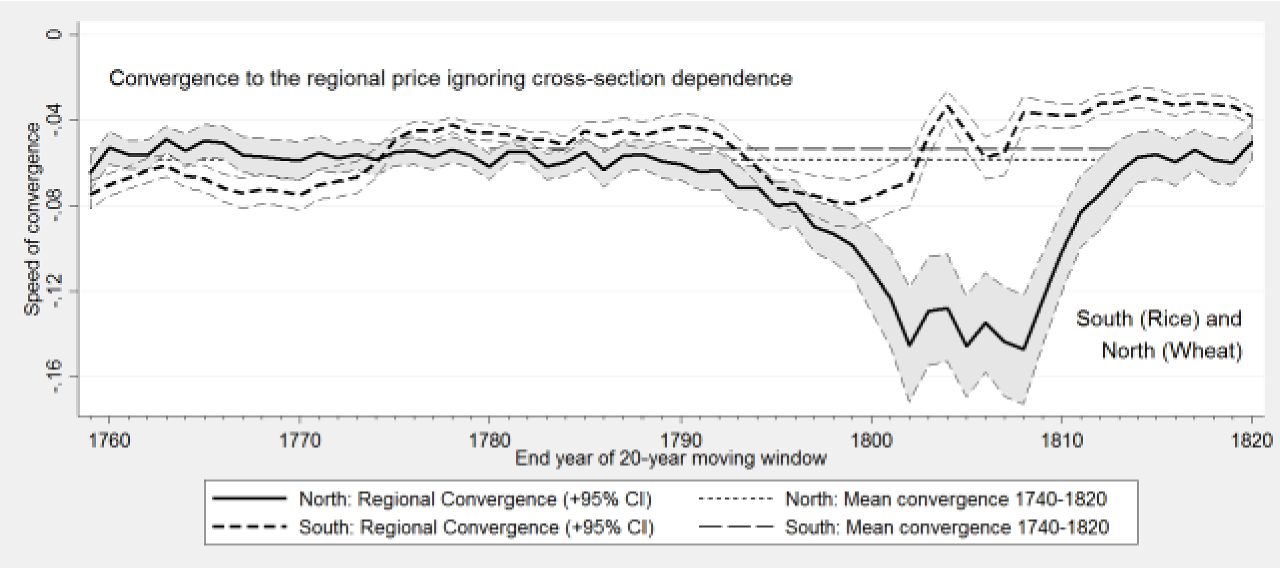
Note: We plot convergence to the provincial and regional average price series in North China, respectively, excluding Zhili province from the sample. Cross-section averages are computed by macro-region following Skinner (1977a), results adopting Buck's (1937) agri-climatic zones are qualitatively identical.

Figure C-9: Wheat Price Convergence in South China



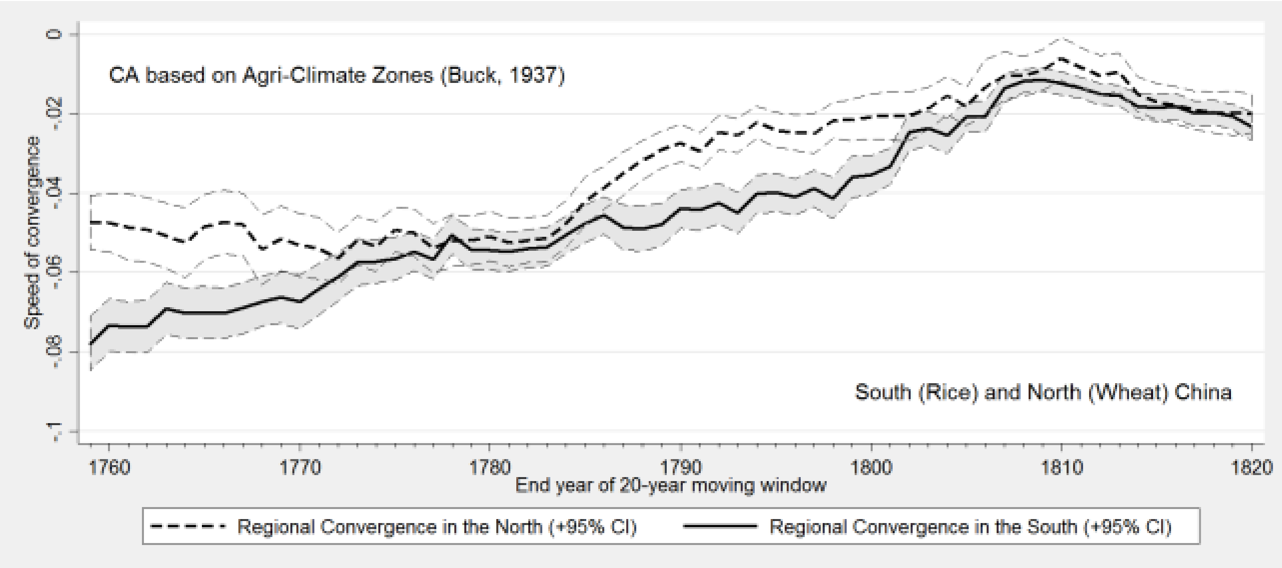
Note: We plot convergence to the provincial and regional average price for wheat prices in South China. Although rice is the primary staple in this region, the availability of wheat prices in a subsample of prefectures (76 instead of 131 for the rice price analysis) enables us to investigate price convergence for this grain. This specification adopts cross-section averages based on Skinner's (1977a) macro-regions for South China to capture the cross-section dependence induced by common shocks and the trade network effect.

Figure C-10: Convergence of Grain Prices
Ignoring Common Shocks and the Trade Network Effect



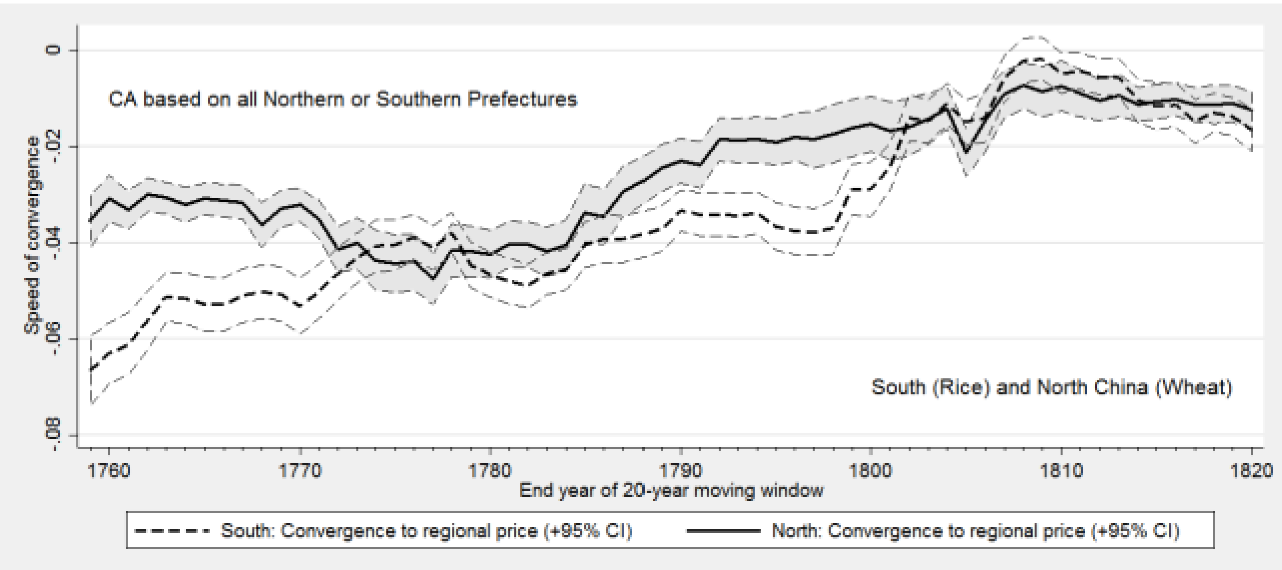
Note: We plot convergence to the regional average price series for rice (South) and wheat (North) in 131 and 80 prefectures, respectively. This specification uses relative prices which have been adjusted for seasonality (as in all of our previous analysis) but *does not include* cross-section averages to capture cross-section dependence induced by common shocks and the trade network effect. In addition to the confidence intervals for the respective convergence estimates, the plot also include the unweighted mean estimate of convergence across the entire sample period (i.e. if we average the estimates for all the rolling windows from the analysis described above), using horizontal dashed lines; these latter estimates illustrate that if we (a) do not account for cross-section dependence, and (b) compute a single estimate across the entire time horizon, we can reproduce the original Shiue and Keller (2007) result of a comparatively high level of market integration in (South) China.

Figure C-11: Convergence of Grain Prices Using Cross-Section Averages Computed by Agri-Climatic Region (Buck, 1937)



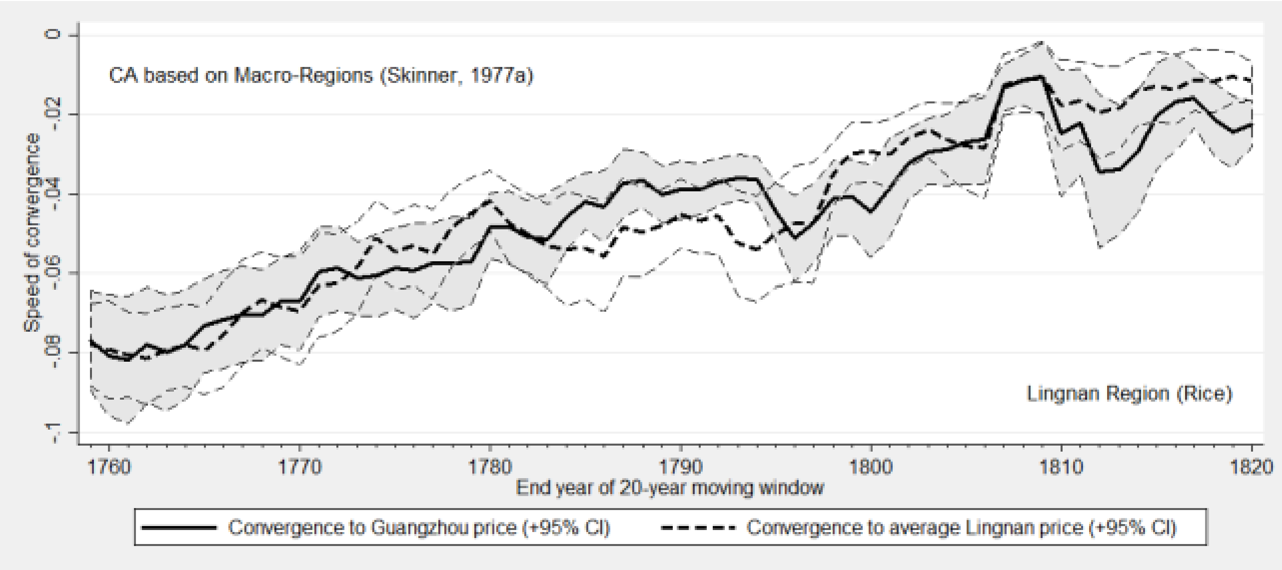
Note: We plot convergence to the provincial and regional average price series for rice (South) and wheat (North) in 131 and 80 prefectures, respectively. This specification adopts cross-section averages based on Buck's (1937) agro-climate regions to capture the cross-section dependence induced by common shocks and the trade network effect.

Figure C-12: Convergence of Grain Prices Using Cross-Section Averages Computed by Region (South, North)



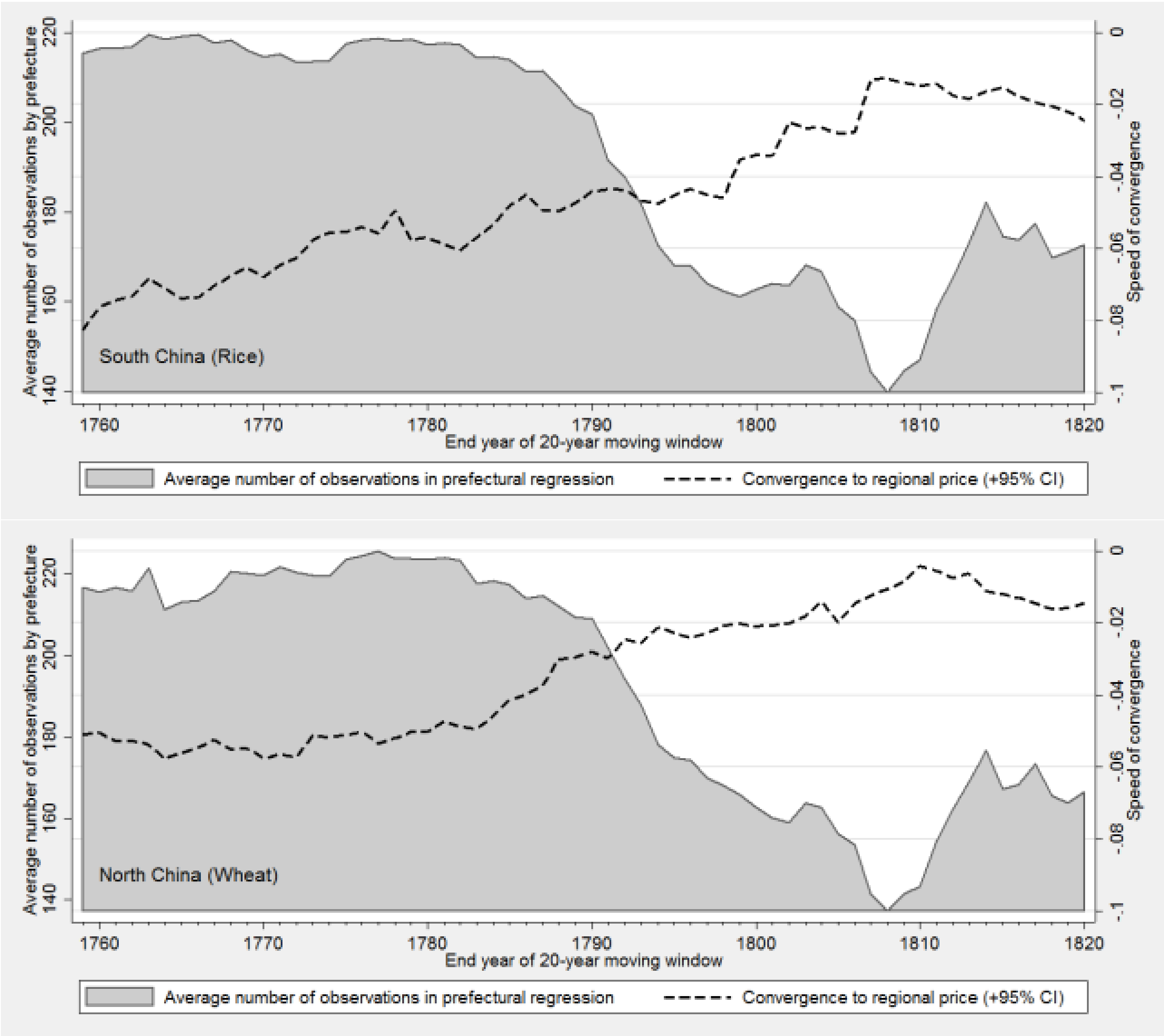
Note: We plot convergence to the regional average price series for rice (South) and wheat (North) in 131 and 80 prefectures, respectively. This specification adopts cross-section averages based on the respective region (North, South) to capture the cross-section dependence induced by common shocks and the trade network effect.

Figure C-13: Rice Price Convergence in the Lingnan Region of South China



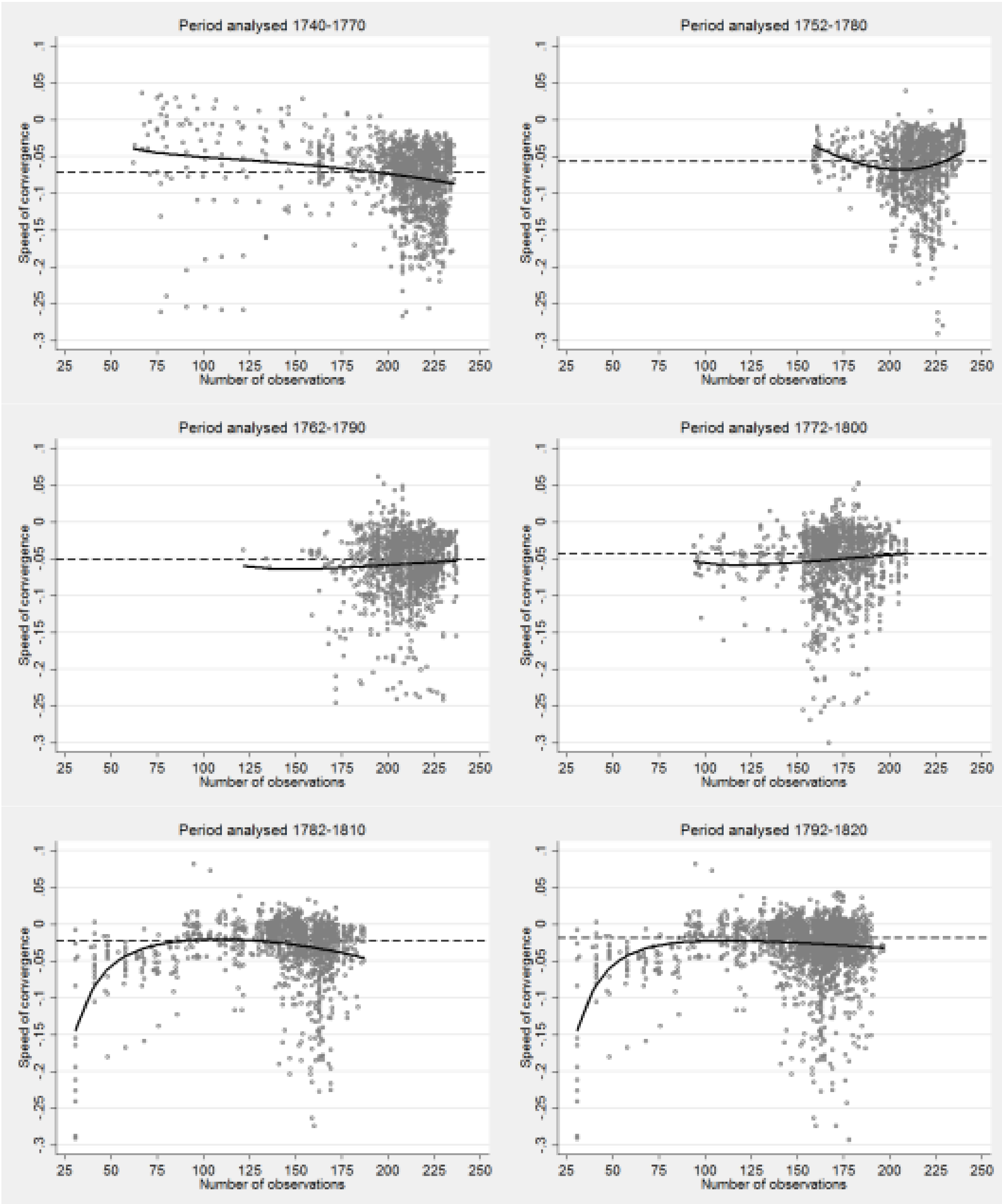
Note: We plot convergence to the Guangzhou and Lingnan region average price for rice prices in the Southern macro-region of Lingnan. This specification adopts cross-section averages based on Skinner's (1977a) macro-region for Lingnan to capture the cross-section dependence induced by common shocks and the trade network effect. Using a specific reference price (here: Guangzhou) is in the spirit of the analysis in Goldberg and Verboven (2005).

Figure C-14: Number of observations and market (dis)integration



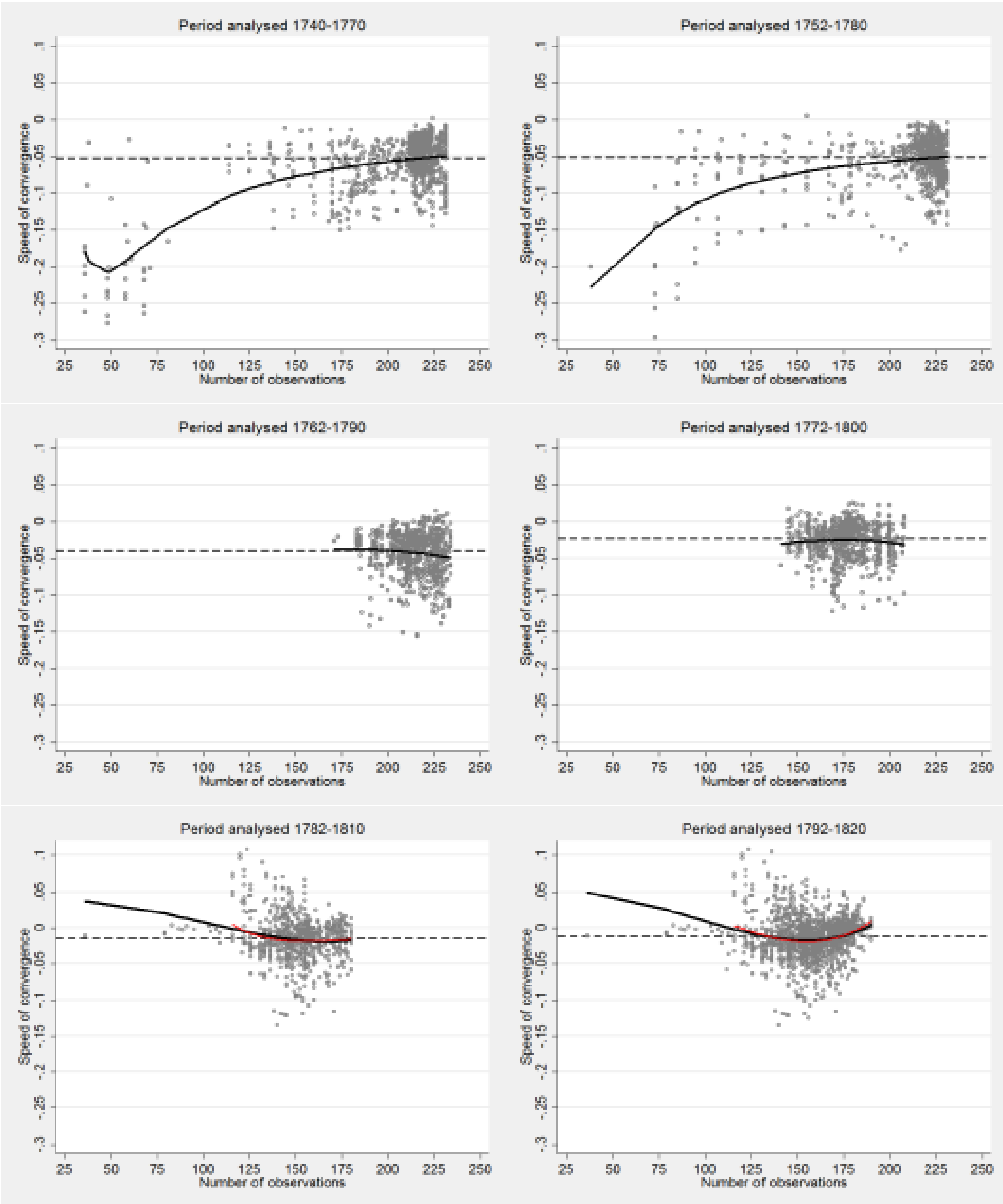
Note: We analyse the patterns of missing observations in our two regional price datasets for rice (top) and wheat (bottom). Each plot charts the convergence to the regional price (in dashes, right axis), which we reported in the main paper (employing Skinner macro-region averages), alongside the (robust) mean number of observations in the prefecture-level convergence regression (shaded area, left axis). The model specification in each case adopts cross-section averages based on Skinner (1977a) macro-regions to capture the cross-section dependence induced by common shocks and the trade network effect.

Figure C-15: Missing observations and market (dis)integration (South)



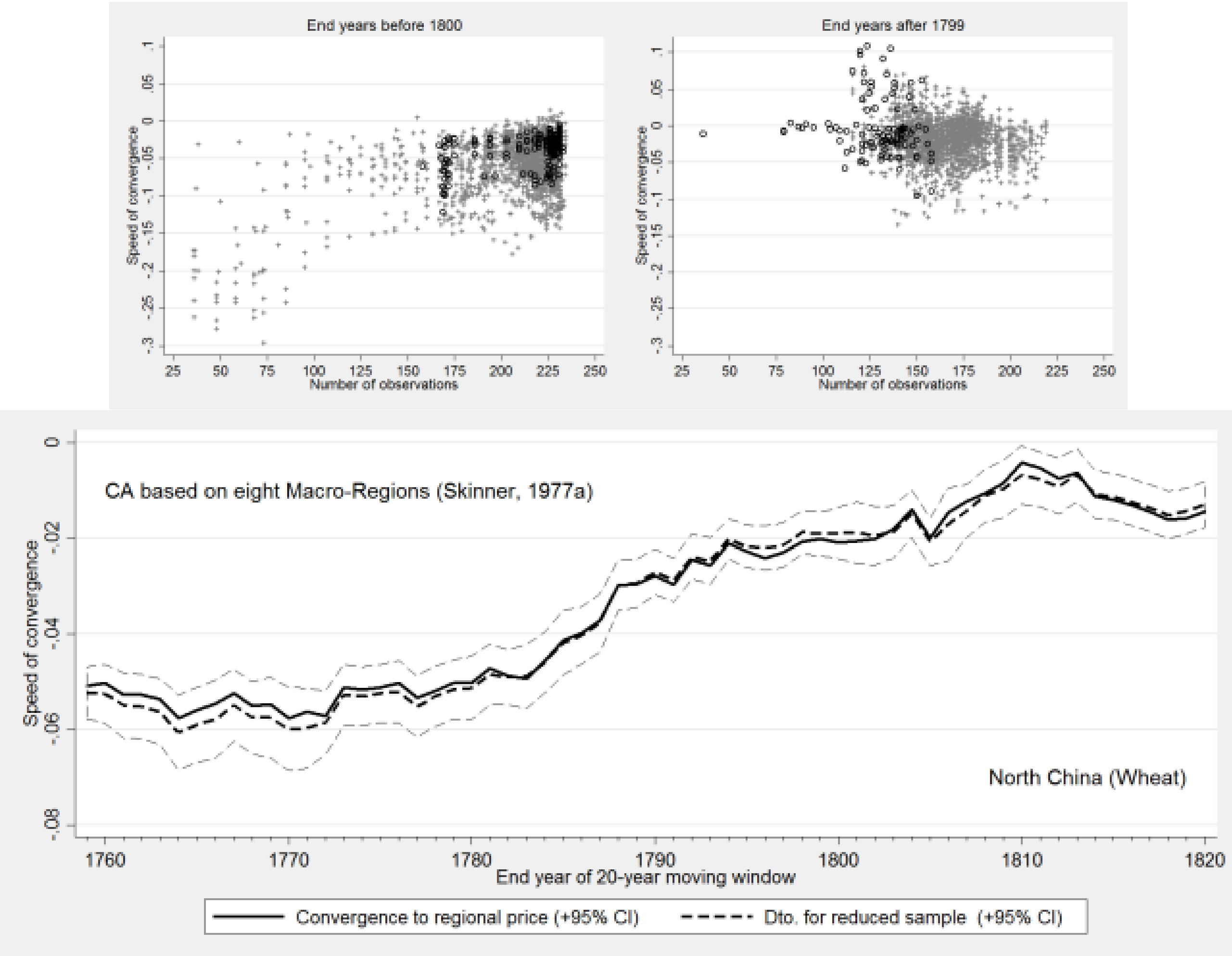
Note: Based on the estimates from 20-year rolling windows we plot the estimated convergence coefficients against the number of prefectural observations (grey circles), alongside a fractional polynomial regression (solid line). In each plot we also estimate the robust mean across all convergence coefficients (dashed line). The scales of axes are identical in all plots. The top left graph uses results from the rolling windows 1740-59, 1741-60,…, 1751-70 (end years 1759 to 1770). In all other plots we use one window less, e.g. 1752-1771,…, 1761-80 (end years 1771 to 1780) in the top right plot. The graphs addresses the concern about the impact of missing observations in the period 1780-1810 (the four graphs at the bottom of the figure): we ask whether there is a clear (linear) relationship between periods with *fewer* observations and (in absolute terms) *lower* speed of convergence? In all four sub-periods, but especially the final two, the convergence terms for prefectures with *fewer* observations are much *larger* (in absolute terms), thus if anything running directly counter to the concern expressed above since they have *higher* speed of convergence.

Figure C-16: Missing observations and market (dis)integration (North)



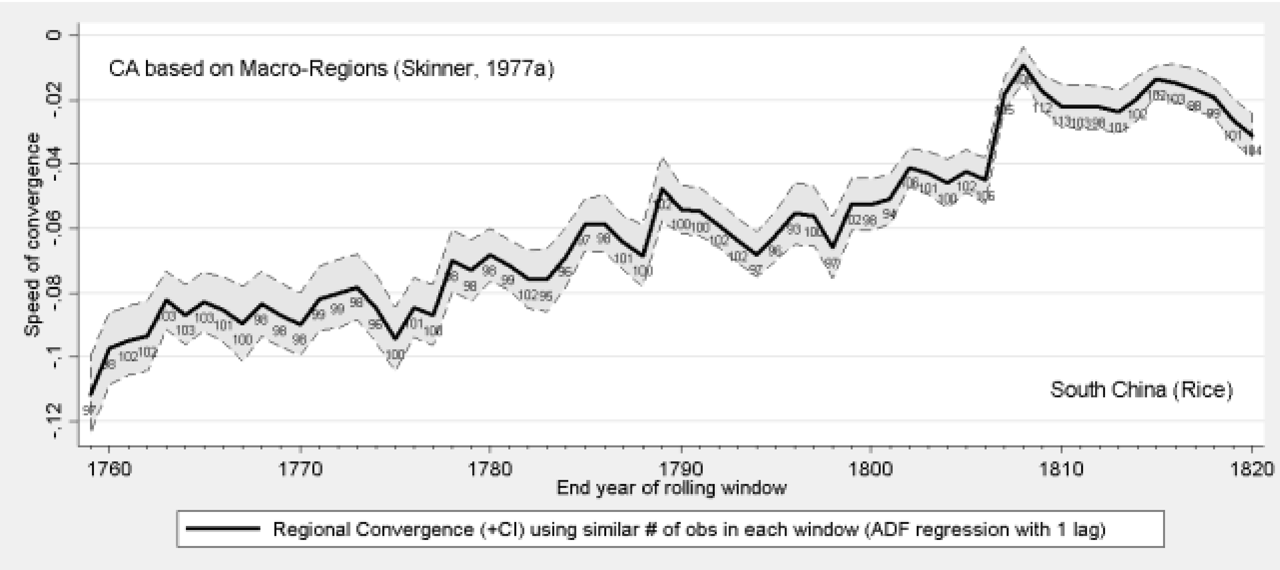
Note: Based on the estimates from 20-year rolling windows we plot the estimated convergence coefficients against the number of prefectural observations (grey circles), alongside a fractional polynomial regression (solid line). In each plot we also estimate the robust mean across all convergence coefficients (dashed line). The scales of axes are identical in all plots. The top left graph uses results from the rolling windows 1740-59, 1741-60,…, 1751-70 (end years 1759 to 1770). In all other plots we use one fewer window less, e.g. 1752-1771,…, 1761-80 (end years 1771 to 1780) in the top right plot. The graphs speak to the concern created by missing observations in the period 1780-1810 (thus in the four graphs at the bottom of the figure): can we detect a clear (linear) relationship between *fewer* observations and (in absolute terms) *lower* speed of convergence? It appears this way in the final two plots/time periods. However, if we exclude 5 prefectures (red fitted line) there once again is no strong relationship. (continued overleaf)

Figure C-16: (continued)



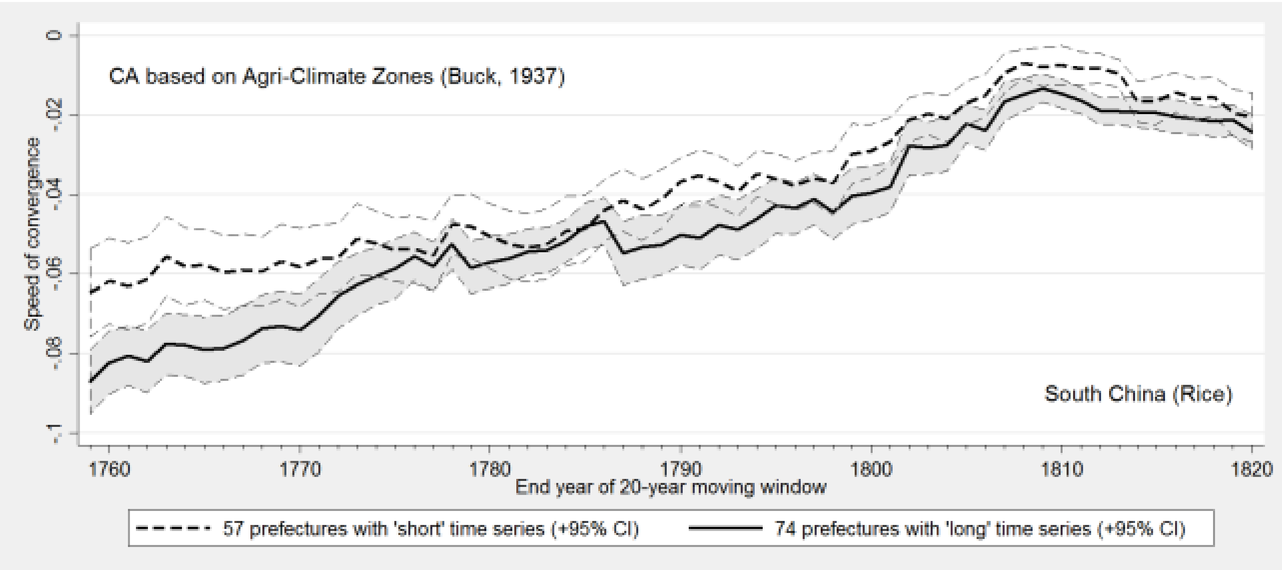
Note (continued): These 5 prefectures are Zhangde (#175 in Figure 1 of the main text) in Henan province and Binzhou (#196), Fuzhou (#192), Shangzhou (#193) and Suide (#189) in Shaanxi. At face value there is nothing unusual about these prefectures, in that they do not constitute remote locations or markets without contiguous neighbours. In the two plots at the top of this Figure we indicate how the convergence estimates and observation counts from these 5 prefectures (black hollow circles) relate to those in all other Northern prefectures (grey + symbols): before 1800 (left plot) they do not appear unusual, both observation count and estimated speed of convergence. In the last decades of the sample period (right plot refers to estimates for 20-year rolling windows *ending* in 1800 to 1820), in contrast, they constitute the bulk of prefectures to the left of the scatter plot, i.e. with the smallest available observations. For robustness we exclude these prefectures from the sample and estimate a convergence plot for the remaining 73 prefectures of Northern China (dashed line + 95% confidence interval in the lower plot), alongside the convergence estimate for the full sample (solid line in the same plot): the two estimates are statistically indistinguishable, which is strong evidence that our empirical result of market disintegration in Northern China is not driven by prefectures with a large number of missing observations.

Figure C-17: Rice Price Convergence in South China using Rolling Windows with Similar Number of Observations



Note: We attempt to address concerns about sample variability over time apparent in the graphs in Figure C-14. Here we fix the number of observations in each of the rolling windows of the regional convergence regression model: we estimated alternative window lengths from 9 to 20 years for each of the start years and then select the window length that equates to about 100 observations (we pick the smallest absolute deviation from 100 observations using the average number of observations across all prefectures for our selection) in the convergence regression model with a single lag of the dependent variable (results for two or three lags are qualitatively similar and available on request). In the earlier and final years of our sample this means the window length is around 9-10 years, in the early 19th century where data are most patchy we have window lengths of around 14 years. In the plot we indicate the average number of observations across prefectures in the selected window length. As is apparent there is no systematic relationship between the number of observations and the average speed of convergence presented.

Figure C-18: Rice Price Convergence in South China comparing Subsamples with More and Less Complete Time Series

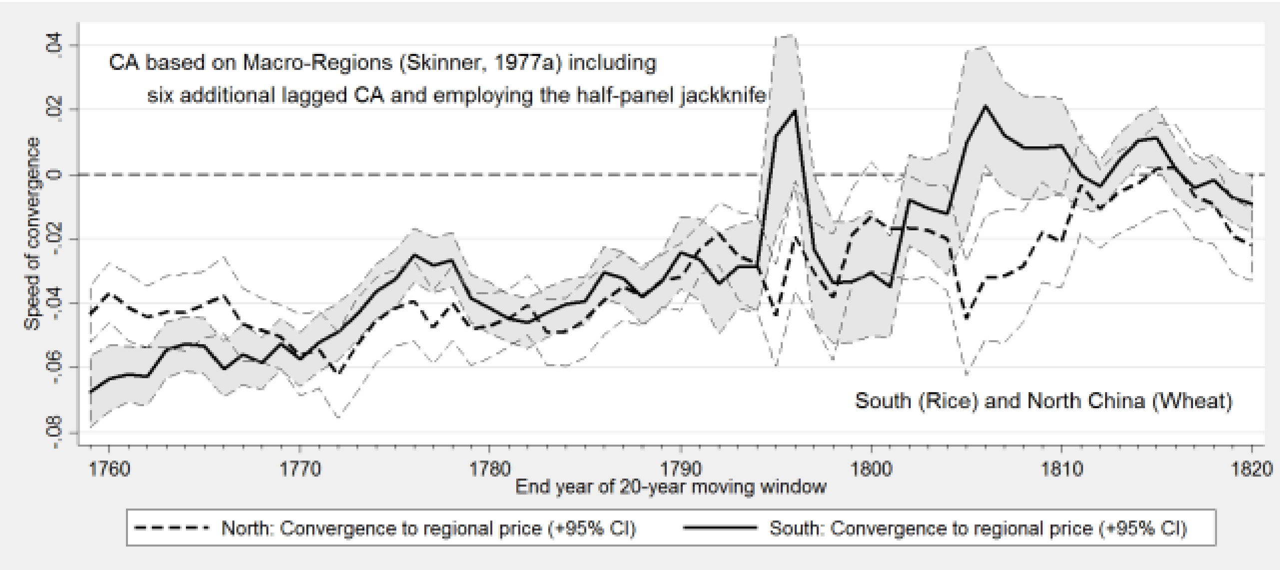


Note: We plot convergence to the regional average price for rice prices in South China. We split the sample of 131 prefectures in two, a subsample of 74 prefectures with comparatively 'long' time series and another of 57 prefectures with comparatively shorter series. The model specification adopts cross-section averages based on Buck's (1937) agri-climatic regions to capture the cross-section dependence induced by common shocks and the trade network effect. Results adopting Skinner (1977a) macro-regions for South China to compute averages are qualitatively identical (available on request).

Figure C-19: Grain Price Convergence Using Rolling Windows of Ten and Fifteen Years

Note: We plot convergence to the provincial and regional average price for rice prices in Southern and Northern China. In the analysis presented in the main section of the paper we adopt a 20-year rolling window. Here we present results adopting a 10-year (top panel) and 15-year (bottom panel) rolling window instead. The model specification in each case adopts cross-section averages based on Skinner (1977a) macro-regions regions to capture the cross-section dependence induced by common shocks and the trade network effect. Results using agro-climatic regions based on Buck (1937) are qualitatively similar.

Figure C-20: Rice Price Convergence – Analysis following Chudik and Pesaran (2015)

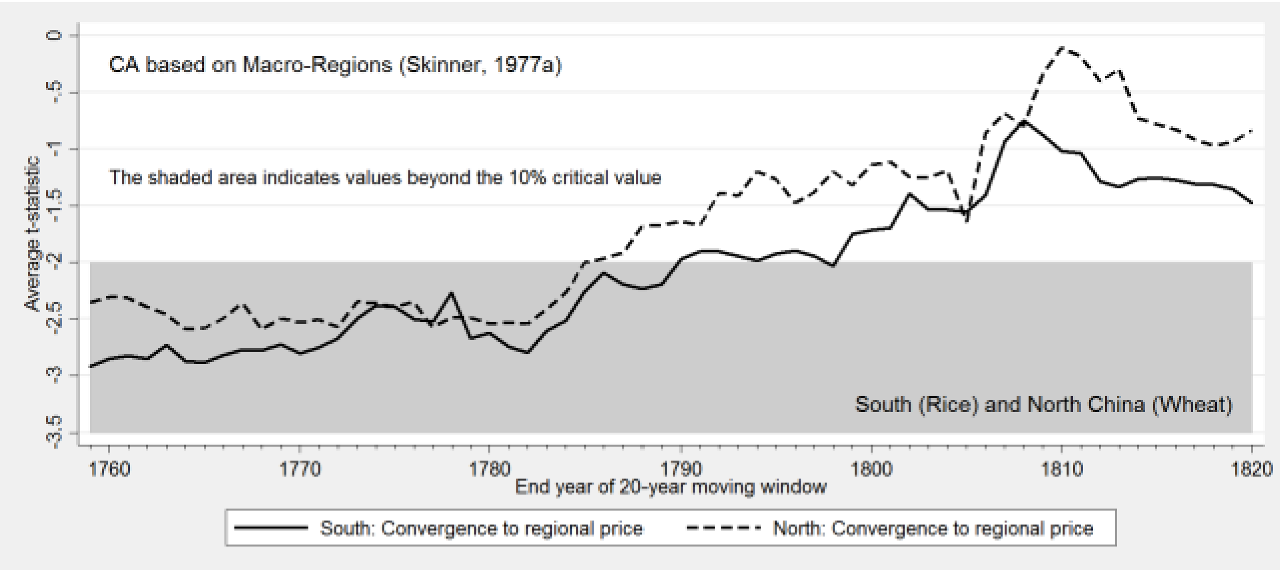


Note: We plot convergence to the regional average price for rice prices in Southern China (solid line) and wheat prices in Northern China (dashed line). The model specification in each case adopts cross-section averages based on Skinner's (1977a) macro-regions to capture the cross-section dependence induced by common shocks and the trade network effect. The specifications differ from those in the main section of the paper by the inclusion of six ($T^{1/3} \approx 6$) lags of the cross-section averages of the dependent variable in the convergence regression model, following the suggestion in Chudik and Pesaran (2015). We also follow these authors' suggestion in applying a bias correction based on the half-panel jackknife: the estimate for each prefecture *i* in each 20-year window is based on

$$\hat{\beta}_i^{Jack} = 2\hat{\beta}_i \ - 0.5(\hat{\beta}_i^A + \hat{\beta}_i^B)$$

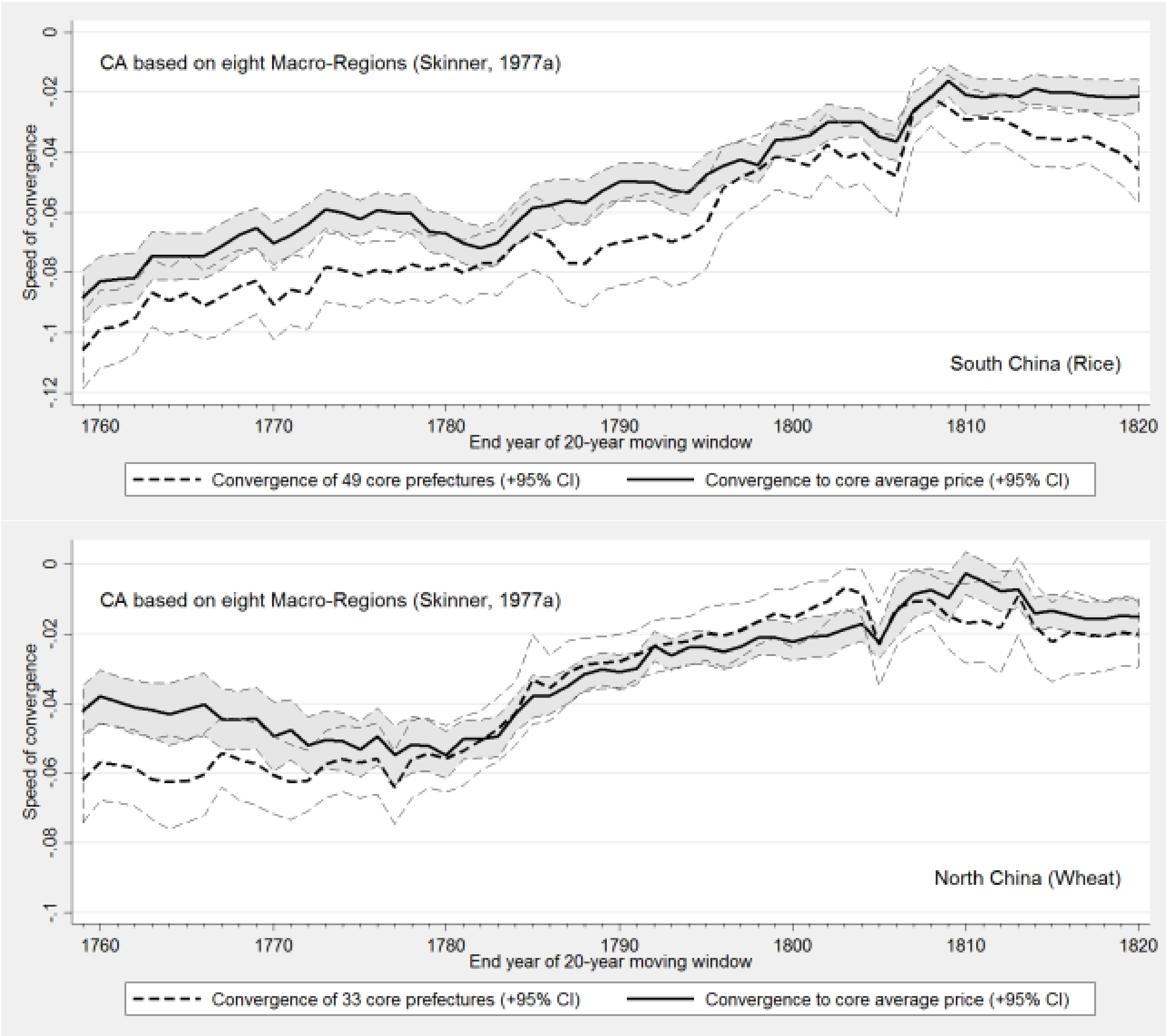
where $\hat{\beta}_i$ is an estimate of the full 20-year period and $\hat{\beta}_i^A$ ($\hat{\beta}_i^B$) is an estimate for the first (last) ten years of the 20-year window. For the 'half-panel' estimates the optimal lag-length is determined separately from that for the full panel model, in all cases using the Schwarz-Bayesian criterion. We highlight the zero threshold (implying infinite half-life or disintegration) with a dashed line. The 95% confidence intervals of both convergence specifications contain zero at one point during the later stages of the sample period.

Figure C-21: Investigating averaged *t*-statistics (unit root analysis)



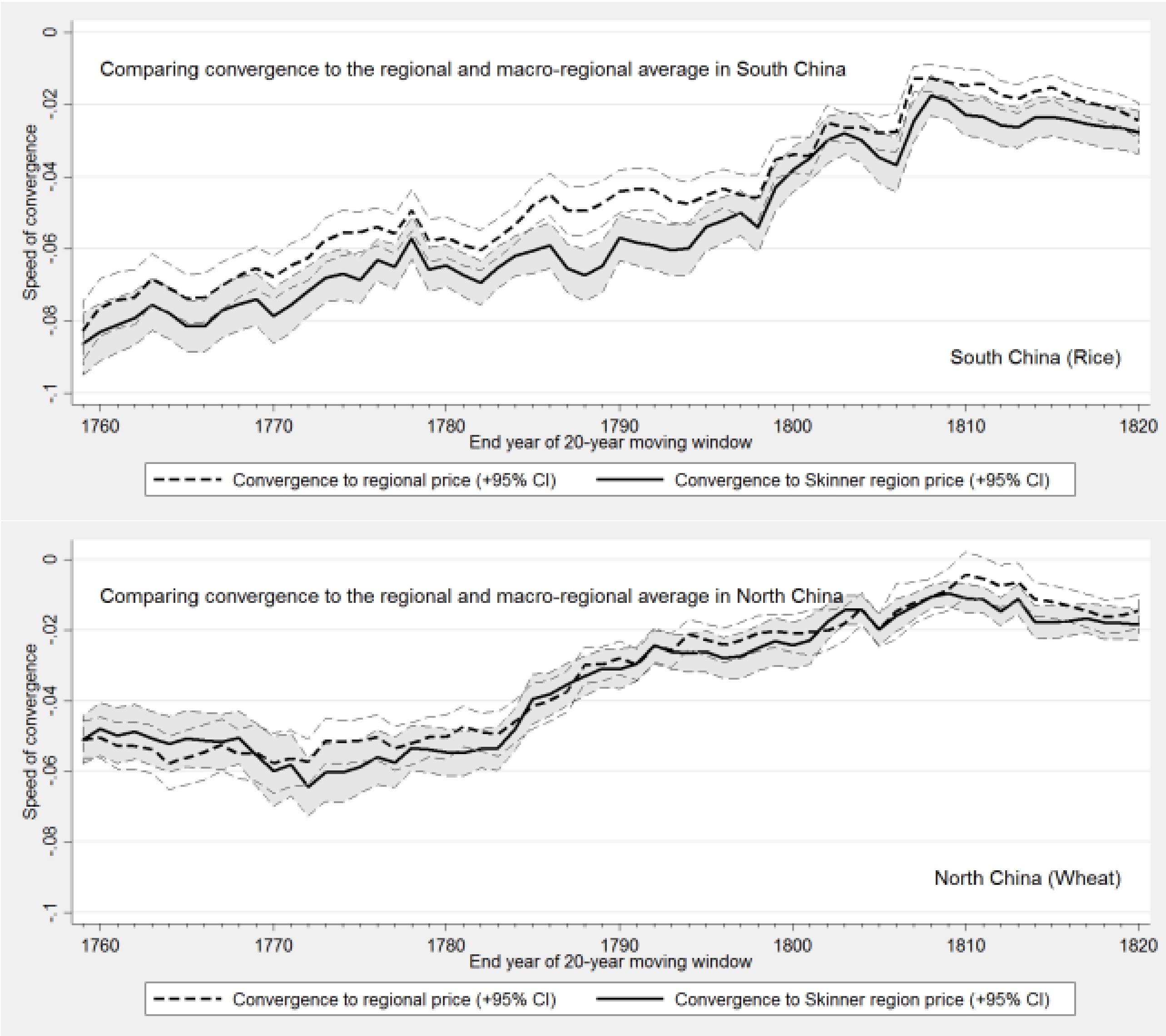
Note: We plot the unweighted cross-section average of the prefecture-specific t-statistic from the convergence regressions to the regional and provincial average price. For an average t-statistic in absolute terms above (below) the critical value, indicated by the shaded (unshaded) region in the graph, we (cannot) reject the null of a unit root in the relative price series. The economic interpretation of this outcome is that markets are (not) integrated. The critical values here have non-standard distributions, so that we simulated them following the setup in Pesaran (2007) for the specific dimensions (*N*,*T*) of our Southern and Northern Chinese panel data (10,000 iterations, constant term but no trend, two lags in the augmented Dickey-Fuller regression, additional lag augmentation with cross-section averages). For our Southern sample (*N*=131, average *T*=190 for each rolling window) we have critical values of -2.007, -2.058 and -2.146 (10%, 5% and 1%, respectively), in the Northern sample (*N*=80, average *T* = 190 for each rolling window) we have critical values of -2.020, -2.082 and -2.180 (dto). In the plot we adopt the 10% critical value for Southern China. Based on the regional convergence analysis the final year where we can reject the unit root null in the relative price series for South (North) China is 1789 (1784). The number of average time series observations for each rolling window declines somewhat over time: critical values computed for shorter *T* will be marginally larger (in absolute terms) than those we adopted in our plots above (we adopted the value for *average T*), with the implication that *if anything* the market disintegration result will be reached earlier than in the results presented.

Figure C-22: Skinner (1977a) macro-region core and periphery



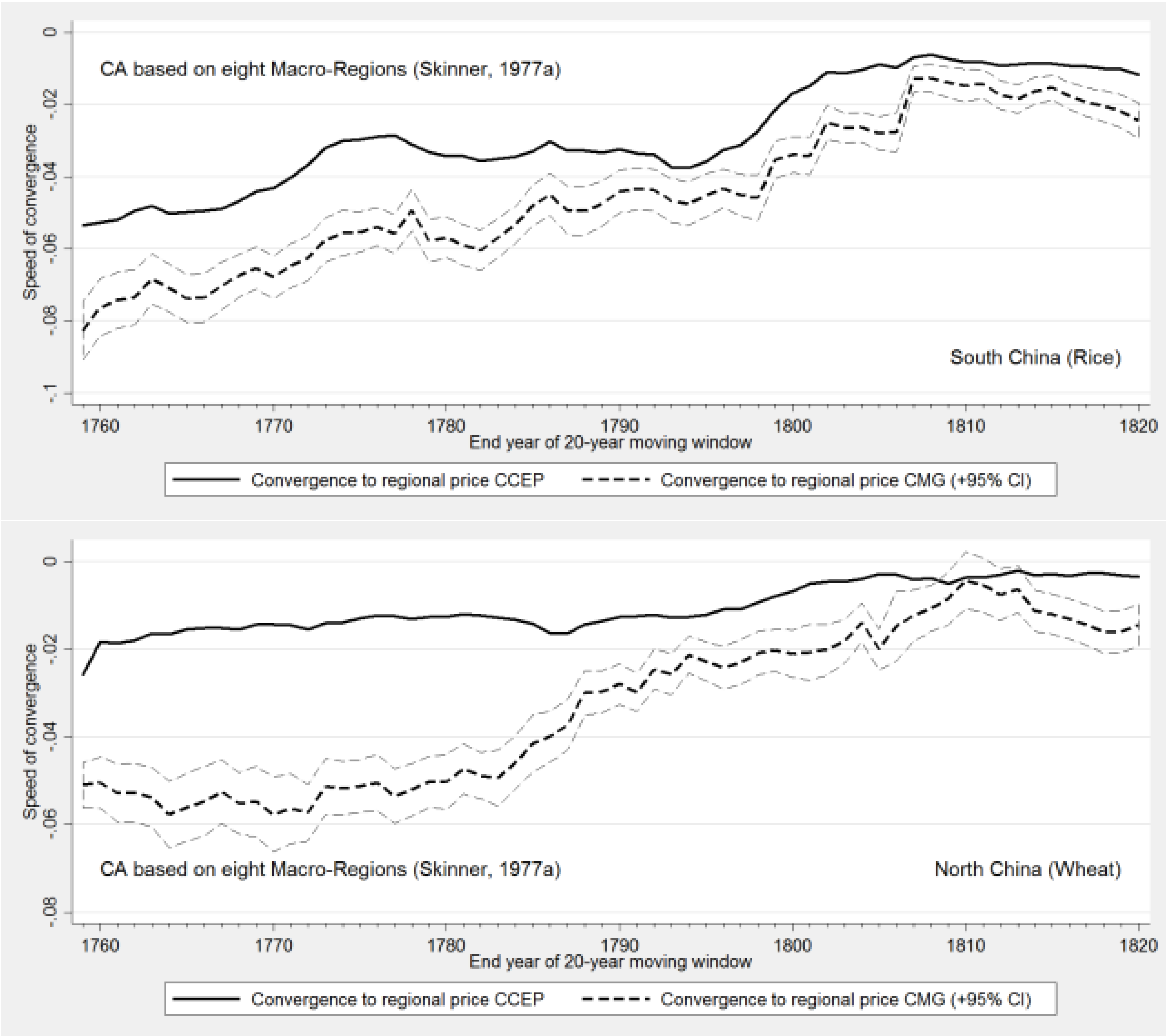
Note: We plot convergence to selected equilibrium benchmark prices in 131 Southern prefectures (top panel) and wheat prices in 78 Northern prefectures (bottom panel). The model specification in each case adopts cross-section averages based on Skinner's (1977a) macro-regions to capture the cross-section dependence induced by common shocks and the trade network effect. We analyse differences in convergence between the macro-region core and periphery prefectures, (i) limiting the sample of prefectures to these core prefectures (dashed line) and (ii) investigating the respective full sample convergence to the macro-region core average.

Figure C-23: Skinner (1977a) macro-region versus regional convergence



Note: We plot convergence to different equilibrium benchmark prices in 131 Southern prefectures (top panel) and wheat prices in 78 Northern prefectures (bottom panel): in each plot we compare convergence to the regional average (dashed line) and convergence to the Skinner (1977a) macro-regional average (solid line). The model specification in each case adopts cross-section averages based on Skinner's (1977a) macro-regions to capture the cross-section dependence induced by common shocks and the trade network effect.

Figure C-24: Price Convergence adopting a common speed of convergence coefficient



Note: We plot convergence results for pooled and heterogeneous convergence specifications for rice prices in 131 Southern Chinese prefectures (top panel) and wheat prices in 78 Northern Chinese prefectures (bottom panel). In each plot we compare convergence to the regional average (dashed line) assuming heterogeneous convergence and the same specification but adopting a common convergence coefficient (solid line). The latter is implemented via the Pesaran (2006) Common Correlated Effects Pooled (CCEP) estimator. We do not plot any confidence intervals for the CCEP estimates as serious difficulties arise in their computation given our moving window specification. The model specification in each case adopts cross-section averages based on Skinner's (1977a) macro-regions to capture the cross-section dependence induced by common shocks and the trade network effect.

D. Qing China: Nonlinear adjustment dynamics

Taylor's (2001) seminal contribution to the empirical analysis of the Law of One Price raised concerns over the analysis of price differentials between two markets when there exists a 'band of inaction' for price adjustment in which no arbitrage occurs despite a non-zero 'price gap'. The assumption of a linear AR(1) specification for the adjustment dynamics is shown to lead to significant bias in the convergence parameter (and thus the half-lives) estimates as well as a substantial loss of power for a unit root test applied to the price gap. For simplicity of exposition, Taylor (2001) employs a three-regime threshold autoregression (TAR) in his simulations, whereby the price gap represents a *random walk* (nonstationary) process in the interval $[-c, +c]$ and a *mean-reverting* (stationary) process if it is outside these bounds. His derivations show that if a linear AR(1) is imposed on a TAR process the estimated speed of convergence and half-lives may be seriously biased, with the implication that estimated half-lives are a multiple of their true values.

In case of the TAR specification, this adjustment between regimes is sharp: the price gap is assumed to switch from a random walk to a mean-reverting process right at the edge of the 'band of inaction.' An alternative smooth transition autoregression (STAR) model assumes that this transition is smoother (Kapetanios, Shin, and Snell, 2006).

As a robustness check, we subject our analysis of price convergence to nonlinear adjustment dynamics in the form of an exponential smooth transition autoregression (ESTAR) model. This approach was developed for single time series data by Kapetanios, et al (2006) and expanded to the panel by Cerrato, de Peretti, Larsson, and Sarantis (2011). The latter authors also introduced a common factor framework into the testing procedure to account for cross-section dependence.[3] In the following we briefly set out the preliminaries of this approach, discuss the implementation and present the results for our grain price series in pre-modern China.

Assume that a process y (in our case the relative price series, $LPP_{it} = ln(P_{it}/\bar{P}_{pt})$, with P_{it} the prefectural price and $\bar{P}_{pt}$ the respective *provincial* average at time *t*; or $LPR_{it} = ln(P_{it}/\bar{P}_{t})$, with $\bar{P}_{t}$ the *regional* average) is generated by the following dynamic nonlinear heterogeneous panel STAR model:

[3] Fan and Wei's (2006) price convergence analysis for 36 Chinese cities also implemented the panel version of a unit root test allowing for an ESTAR process under the alternative. In contrast to the method developed by Cerrato et al (2011), their analysis did not account for cross-section dependence.

$$y_{it} = \beta_i y_{i,t-1} + \nu_i \, y_{i,t-1} \, Z\big(\theta_i;\ y_{i,t-d}\big) + u_{it}, \tag{D-1}$$

where $y_{i,0}$ is given and the error term has a multifactor structure:

$$u_{it} = \lambda_i f_t + \varepsilon_{it}, \tag{D-2}$$

with ε_{it} white noise. In case of the ESTAR model the 'transition function' $Z(\cdot)$ is defined as an exponential function, namely:

$$Z\big(\theta_i;\ y_{i,t-d}\big) = 1 - \exp(-\theta_i y_{i,t-1}^2) \tag{D-3}$$

with $\theta_i \geq 0$ and the 'delay parameter' d set equal to unity as is common practice in this literature. Taking these equations together and expressing the ESTAR model in first differences we can write:

$$\Delta y_{it} = \phi_i y_{i,t-1} + \nu_i \, y_{i,t-1} \, [1 - \exp\big(-\theta_i y_{i,t-1}^2\big)] + \lambda_i f_t + \varepsilon_{it} \tag{D-4}$$

for $\phi_i = \beta_i - 1 = -(1 - \beta_i)$.

What does such a stationary ESTAR process look like? The graphs in Figure D-1 provide four simulated time series (we ignore the heterogeneous panel and common factor structure) to illustrate the generic ESTAR process; in all four cases we set $\phi_i = 0$, i.e. each y is *nominally* a random walk process.[4] The graph in the upper panel is for a sub-period (240 observations) to aid illustration; the lower panel graph is for the full 900 observations sample.

The black line is a simple random walk, i.e. $\Delta y_t = \varepsilon_t$, the red and blue lines are ESTAR processes for $\nu_i = -1$ and $\theta_i = \{0.01, 0.05\}$, and the green line is an ESTAR process for $\nu_i = -0.01$ and $\theta_i = 0.05$. In Figure D-1, we can easily see for the red and blue lines the notion of a 'band of inaction' within which the y process is a random walk but to which the process returns/converges quickly once it strays beyond the band's edge. Their position relative to that of the green line (also an ESTAR process) indicates how ν_i determines the *width* of the band as well as the *speed* at which the process returns to it, namely much more slowly for the green than the red and blue processes. Note the difference in the evolution of the black line (random walk): this process *never* returns to any band. This is not obvious from the top-panel graph, but can be observed in the bottom-panel plot for the full-simulated time series (900 observations).

Having thus provided some intuition for the nature of the ESTAR process, its relevance for the analysis of market integration is that relative price series may only be evolving in a random

[4] We simulate 1,800 time series observations and discard the first 900. The choice of the window presented (window length: 240 periods = 20 years times 12 months) starting at time period 240 is arbitrary but matches the rolling window length and total sample size of our Qing grain price data.

walk fashion within a (narrow) 'band of inaction', but a linear test of convergence (like that applied in our analysis throughout) may mistake this for a random walk process for all time periods. Cerrato, et al. (2011) derive a *t*-test for the null of a nonstationary process in all cross-section units (in our case: prefectures) and the alternative of a stationary ESTAR process in *some* cross-section units.[5] In addition to the factor structure this test allows for serial correlation (as in a standard 'Augmented' Dickey-Fuller test), which is accounted for by adding lags of the dependent variable to the equation. The test is based on the following auxiliary regression estimated in each cross-section unit (prefecture) separately:

$$\Delta y_{it} = a_i + b_i y_{i,t-1}^3 + g_{ij} \sum_{j=1}^{p_i} \Delta y_{i,t-j}$$
$$+c_i \overline{y_{t-1}^3} + d_{ij} \sum_{j=0}^{p_i} \Delta \overline{y_{t-j}^3} + e_{it} \quad \text{(D-5)}$$

In words: the first difference of the relative price *y* – note that prior to the analysis the individual relative price series are within-transformed and detrended – is regressed on (i) the lag of its cubed level, (ii) its own lags (to account for serial correlation), as well as (iii) the cross-section average of the cubed lag level, and (iv) the cross-section averages of the lagged differences of the cubed prices (to account for cross-section dependence). The statistics of interest here are the *t*-ratios for the b_i coefficients, of which there are *N* (one for each prefecture), and from which an unweighted average is computed akin to the Im, Pesaran and Shin (2002) panel unit root test statistic. Critical values for this average *t*-statistic are non-standard and simulated values are provided by Cerrato, et al. (2011).

Figure D-2 present the results for our rice and wheat price series in South and North China in graphical form. The 10% critical value for a panel of dimensions *N=100* and *T=200* is indicated in each plot – note that this is a very conservative choice *in favour of concluding price convergence*. If the line for the estimated average *t*-statistic is below the critical value (larger, in absolute terms), then the null of a nonstationary price gap is rejected in favour of the alternative of a stationary ESTAR process; if it is above the critical value (smaller, in absolute terms), then we cannot reject the null. These plots are conceptually identical to those analyzing unit roots in Figure C-22; they differ in that the latter investigate nonstationary versus stationary price gaps *with linear dynamics*, whereas the below plots are from a test which allows for non-linear dynamics. What if the processes

[5] Note that this heterogeneous alternative hypothesis is present throughout our testing of stationarity versus nonstationarity: once we moved from homogeneous to heterogeneous models the rejection of the null no longer implies the alternative is likely to be present for *all* cross-section units.

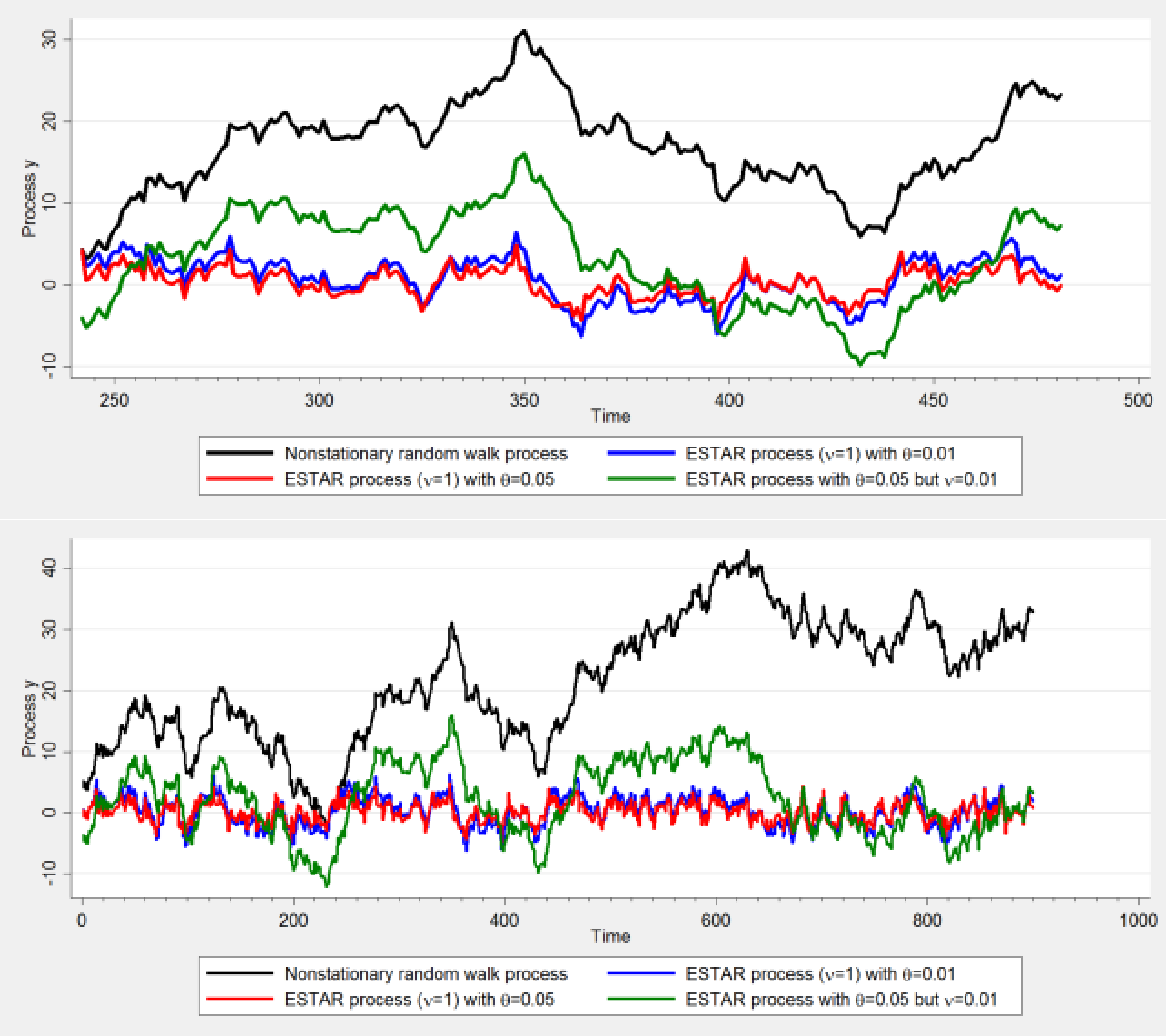
are stationary, but the assumption of non-linear dynamics is wrong? Simulations suggest that the Cerrato, et al (2011) test still has good power properties in that case; further, all of our previous analysis has found strong evidence for secular price divergence assuming linear dynamics.

Figure D-2 presents the results for South and North China respectively. In the South regional convergence from 1790 onwards (end year of 20-year rolling window) cannot reject the null of nonstationarity, whereas in the North the regional convergence result is somewhat mixed: while early on the average *t*-statistic hovers close to the critical value (i.e. markets are integrated but perhaps marginally so), for most of the end years and from a similar point in time onwards we can no longer reject the nonstationarity null, the test statistic subsequently returns to hover close to the critical value from 1806 onwards.

We can further investigate the share of prefectures for which in each year the individual *t*-statistic exceeds the critical value (this differs from the critical value for the averaged *t*-statistic), in our case -2.83 and -2.82 for the North and South China samples, respectively. For the regional (provincial) convergence model in the North, this share changes from 70% (35%) in the 1760s (end year) to around 45% (35%) in the 1780s, from where it declines to reach around 25% (10%) from 1807 onwards until the end of the sample. In the South the results are 35% (50%), 25% (35%), and 17% (13%) for the same intervals.

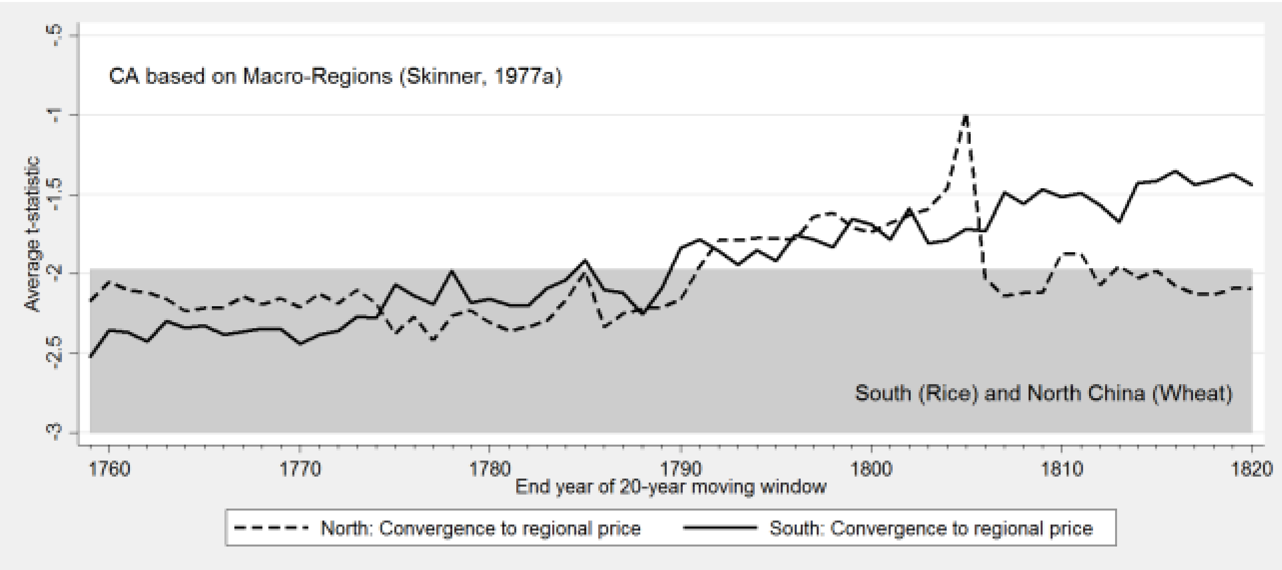
Taken together these results provide fairly consistent results with our linear dynamic adjustment models, suggesting that the serious deterioration in Chinese market integration was well under way by the early 1790s, to the extent that from let late 18th century onward our statistical tests can no longer detect significant price co-movement interpretable as the forces of arbitrage.

Figure D-1: Simulated ESTAR and random walk processes



Note: We present nonlinear adjustment dynamics in an ESTAR model using simulated data (see text). The upper panel limits the time series to a subsample of around 240 observations (equivalent to 20 years if data were monthly), whereas in the lower panel the entire 900 observations (equivalent to around 75 years) are presented. As stated in the text we adopt a burn-in of 900 time periods, which are discarded.

Figure D-2: Nonlinear Adjustment Dynamics of Price Divergence



Note: We investigate nonlinear adjustment dynamics in an ESTAR model, where the null hypothesis of the test is that all relative price series are nonstationary, whereas the alternative hypothesis is that some relative price series follow a stationary ESTAR process. The shaded area marks the region in which we can reject the null at the 10% level. In our empirical setup the null and alternative hypotheses is equivalent to evidence for market disintegration and integration, respectively.

E. Additional Convergence Regression Results and Related Statistics

Table E-1: Convergence Regressions with Monthly Data (China)

Panel A	**South China (Rice)**						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Period	**Full**	**Early**	**Late**	**Period 1**	**Period 2**	**Period 3**	**Period 4**
	1740-1820	1740-73	1774-1820	1740-60	1761-80	1781-1800	1801-20
Average β_i	-0.034 [0.001]***	-0.056 [0.003]***	-0.026 [0.001]***	-0.070 [0.004]***	-0.047 [0.002]***	-0.041 [0.003]***	-0.025 [0.003]***
95% CI		[-0.06, -0.05]	[-0.03, -0.02]	[-0.08, -0.06]	[-0.05, -0.04]	[-0.05, -0.03]	[-0.03, -0.02]
CD test	-6.49 (.00)	-2.61 (.01)	17.25 (.00)	-0.93 (.35)	3.75 (.00)	36.95 (.00)	37.51 (.00)
Obs.	8,559	41,428	41,411	25,177	27,559	14,938	17,614
Markets	113	131	131	131	131	131	117
Average T	65.3	316.2	316.1	192.2	210.4	114.0	150.5

Panel B	**North China (Wheat)**						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Period	**Full**	**Early**	**Late**	**Period 1**	**Period 2**	**Period 3**	**Period 4**
	1740-1820	1740-75	1776-1820	1740-60	1761-80	1781-1800	1801-20
Average β_i	-0.029 [0.001]***	-0.042 [0.002]***	-0.021 [0.001]***	-0.036 [0.002]***	-0.048 [0.003]***	-0.021 [0.003]***	-0.023 [0.002]***
95% CI		[-0.05, -0.04]	[-0.024, -0.018]	[-0.04, -0.03]	[-0.05, -0.04]	[-0.03, -0.02]	[-0.03, -0.02]
CD test	-3.19 (.00)	-2.37 (.02)	12.67 (.00)	-2.51 (.01)	6.52 (.00)	10.48 (.00)	27.26 (.00)
Obs.	49,610	24,261	25,349	12,638	16,890	10,189	11,500
Markets	80	80	80	70	80	80	80
Average T	620.1	303.3	316.9	180.5	211.1	127.4	143.8

Notes: We report robust Common Correlated Effects (CCE) Mean Group estimates on the lagged level of relative price *LPR* in market *i* at time *t*, where *LPR* is the natural logarithm of the ratio between observed price *P* in *i* and the average price in 131 Southern and 80 Northern prefectures. *** denote 1% significance level. Average constant terms are estimated but not reported. We also include 5 lags of the dependent variable to account for serial correlation (estimates not reported). CD test reports the result for the Pesaran (2015) test for cross-section dependence, which under the null of weak dependence is distributed standard normal – rejection of the null implies the residuals are cross-sectionally strongly dependent.

Table E-2: Convergence Regressions with Annual Data using Provincial Capitals and Neighbouring Prefectures (China)

	South China subsample			North China subsample		
	(1)	(2)	(3)	(4)	(5)	(6)
Period	**Full**	**Early**	**Late**	**Full**	**Early**	**Late**
	1740-1820	1740-73	1774-1820	1740-1820	1740-75	1776-1820
Average β_i	-0.273 [0.023]***	-0.596 [0.037]***	-0.375 [0.038]***	-0.206 [0.026]***	-0.386 [0.033]***	-0.164 [0.056]***
95% CI		[-0.78, -0.58]	[-0.54, -0.35]		[-0.45, -0.32]	[-0.27, -0.05]
CD test	-2.42 (.02)	0.56 (.57)	-0.19 (.85)	-1.79 (.07)	-1.27 (.21)	1.64 (.10)
Obs.	3,871	2,032	1,839	2,533	1,227	1,306
Markets	59	59	59	37	37	37
Average T	65.6	34.4	31.2	68.5	33.2	35.3

Notes: We report robust Common Correlated Effects (CCE) Mean Group estimates on the lagged level of relative price *LPR* in market *i* at time *t*, where *LPR* is the natural logarithm of the ratio between observed price *P* in *i* and the average price in 59 Southern and 37 Northern Chinese prefectures, representing (a) the prefectures hosting the provincial capitals, and (b) their contiguous neighbours within the same province. *** denote 1% significance level. Average constant terms are estimated but not reported We also include 5 lags of the dependent variable to account for serial correlation (estimates not reported). CD test reports the result for the Pesaran (2015) test for cross-section dependence, which under the null of weak dependence is distributed standard normal – rejection of the null implies the residuals are cross-sectionally strongly dependent.

Table E-3: Convergence Regressions for Specific Months (South China)

	February (price trough)			July (price peak)		
	(1)	(2)	(3)	(4)	(5)	(6)
Period	**Full**	**Early**	**Late**	**Full**	**Early**	**Late**
	1740-1820	1740-69	1770-1820	1740-1820	1740-69	1770-1820
Average β_i	-0.277 [0.021]***	-0.837 [0.072]***	-0.221 [0.029]***	-0.317 [0.024]***	-0.812 [0.053]***	-0.263 [0.036]***
95% CI		[-.98,-.70]	[-.28,-.16]		[-.92,-.71]	[-.33,-.19]
CD test	-0.52 (.60)	-0.64 (.52)	-0.96 (.34)	-2.75 (.00)	-0.89 (.37)	-1.17 (.24)
Obs.	5,016	2,300	2,708	4,936	2,448	2,280
Markets	131	130	131	131	120	118
Average T	38.3	17.7	20.7	37.7	20.4	19.3

Notes: As Figure B-2 above show, prices fluctuate over the calendar year in line with the harvest cycle. For South China the (solar) months of February and July are particularly interesting since they represent periods when prices are typically low and high, respectively. Like in the analysis presented in Table E-2, we apply a split in order to balance the 'early' and 'late' panels (average # of time series observations). We present the Common Correlated Effects (CCE) Mean Group estimates using cross-section averages at the Skinner (1977a) macro-region. As can be seen, the 95% confidence intervals for the 'Early' and 'Late' period estimates never overlaps, with the latter always lower, thus confirming the main finding of market disintegration over time.

Table E-4: Convergence Regressions for Specific Months (North China)

	September (price trough)			May (price peak)		
	(1)	(2)	(3)	(4)	(5)	(6)
Period	**Full**	**Early**	**Late**	**Full**	**Early**	**Late**
	1740-1820	1740-69	1770-1820	1740-1820	1740-69	1770-1820
Average β_i	-0.272 [0.0290]***	-0.665 [0.0765]***	-0.231 [0.0348]***	-0.251 [0.0274]***	-0.714 [0.0523]***	-0.142 [0.0296]***
95% CI		[-.81,-.51]	[-.30,-.16]		[-.82,-.61]	[-.20,-.08]
CD test	0.63 (.53)	-1.31 (.19)	-1.75 (.08)	-1.27 (.20)	0.36 (.72)	0.88 (.38)
Obs.	2,683	1,091	1,542	3,138	1,336	1,674
Markets	78	64	78	78	55	78
Average T	34.4	17.0	19.8	40.2	24.3	21.5

Notes: As Figure B-2 above show, prices fluctuate over the calendar year in line with the harvest cycle. For North China the (solar) months of September and May are particularly interesting since they represent periods when prices are typically low and high, respectively. Like in the analysis presented in Table E-2, we apply a split in order to balance the 'early' and 'late' panels (in terms of average # of time series observations). We present the CMG estimates using cross-section averages at the Skinner (1977a) macro-region. As can be seen, the 95% confidence intervals for the 'Early' and 'Late' period estimates never overlaps, with the latter always lower, thus confirming the main finding of market disintegration over time.

Table E-5: Convergence Estimates Compared

	North China					South China				
	Speed of Conv.		Half-lives			Speed of Conv.		Half-lives		
End year	CMG	MG	CMG	MG	Ratio	CMG	MG	CMG	MG	Ratio
1759	-0.0510	-0.0649	13.2	10.3	1.3	-0.0828	-0.0751	8.0	8.9	0.9
1760	-0.0504	-0.0531	13.4	12.7	1.1	-0.0763	-0.0703	8.7	9.5	0.9
1761	-0.0528	-0.0563	12.8	12.0	1.1	-0.0744	-0.0671	9.0	10.0	0.9
1762	-0.0528	-0.0565	12.8	11.9	1.1	-0.0734	-0.0636	9.1	10.5	0.9
1763	-0.0537	-0.0490	12.6	13.8	0.9	-0.0683	-0.0614	9.8	10.9	0.9
1764	-0.0577	-0.0544	11.7	12.4	0.9	-0.0709	-0.0661	9.4	10.1	0.9
1765	-0.0561	-0.0499	12.0	13.5	0.9	-0.0738	-0.0675	9.0	9.9	0.9
1766	-0.0546	-0.0507	12.3	13.3	0.9	-0.0736	-0.0719	9.1	9.3	1.0
1767	-0.0525	-0.0564	12.9	11.9	1.1	-0.0703	-0.0745	9.5	9.0	1.1
1768	-0.0551	-0.0571	12.2	11.8	1.0	-0.0675	-0.0725	9.9	9.2	1.1
1769	-0.0548	-0.0585	12.3	11.5	1.1	-0.0654	-0.0735	10.2	9.1	1.1
1770	-0.0577	-0.0590	11.7	11.4	1.0	-0.0679	-0.0752	9.9	8.9	1.1
1771	-0.0564	-0.0554	11.9	12.2	1.0	-0.0646	-0.0704	10.4	9.5	1.1
1772	-0.0573	-0.0580	11.7	11.6	1.0	-0.0626	-0.0687	10.7	9.7	1.1
1773	-0.0513	-0.0563	13.2	12.0	1.1	-0.0576	-0.0668	11.7	10.0	1.2
1774	-0.0517	-0.0586	13.1	11.5	1.1	-0.0556	-0.0604	12.1	11.1	1.1
1775	-0.0512	-0.0550	13.2	12.3	1.1	-0.0554	-0.0496	12.2	13.6	0.9
1776	-0.0504	-0.0544	13.4	12.4	1.1	-0.0539	-0.0448	12.5	15.1	0.8
1777	-0.0535	-0.0572	12.6	11.8	1.1	-0.0559	-0.0455	12.0	14.9	0.8
1778	-0.0521	-0.0540	13.0	12.5	1.0	-0.0493	-0.0423	13.7	16.0	0.9
1779	-0.0503	-0.0565	13.4	11.9	1.1	-0.0577	-0.0455	11.7	14.9	0.8
1780	-0.0503	-0.0618	13.4	10.9	1.2	-0.0569	-0.0461	11.8	14.7	0.8
1781	-0.0473	-0.0547	14.3	12.3	1.2	-0.0590	-0.0471	11.4	14.4	0.8
1782	-0.0488	-0.0550	13.9	12.3	1.1	-0.0604	-0.0493	11.1	13.7	0.8
1783	-0.0494	-0.0620	13.7	10.8	1.3	-0.0570	-0.0495	11.8	13.7	0.9
1784	-0.0458	-0.0599	14.8	11.2	1.3	-0.0534	-0.0516	12.6	13.1	1.0
1785	-0.0415	-0.0551	16.4	12.2	1.3	-0.0480	-0.0451	14.1	15.0	0.9
1786	-0.0399	-0.0633	17.0	10.6	1.6	-0.0449	-0.0477	15.1	14.2	1.1
1787	-0.0373	-0.0570	18.2	11.8	1.5	-0.0493	-0.0452	13.7	15.0	0.9
1788	-0.0299	-0.0563	22.8	12.0	1.9	-0.0495	-0.0472	13.7	14.3	1.0
1789	-0.0296	-0.0595	23.1	11.3	2.0	-0.0474	-0.0447	14.3	15.2	0.9
1790	-0.0279	-0.0607	24.5	11.1	2.2	-0.0441	-0.0431	15.4	15.7	1.0
1791	-0.0297	-0.0644	23.0	10.4	2.2	-0.0435	-0.0439	15.6	15.4	1.0
1792	-0.0245	-0.0639	27.9	10.5	2.7	-0.0437	-0.0473	15.5	14.3	1.1
1793	-0.0257	-0.0717	26.6	9.3	2.9	-0.0467	-0.0548	14.5	12.3	1.2
1794	-0.0212	-0.0717	32.3	9.3	3.5	-0.0475	-0.0623	14.2	10.8	1.3
1795	-0.0228	-0.0801	30.1	8.3	3.6	-0.0452	-0.0719	15.0	9.3	1.6
1796	-0.0242	-0.0790	28.3	8.4	3.4	-0.0433	-0.0738	15.7	9.0	1.7
1797	-0.0229	-0.0901	29.9	7.3	4.1	-0.0451	-0.0755	15.0	8.8	1.7
1798	-0.0209	-0.0933	32.8	7.1	4.6	-0.0459	-0.0783	14.8	8.5	1.7
1799	-0.0202	-0.0987	34.0	6.7	5.1	-0.0353	-0.0793	19.3	8.4	2.3
1800	-0.0210	-0.1106	32.7	5.9	5.5	-0.0338	-0.0762	20.2	8.7	2.3
1801	-0.0207	-0.1234	33.1	5.3	6.3	-0.0342	-0.0723	19.9	9.2	2.2

1802	-0.0201	-0.1454	34.1	4.4	7.7	-0.0250	-0.0689	27.4	9.7	2.8
1803	-0.0182	-0.1294	37.7	5.0	7.5	-0.0266	-0.0473	25.7	14.3	1.8
1804	-0.0140	-0.1280	49.2	5.1	9.7	-0.0264	-0.0334	25.9	20.4	1.3
1805	-0.0201	-0.1459	34.1	4.4	7.8	-0.0280	-0.0456	24.4	14.9	1.6
1806	-0.0147	-0.1348	46.8	4.8	9.8	-0.0277	-0.0578	24.7	11.6	2.1
1807	-0.0124	-0.1438	55.6	4.5	12.4	-0.0130	-0.0550	53.0	12.3	4.3
1808	-0.0107	-0.1474	64.4	4.3	14.8	-0.0128	-0.0365	53.8	18.6	2.9
1809	-0.0085	-0.1241	81.2	5.2	15.5	-0.0140	-0.0371	49.2	18.3	2.7
1810	-0.0042	-0.1018	164.7	6.5	25.5	-0.0148	-0.0383	46.5	17.7	2.6
1811	-0.0054	-0.0828	128.0	8.0	16.0	-0.0143	-0.0378	48.1	18.0	2.7
1812	-0.0075	-0.0748	92.1	8.9	10.3	-0.0175	-0.0324	39.3	21.0	1.9
1813	-0.0063	-0.0645	109.7	10.4	10.5	-0.0185	-0.0320	37.1	21.3	1.7
1814	-0.0113	-0.0576	61.0	11.7	5.2	-0.0163	-0.0292	42.2	23.4	1.8
1815	-0.0120	-0.0562	57.4	12.0	4.8	-0.0153	-0.0308	45.0	22.2	2.0
1816	-0.0131	-0.0599	52.6	11.2	4.7	-0.0177	-0.0334	38.8	20.4	1.9
1817	-0.0145	-0.0539	47.5	12.5	3.8	-0.0194	-0.0319	35.4	21.4	1.7
1818	-0.0162	-0.0586	42.4	11.5	3.7	-0.0206	-0.0327	33.3	20.8	1.6
1819	-0.0159	-0.0601	43.2	11.2	3.9	-0.0219	-0.0336	31.3	20.3	1.5
1820	-0.0145	-0.0504	47.5	13.4	3.5	-0.0245	-0.0383	27.9	17.7	1.6

Notes: We report the robust mean estimates and associated half-lives for convergence regressions in North and South China, contrasting the results where we include cross-section averages (computed at the Skinner, 1977a, macro-region level) in the columns marked 'CMG' with those from specifications without cross-section averages in the columns marked 'MG'. Each row is a associated with a 20-year rolling window, with the end years indicated in the very first column of the table. The first two columns in each panel for North and South China report the speed of convergence estimate, the next two columns the associated half-lives, and the fifth columns the 'ratio' of CMG half-life to MG half-life. A value above one for this ratio indicates that ignoring cross-section dependence yields higher speed of convergence and lower half-lives. For North China, this is the case almost every time, whereas for South China this is the case from the early 1790s onwards. Figure 3(a) in the main text plots the convergence estimates for CMG (and their 95% confidence intervals), Figure 1c those for MG reported here. The two numbers quoted in the main text (25 fold and four-fold differences in half-lives between CMG and MG in North and South China, respectively) can be found in the end years 1810 and 1807.

F. Variable Time Series Properties

Table F-1: Panel Unit Root Tests (South China)

Panel A	**Variable: raw mean price**							
	ADF with constant term				ADF with constant and trend			
lags	MW	(*p*)	CIPS	(*p*)	MW	(*p*)	CIPS	(*p*)
0	907.00	0.00	-25.71	0.00	956.88	0.00	-21.94	0.00
1	1902.51	0.00	-36.00	0.00	2353.66	0.00	-33.77	0.00
2	1434.83	0.00	-27.49	0.00	1756.51	0.00	-23.95	0.00
3	1114.54	0.00	-26.04	0.00	1441.73	0.00	-22.24	0.00
4	869.52	0.00	-22.51	0.00	1093.71	0.00	-18.21	0.00
5	735.17	0.00	-21.05	0.00	953.55	0.00	-16.71	0.00
6	683.64	0.00	-19.83	0.00	901.43	0.00	-15.35	0.00
7	588.35	0.00	-18.03	0.00	789.16	0.00	-13.46	0.00
8	537.25	0.00	-15.42	0.00	674.46	0.00	-10.34	0.00
9	477.92	0.00	-13.07	0.00	611.60	0.00	-7.84	0.00
10	513.82	0.00	-12.76	0.00	642.30	0.00	-7.40	0.00
11	546.58	0.00	-12.74	0.00	703.00	0.00	-7.20	0.00
12	569.97	0.00	-12.33	0.00	745.14	0.00	-6.59	0.00

Panel B	**Variable: mean price adjusted for seasonality**							
	ADF with constant term				ADF with constant and trend			
lags	MW	(*p*)	CIPS	(*p*)	MW	(*p*)	CIPS	(*p*)
0	843.32	0.00	-26.53	0.00	891.12	0.00	-23.07	0.00
1	1425.61	0.00	-33.83	0.00	1706.60	0.00	-31.23	0.00
2	1131.48	0.00	-27.48	0.00	1357.10	0.00	-24.05	0.00
3	898.05	0.00	-26.01	0.00	1151.61	0.00	-22.71	0.00
4	736.50	0.00	-22.44	0.00	924.52	0.00	-18.78	0.00
5	679.22	0.00	-21.58	0.00	905.51	0.00	-17.76	0.00
6	666.65	0.00	-19.37	0.00	906.02	0.00	-15.40	0.00
7	637.26	0.00	-17.70	0.00	881.23	0.00	-13.36	0.00
8	632.66	0.00	-15.39	0.00	797.67	0.00	-10.78	0.00
9	566.43	0.00	-13.79	0.00	732.40	0.00	-8.85	0.00
10	596.41	0.00	-13.29	0.00	736.66	0.00	-8.35	0.00
11	593.21	0.00	-13.30	0.00	726.10	0.00	-8.09	0.00
12	564.59	0.00	-14.09	0.00	747.63	0.00	-8.92	0.00

Notes: We report results for the Maddala and Wu (1999; MW) and Pesaran (2007; CIPS) panel unit root tests, where 'lags' indicates the number of lagged differences included in the Augmented Dickey Fuller regression (at the prefecture level). Under the null of nonstationary series in all prefectures the MW test statistic is distributed $\chi^2(2N)$ where N is the number of cross-section units (here: 131), with the CIPS test statistic following a non-standard distribution. Probability values are provided for each test, lag and specification. Note that the cointegration approach to the analysis of market integration requires the price series to be nonstationary – a data property emphatically rejected by our panel unit root analysis.

Table F-2: Panel Unit Root Tests (North China)

Panel A	**Variable: raw mean price**							
	ADF with constant term				ADF with constant and trend			
lags	MW	(*p*)	CIPS	(*p*)	MW	(*p*)	CIPS	(*p*)
0	311.04	0.00	-11.72	0.00	212.52	0.00	-7.85	0.00
1	686.63	0.00	-18.35	0.00	622.70	0.00	-15.34	0.00
2	554.69	0.00	-15.77	0.00	485.77	0.00	-11.71	0.00
3	626.58	0.00	-16.00	0.00	557.45	0.00	-11.80	0.00
4	510.93	0.00	-13.89	0.00	459.97	0.00	-9.37	0.00
5	430.53	0.00	-12.66	0.00	394.95	0.00	-8.10	0.00
6	373.21	0.00	-10.96	0.00	336.06	0.00	-6.29	0.00
7	376.50	0.00	-10.49	0.00	341.28	0.00	-5.63	0.00
8	328.17	0.00	-9.50	0.00	285.57	0.00	-4.71	0.00
9	297.99	0.00	-8.09	0.00	258.13	0.00	-3.25	0.00
10	293.73	0.00	-7.11	0.00	259.66	0.00	-1.97	0.02
11	293.92	0.00	-6.26	0.00	292.57	0.00	-1.32	0.09
12	301.88	0.00	-4.99	0.00	296.44	0.00	0.02	0.51

Panel B	**Variable: mean price adjusted for seasonality**							
	ADF with constant term				ADF with constant and trend			
lags	MW	(*p*)	CIPS	(*p*)	MW	(*p*)	CIPS	(*p*)
0	292.84	0.00	-10.89	0.00	197.89	0.02	-7.05	0.00
1	552.29	0.00	-16.05	0.00	478.26	0.00	-13.04	0.00
2	488.53	0.00	-15.66	0.00	424.15	0.00	-11.77	0.00
3	585.40	0.00	-16.41	0.00	520.74	0.00	-12.40	0.00
4	483.16	0.00	-13.85	0.00	431.31	0.00	-9.56	0.00
5	436.43	0.00	-13.31	0.00	415.37	0.00	-9.21	0.00
6	384.66	0.00	-11.60	0.00	361.74	0.00	-7.42	0.00
7	400.33	0.00	-11.43	0.00	389.95	0.00	-7.28	0.00
8	364.57	0.00	-10.39	0.00	336.83	0.00	-6.11	0.00
9	324.53	0.00	-9.01	0.00	308.46	0.00	-4.84	0.00
10	305.99	0.00	-7.54	0.00	283.68	0.00	-2.98	0.00
11	278.22	0.00	-6.47	0.00	277.89	0.00	-2.07	0.02
12	271.32	0.00	-5.39	0.00	275.19	0.00	-0.83	0.20

Notes: We report results for the Maddala and Wu (1999; MW) and Pesaran (2007; CIPS) panel unit root tests, where 'lags' indicates the number of lagged differences included in the Augmented Dickey Fuller regression (at the prefecture level). Under the null of nonstationary series in all prefectures the MW test statistic is distributed $\chi^2(2N)$ where N is the number of cross-section units (here: 80), with the CIPS test statistic following a non-standard distribution. Probability values are provided for each test, lag and specification. Note that the cointegration approach to the analysis of market integration requires the price series to be nonstationary – a data property emphatically rejected by our panel unit root analysis.

Table F-3: Individual Time Series Unit Root Tests (South China)

Prefecture	nd	d	**Prefecture**	nd	d	**Prefecture**	nd	d	**Prefecture**	nd	d
Taiwan	0.11	0.00	Wuzhou	0.79	0.00	Huizhou	0.49	0.07	Hengzhou	0.87	0.36
Shiqian	0.18	0.00	Luoding	0.68	0.00	Zhenjiang	0.53	0.07	Jiangning	0.78	0.36
Zunyi	0.22	0.00	Tingzhou	0.79	0.00	Nanxiong	0.78	0.07	Sicheng	0.75	0.37
Quzhou	0.23	0.00	Gaozhou	0.55	0.00	Zhangzhou	0.85	0.07	Anlu	0.62	0.40
Ningbo	0.36	0.00	Xunzhou	0.70	0.00	Lianzhoufu	0.58	0.09	Lizhou	0.87	0.48
Tongren	0.36	0.00	Quanzhou	0.59	0.00	Yanping	0.45	0.10	Wuchang	0.75	0.48
Duyun	0.45	0.00	Jiaxing	0.37	0.00	Linjiang	0.82	0.10	Changsha	0.76	0.49
Shaozhou	0.45	0.00	Baoqing	0.65	0.00	Jingzhoufu	0.29	0.10	Yazhou	0.45	0.50
Ganzhou	0.46	0.00	Xinghua	0.76	0.00	Guiyang	0.62	0.10	Baoning	0.87	0.53
Nan’an	0.50	0.00	Qingyuan	0.82	0.00	Taicang	0.77	0.11	Guangde	0.69	0.55
Raozhou	0.53	0.00	Hangzhou	0.44	0.00	Zhongqing	0.54	0.11	De’an	0.71	0.56
Guangxin	0.53	0.00	Jianning	0.49	0.00	Songjiang	0.74	0.12	Shinan	0.55	0.57
Zhenyuan	0.87	0.00	Qiongzhou	0.68	0.01	Jiading	0.36	0.14	Tongchuan	0.72	0.59
Fuzhou	0.42	0.00	Huzhou	0.48	0.01	Yongshun	0.70	0.15	Ningguo	0.75	0.62
Wenzhou	0.44	0.00	Jiaying-zhou	0.83	0.01	Taiping	0.49	0.17	Sizhou	0.69	0.63
Nankang	0.56	0.00	Sizhou	0.51	0.01	Chengdu	0.48	0.17	Chenzhou-fu	0.76	0.65
Chaozhou	0.68	0.00	Lianzhou	0.55	0.01	Shunqing	0.62	0.17	Jingzhou	0.89	0.65
Jiujiang	0.31	0.00	Huizhou	0.75	0.01	Ningyuan	0.85	0.18	Hanyang	0.80	0.67
Jianchang	0.63	0.00	Ji’an	0.67	0.01	Xuzhou	0.71	0.20	Huangzhou	0.70	0.71
Yanzhou	0.30	0.00	Zhaoqing	0.67	0.01	Xingyi	0.06	0.20	Yichang	0.70	0.72
Dading	0.31	0.00	Yuanzhou	0.68	0.01	Tongzhou	0.60	0.21	Haizhou	0.77	0.75
Taizhou	0.40	0.00	Shaoxing	0.60	0.02	Hezhou	0.31	0.22	Anqing	0.81	0.77
Taipingfu	0.59	0.00	Yuanzhou	0.75	0.02	Anshun	0.48	0.22	Shaowu	0.49	0.78
Yongchun	0.60	0.00	Suzhou	0.55	0.02	Huai’an	0.49	0.23	Xiangyang	0.90	0.79
Pingyue	0.45	0.00	Leizhou	0.54	0.02	Guiyang	0.43	0.23	Changde	0.94	0.84
Jinhua	0.25	0.00	Nanchang	0.79	0.03	Liping	0.73	0.24	Liu’an	0.66	0.86
Ruizhou	0.54	0.00	Longyan	0.86	0.03	Changzhou	0.71	0.25	Chenzhou	0.89	0.88
Nanning	0.66	0.00	Zhen’an	0.71	0.03	Kuizhou	0.79	0.25	Yunyang	0.84	0.89
Liuzhou	0.72	0.00	Yangzhou	0.48	0.04	Long'an	0.56	0.27	Yingzhou	0.75	0.90
Yongzhou	0.81	0.00	Funing	0.77	0.05	Si'en	0.84	0.27	Chizhou	0.85	0.93
Yulin	0.77	0.00	Guangzhou	0.70	0.05	Chuzhou	0.54	0.35	Luzhou	0.83	0.95
Fuzhou	0.70	0.00	Ningdu	0.79	0.05	Pingle	0.80	0.35	Fengyang	0.83	0.97
Guilin	0.76	0.00	Yuezhou	0.86	0.06	Sinan	0.77	0.35			

Notes: We report the probability (p-) values from prefecture-specific Augmented Dickey Fuller tests for a specification without drift (nd) and with drift (d) term. Since the price series show some upward trend over time, the specification with a drift seems logically more appropriate for these data. The 131 Southern prefecture series are in order of the p-value of the test with a drift term. This highlights two facts: (a) at the 10% level of significance, 54% of prefectures reject the null of a unit root based on the test with a drift; (b) at the same level of significance, no prefecture rejects the null of a unit root if we do not include a drift term.

Table F-4: Individual Time Series Unit Root Tests (North China)

Prefecture	nd	d	**Prefecture**	nd	d	**Prefecture**	nd	d
Runing	0.03	0.00	Xi'ning	0.46	0.06	Wuding	0.79	0.66
Chenzhou	0.03	0.00	Fenzhou	0.65	0.07	Shuoping	0.96	0.73
Guangzhou	0.04	0.00	Taiyuan	0.84	0.07	Fuzhou	0.69	0.73
Shanzhou	0.05	0.00	Laizhou	0.51	0.08	Xi'an	0.71	0.78
Xuzhou	0.05	0.00	Dingzhou	0.47	0.08	Jinan	0.81	0.81
Nanyang	0.30	0.00	Shenzhou	0.33	0.09	Caozhou	0.70	0.81
Jiangzhou	0.42	0.00	Hejian	0.48	0.15	Yanzhou	0.74	0.83
Henanfu	0.19	0.00	Ganzhou	0.46	0.22	Zunhuazhou	0.46	0.89
Puzhou	0.44	0.00	Suide	0.50	0.23	Baoding	0.64	0.97
Lanzhou	0.13	0.00	Shangzhou	0.20	0.23	Zhaozhou	0.77	0.97
Gongchang	0.08	0.00	Shunde	0.43	0.26	Tongzhou	0.88	1.00
Suzhou	0.17	0.00	Yan'an	0.59	0.27	Qianzhou	0.95	1.00
Huaiqing	0.18	0.00	Yizhou	0.54	0.27	Binzhou	0.92	1.00
Jiezhou	0.37	0.00	Zhangde	0.28	0.28	Fengxiang	0.94	1.00
Lu'an	0.72	0.00	Datong	0.82	0.29			
Pingliang	0.21	0.00	Guangpingfu	0.55	0.30			
Pingyang	0.60	0.00	Qingzhou	0.73	0.37			
Xuanhua	0.34	0.00	Yizhou	0.47	0.37			
Xizhou	0.41	0.00	Zhengding	0.41	0.39			
Qingyang	0.34	0.00	Yongping	0.66	0.40			
Ruzhou	0.34	0.00	Pingding	0.88	0.42			
Qinzhou	0.72	0.01	Dengzhou	0.79	0.43			
Qinzhou	0.31	0.01	Daizhou	0.73	0.43			
Ningxia	0.18	0.01	Tianjin	0.36	0.44			
Liangzhou	0.20	0.01	Xing'an	0.54	0.48			
Jiezhou	0.45	0.01	Baode	0.68	0.52			
Weihui	0.19	0.02	Guide	0.59	0.53			
Kaifeng	0.30	0.02	Ningwu	0.77	0.54			
Daming	0.32	0.03	Tai'an	0.63	0.55			
An'xi	0.15	0.03	Yulin	0.67	0.58			
Liaozhou	0.70	0.03	Hanzhong	0.62	0.62			
Zezhou	0.67	0.03	Dongchang	0.70	0.63			
Xinzhou	0.69	0.06	Jizhou	0.34	0.65			

Notes: We report the probability (p-) values from prefecture-specific Augmented Dickey Fuller tests for a specification without drift (nd) and with drift (d) term. Since the price series show some upward trend over time, the specification with a drift seems logically more appropriate for these data. The 80 Northern prefecture series are in order of the p-value of the test with a drift term. This highlights two facts: (a) at the 10% level of significance, 49% of prefectures reject the null of a unit root based on the test with a drift; (b) at the same level of significance, only 6 prefectures (8%) reject the null of a unit root if we do not include a drift term.

Table F-5: Cross-Section Dependence (North and South China)

Panel A: South China	(1)	(2)	(3)	(4)	(5)
Region CA		1.042 (0.041)***			
Skinner Region CA			1.054 (0.025)***		0.647 (0.046)***
Agro-Climatic Region CA				0.985 (0.022)***	0.443 (0.041)***
CD test	1089.92***	64.17***	-0.20	-4.31***	2.57***
Exponent α	0.991	0.709	0.449	0.271	0.275
RMSE	n/a	0.132	0.094	0.108	0.087
Prefectures	131	131	131	131	131
Obs.	103,247	103,247	103,247	103,247	103,247
Panel B: North China	(1)	(2)	(3)	(4)	(5)
Region CA		0.964 (0.050)***			
Skinner Region CA			0.959 (0.045)***		0.282 (0.144)*
Agro-Climatic Region CA				0.933 (0.038)***	0.737 (0.117)***
CD test	652.14***	29.40***	25.13***	31.77***	35.88***
Exponent α	0.993	0.655	0.604	0.644	0.651
RMSE	n/a	0.185	0.172	0.162	0.150
Prefectures	80	80	78$^{\sharp}$	79$^{\sharp}$	77$^{\sharp}$
Obs.	62,833	62,833	61,179$^{\sharp}$	62,081$^{\sharp}$	60,427$^{\sharp}$

Notes: We report robust Mean Group estimates on cross-section averages (CA) of grain prices using various geographic units, with standard errors computed following Pesaran and Smith (1995). The dependent variable is the seasonally-adjusted log monthly price for rice or wheat in prefecture *i* of region *r* (South or North), agricultural region *a* (following Buck, 1937), Skinner region *s* and time *t*. ***, ** and * denote 1%, 5% and 10% significance level, respectively. Average constant terms are estimated but not reported. CD test reports the results of the Pesaran (2015) test for cross-section dependence, which under the null of weak dependence is distributed standard normal. Column (1) reports the CD-test result for (seasonally-adjusted) observed prices (in logs). The exponent of cross-section dependence α (Bailey, et al, 2016) indicates strong cross-section dependence if $\alpha>1/2$. ♯ In the models with Skinner and agro-climate region CA for North China we have 2 and 1 prefectures, respectively, which are isolates (the only prefecture in the sub-region), so that we are forced to drop these prefectures from the analysis. Therefore in Panel B, column (5) we drop 3 prefectures. These results in column (1) of the respective panel reveal strong cross-section dependence in the log price series (CD statistics in the hundreds, Exponent close to unity), whereas in both Southern and Northern samples the approach using Skinner region cross-section averages in column (3) goes a long way to capture the strong common factors (CD test much reduced, Exponent below or close to 0.5).

G. Other Markets: Introduction

The following sections G-J contain supporting details related to the analysis of market integration in locations other than China reported in the main paper. Five datasets are examined. Our main focus is the discussion and analysis of price series from (1) late 18th and early 19th century England, in form of the *English Corn Returns*, which offer weekly wheat prices in 40 counties from 1770 to 1820. This focus allows for comparison of results for different data frequency (weekly, monthly) and their investigation avoids the pitfalls of low-frequency data analysis highlighted by Taylor (2001) and Brunt and Cannon (2014). We further analyse intra-national market integration using datasets (2) for monthly wheat prices of 20 markets in the Austrian Low Countries (Belgium) for 1765 to 1794, (3) for monthly wheat prices in 85 French départments for 1800 to 1872, and (4) for annual rye prices in 12 German markets for 1500-1800. Finally, we adopt two cross-national grain price series (5) for wheat covering 55 European markets from 1700 to 1820.

Following discussion and descriptive analysis of these price series, we estimate heterogeneous price convergence models of the type used for grain prices from China in the main paper. Results will again be in the form of 'convergence plots' for rolling window estimations, separately for each dataset and later combined results for Europe and China in one plot, which report estimated half-lives. A final plot reports half-life analysis for Chinese macro-regions compared with results for England, Belgium, and France.

While we discuss the background for each of the price series and country contexts, our treatment is no more than the bare bones. Readers are referred to relevant studies. We also limit our interpretation of the findings and leave further detailed analysis for future work.

The remainder of this appendix is structured as follows: Section H discusses the data sources and background for each of the national and European price series we use in our analysis. Section I reports and discusses the results, followed by a brief conclusion in Section J.

H Other Markets: Data Description and Background

H.1 The English Corn Returns

The analysis of market integration in England used the *English Corn Returns* (published in the *London Gazette*, the official government newspaper, between 1700 and 1914), specifically the weekly wheat prices from 1770 to 1820 collected and digitized by Liam Brunt and Edmund Cannon (henceforth BC). These are available from the History Data division of the UK Data Service. A detailed discussion of the *Returns* is in Brunt and Cannon (2013, 2014, and the respective supplementary appendices). Below we provide a brief overview of this resource.[6]

The British government compiled the *English Corn Returns* to monitor grain trade in England, Wales and Scotland to give effect to the Corn Laws, designed to regulate domestic grain prices from the 1690s until 1846.

In the first 20 years of the *Returns* local Justices of the Peace (JPs) collected prices from between two and six market towns in their jurisdictions and each week sent these to the Treasury in London. The identity of market towns from which these prices were drawn was not stipulated and most likely differed between weekly *Returns*. From 1789 onwards a system in place for London since 1781 was extended across the nation whereby Inspectors of Corn Returns were appointed in each designated market town to collect sworn records of 'all sales' of domestic produce (including wholesale and re-sale of grain which had already been traded in the market) and each week to forward (weighted) averages of these prices to the Receiver of Corn Returns in London. The identity of the monitored market towns was now fixed[7] and their number by county varied between two in Rutland and 12 in Norfolk. The Treasury-based Receiver calculated the county averages that were published in the *London Gazette*. This feature of the English grain price data is similar to our Chinese price series: spatial aggregation leads to an average price being recorded that we use in our empirical analysis. For English counties, the average is computed from a number of market towns, for Chinese prefectures from the highest and lowest price recorded at the prefecture level.

The recorded data for the 1770-1820 period are county average prices per (Winchester) bushel of grain in shillings and pence (converted to pence for analysis). We exclude London prices.

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6 Unless indicated, all of the statements below are based on the discussion in these articles and supplements.

7 For instance in Nottinghamshire prices were collected in Mansfield, Newark-on-Trent, Nottingham, Retford and Worksop.

Wheat was the staple food grain for the majority of English and Welsh consumers at the time. Although grain trade volumes are widely thought to have been under-reported in the *Returns*, BC argue that monitored and non-monitored grains were identical (in terms of quality and other attributes) and likely traded at the same price. Due to a high level of on-farm storage trade *volumes* for wheat – and hence prices – varied little throughout the year. Figure I-1 below show that despite storage the English wheat price series still display significant seasonal patterns.[8]

Data coverage for wheat prices in the 1770-1820 subsample is 99.7% (i.e. only 0.3% of county averages are missing). Potential causes for missing records are discussed in the Supplemental Appendix of BC (2013) and issues of data accuracy in BC (2013).

CB (2013) conclude the *Returns* constitute high quality data, despite several concerns about the level, trend and fluctuation of the price series covered. Two of these concerns, the underestimation of price fluctuations over time due to quality heterogeneity, and the absence of imported grain prices (again, related to grain quality), are relevant for but unlikely to impact our analysis of price convergence significantly. Changes in grain quality are not isolated to individual markets but are common across wider regions, so our empirical approach that accounts for cross-section dependence will capture the common shocks regardless of their magnitudes. The latter concern is relevant for the study of grain consumption but not the analysis of market integration.

In contrast to what we have argued for China, the period 1770-1820 witnessed substantial infrastructure improvements in English counties, including the expansion of the canal network and improvements to the road network (see BC, 2013: 112). The counties in the sample are listed in Table H-1.

[8] In our empirical implementation we include time (monthly) dummies to capture seasonal patterns.

H.2 Wheat prices in the Austrian Low Countries

From the middle of the 18th century onward the Austrian Low Countries' central government implemented a program to closely monitor local grain prices. Like in the Chinese and English cases, this effort was intended to organize an efficient food supply and move away from the past *ad hoc* management of food crises (Buyst, Dercon and Van Campenhout, 2006). Between 1765 and 1794, customs officials recorded the prevailing market prices for various agricultural products in a standardized fashion, which were passed reported weekly to specialized civil servants who oversaw the data collation process and compared the figures with those obtained from city governments. Although data collection was standardized, different cities used different measurement systems, so the specialized civil servants converted the data to a common unit – Brabantine *stuivers* per *razier* from Brussels (49 litres).

The wheat prices used in our analysis are those observed on the first market day of the month for all markets considered, as collated and recorded in Vandenbroeke (1973). The dataset comprises 20 markets with data available for almost all of the 360 months between 1765 and 1794. Buyst et al (2006: 188) report the markets covered "compose a representative sample of all large and medium-sized grain markets in the Austrian Low Countries" at the time. The markets are listed in Table H-2. Following Buyst et al, we prefer wheat over rye prices, which are also available in 18 markets for the same time period, due to wheat's higher value-to-weight ratio and thus higher incentives to profit from trade and arbitrage across markets. Road infrastructure during the sample period was improved between major towns from the mid-1750s onwards such that the Austrian Low Countries had "the highest paved road density in Europe" by the early 1790s (Buyst et al, 2006: 193).

H.3 Wheat prices in French départements

From Labrousse, Romano and Dreyfus (1970), we collect monthly average wheat prices in 85 departments for the period September 1800 to December 1872. All prices are in francs per hectoliter. Table H-3 lists the *départements*. Our sample covers nearly the entire French heartland with the exception of the following *départements*: *Alpes-Maritime, Corse, Mont-Blanc et Savoie* and *Leman et Savoie-Haute*. The sample includes *départements* such as Rhin or Rhin-Haute, which following the war with Germany in 1870 fell into German hand such that their time series end in

August 1870. The data tables in Labrousse et al (1970) are divided into 1800-1805 covered by the French Republican Calendar (FRC)[9] and 1806-1870s in the standard Gregorian calendar. In order to convert the FRC values into the time frame of the remainder of the data we weight the value of the previous FRC month by 2/3 and that of the present FRC month by 1/3 to arrive at the present Gregorian month value. The maximum time series is 867 months and our coverage is 99.4% (i.e. only 0.6% missing values – worst coverage is for the *départements Seine*, 733 observations, and *Tarn-et-Garonne*, 768 observations).

Nineteenth century France was the foremost producer of wheat in Europe, with output several times that of England, and globally ranked second behind the United States (Roehner, 1994). Daudin (2010: 717) writes that late 18th century France had "higher trade costs than Britain due to smaller density, geography, internal barriers, limited development of new methods of distribution and more limited investment in transport infrastructures." Our sample period largely predates the "ambitious plan of repairing and extending inland navigation" and the dominance of rail transport, with canals still the "principal means of transport" (Ejrnæs and Persson, 2000: 153).

H.4 Rye prices in Germany

We adopt annual average prices for rye from Rahlf (1996, Appendix Table A1), available online at the GESIS Leibniz Institute für Sozialwissenschaften (www.gesis.org/histat). These prices have been converted into grams of silver per hectoliter by the author. The 12 cities in our sample are: Aachen, Augsburg, Danzig (Gdansk), Düren, Frankfurt, Köln, Leipzig, München, Speyer, Strassburg, Würzburg and Xanten. Prices in local currency and measures are available for 16 cities, but due to lack of silver exchange rates we do not have data for Braunschweig, Lüneburg, Hannover, and Münster. The geographic distribution of markets is skewed toward the Rhineland and surrounding areas (the focus of analysis in Rahlf, 1996) as well as Southern Germany (Augsburg, München, Würzburg), whereas only two markets, Leipzig and the Prussian city of Danzig, are available for North and East Germany. One difficulty with these price series is the differential definition of the time dimension, which for Aachen, Augsburg, Düren, Frankfurt, Köln, Leipzig, München, Speyer, and Würzburg is the harvest year, whereas for the three remaining cities

[9] This divides the year into 30-day periods, with the year running from Vendemiaire in the autumn to Fructidor in late summer.

data are based on the calendar year. In order to adjust for this difference the former are transformed by taking averages for two consecutive years, as suggested in Phelps-Brown and Hopkins (1959).

The time series of these data cover 1500 to 1800 (with some gaps), thus including the period of the 30-year war from 1618-48.

I.5 Allen and Unger's data for wheat prices in European markets

The cross-European prices are taken from the Global Commodity Prices Database collated by Bob Allen and Richard Unger – online access at www.gcpdb.info. All prices have been converted into grams of silver per litre by the data providers. The list of markets for our analysis of wheat prices is contained in Table H-4. Our sample selection was exclusively based on data availability over the long time horizon, requiring each market to have data for at least 50% of the 121 observations between 1700 and 1821. Like the German price series, the Allen and Unger data is a mix of prices reported for the harvest and calendar year; we adjusted the harvest years using the same methodology as above. Classification of markets into these two categories was somewhat more cumbersome: we relied in part on Bateman's (2007) previous findings, some investigation of the original sources as well as some educated guesswork. Table H-4 provides additional information on this issue.

Table H-1 List of English and (one) Welsh Counties in the *English Corn Returns*

Bedfordshire	Lincolnshire
Berkshire	Middlesex
Buckinghamshire	Monmouthshire (Wales)
Cambridgeshire	Norfolk
Cheshire	Northampton
Cornwall	Northumberland
Cumberland	Nottingham
Derbyshire	Oxford
Devon	Rutland
Dorsetshire	Salop (Shropshire)
Durham	Somerset
Essex	Stafford
Gloucestershire	Suffolk
Hampshire	Surrey
Herefordshire	Sussex
Hertfordshire	Warwick
Huntingdonshire	Westmorland
Kent	Wilts
Lancashire	Worcester
Leicestershire	York

Notes: These are the 39 English and 1 Welsh counties for which data covers 1770-1820.Our sample excludes London.
Source: Note to 'History Data Service, SN 4383 Weekly British Grain Prices from the London Gazette, 1770-1820'

Table H-2 List of Markets in the Austrian Low Countries data

Antwerp	Lier
Ath	Mechelen
Binche	Mons (Bergen)
Bruges	Namur (Namen)
Brussels	Nieuwpoort
Charleroi	Oostende
Ghent	St. Niklaas
Ieper (Ypres)	Tienen
Kortrijk	Tournai (Doornik)
Leuven	Veurne

Notes: The 20 market locations covered in the analysis of the Austrian Low Countries. This sample includes the 18 markets analysed in Buyst, Dercon and Van Campenhout (2006) and additionally Oostende and Nieuwpoort.
Source: Vandenbroeke (1973)

Table H-3 List of French *départements*

Department	Obs	Department	Obs
Ain	793	Loiret	794
Aisne	794	Lot	791
Allier	794	Lot-et-Garonne	791
Alpes-Basses	793	Lozere	792
Alpes-Hautes	793	Maine-et-Loire	794
Ardeche	793	Manche	794
Ardenne	792	Marne	791
Ariege	793	Marne-Haute	787
Aube	786	Mayenne	794
Aude	793	Meurthe	785
Aveyron	794	Meuse	786
Bouches-du-Rhone	794	Morbinhan	794
Calvados	794	Moselle	767
Cantal	794	Nievre	794
Charante	794	Nord	792
Charante-Inferieure	794	Oise	794
Cher	794	Orne	794
Correze	793	Pas-de-Calais	794
Cote d'Or	792	Puys-de-Dome	793
Cotes-du-Nord	792	Pyrenees-Basses	794
Creuse	794	Pyrenees-Hautes	793
Deux-Sevres	794	Pyrenees-Orientales	793
Dordogne	794	Rhin-Bas	765
Doubs	793	Rhin-Haute	767
Drome	794	Rhone	791
Eure	794	Saone-Haute	788
Eure-et-Loire	790	Saone-et-Loire	794
Finistere	794	Sarthe	794
Gard	794	Seine	639
Garonne-Haute	792	Seine-Inferieure	794
Gers	793	Seine-et-Marne	794
Gironde	794	Seine-et-Oise	787
Herault	794	Somme	794
Ile-et-Vilaine	794	Tarn	794
Indre	791	Tarn-et-Garonne	704
Indre-et-Loire	794	Var	792
Isere	794	Vaucluse	794
Jura	792	Vendee	793
Landes	794	Vienne	794
Loire	789	Vienne-Haute	792
Loire-Haute	794	Vosges	793
Loire-Inferieure	794	Yonne	794
Loire-et-Cher	792		

Notes: The 85 departments covered in the analysis of wheat prices in France, with the second columns indicating the number of available observations.
Source: E. Labrousse et al (1970)

Table H-4: Sample Make-up – Wheat Prices in Europe (Allen and Unger data)

market	Obs	H	C	Source	market	Obs	H	C	Source
Aix	90		X	Baehrel (1961)	Madrid	88		X	Bateman (2007)
Amsterdam	108		X	Bateman (2007)	Marseilles	89		X	Baehrel (1961)
Ancona	112		O	not in HCPP	Milan	120		O	
Angers	90		X	Bateman (2007)	Munich	63	X		Bateman (2007)
Antwerp	80		X	HCPP	Nancy	121		O	
Arles	87		X	Baehrel (1961)	Naples	98		O	
Arnhem	121		O		New Castile	88		O	
Augsburg	91	X		Elsas (1936)	Paris	115		O	
Avignon	90		O	not in Baehrel	Pesaro	113		O	
Barcelona	109		X	Feliu (1991)	Pisa	119		O	
Bassano	88		O		Porto	71			
Bilbao	117	X		HCPP	Rennes	71		X	Hauser (1936)
Brescia	97		O		Senigallia	90		O	
Chateau Gonier	87		X	Hauser (1936)	Siena	66		X	Bateman (2007)
Cologne	94	O			Strasbourg	119		O	
Danzig	114	O		not in HCPP	Toulouse	93		X	Bateman (2007)
Douai	90		O	unknown	Tours	113		O	
Draguignan	91		X	Baehrel (1961)	Tuscany	121		O	
Dresden	70	O			Udine	121		O	
Edinburgh	81	O			Utrecht	92		O	
Eton	117	X		Mitchell (1971)	Valencia	90		X	Bateman (2007)
Exeter	113	X		Bateman (2007)	Vienna	101	X		Bateman (2007)
Frankfurt	82	X		Elsas (1936)	Warsaw	61	O		
Grenoble	79		X	Bateman (2007)	Weyer	83	O		
Konigsberg	79	O			Winchester	117	X		Bateman (2007)
Krakow	90	O			Windsor	102	O		
Leipzig	121	X		Bateman (2007)	Wurzburg	82	X		Bateman (2007)

Notes: Obs is the annual observations for each of the 55 markets used in the wheat price analysis for 1700-1820. We next show whether the market price series is for the harvest year (H) or the calendar year (C). We use an X if a known source is identified, reported in column Source. As not all markets are covered, we allocate markets for which we were unable to establish the nature of the price series based on a simple rule that the harvest cycle group is likely to conform to the pattern for other markets in the same economy. To distinguish these markets we label them with O. HCPP stands for the UK Government House of Commons Parliamentary Papers 1826-27.
Source: ?? Allen and Unger *Global Commodities Prices Database*

I Other Markets: Empirical Results

Raw price series in the different countries are graphed: Figure I-1 shows the seasonality in each of our monthly datasets, for English counties, Belgian markets and French departments. Although all three price series are for wheat, the seasonality for the French data differs from the other two countries: prices peak in May, rather than August, with lowest prices in September rather than December (England) and March (Belgium). Figures I-2 and I-3 report median and individual department/market/county price movements over time for each of the national and Europe-wide samples.

We begin our regression analysis with the English county data for which rolling window convergence regression results are presented in Figure I-4 (weekly data, top panel; monthly data, bottom panel).

The solid line with the gray shaded area in the weekly data plot is for a 5-year rolling window (including 95% confidence interval), so that the first end-year observed is 1774.[10] The early and late periods indicate persistent levels of market integration, with convergence coefficient of -0.1 equating to a half-life of around 1.6 months; the middle period for the 20 years between 1785 and 1805 show a marked increase in market integration. In the background of the graph we indicate plots for 10- and 20-year windows, starting in 1779 and 1789, respectively. As one would expect, these smooth the 1785-1805 period, but all three sets of results agree on a comparatively high level of market integration with fast price convergence and low half-lives.

The monthly data series were constructed by picking the reported prices for the first weekly observation each month. We use the observed values instead of an average because time averaging can introduce substantial bias into the price convergence estimate (see Taylor, 2001; Brunt and Cannon, 2014). The choice of the first week each month is arbitrary; the results for later weeks are qualitatively unchanged. The noticeable U-shaped pattern over time is maintained if we move from weekly to monthly data in the lower panel of the Figure, regardless of whether we use a 10-year (solid line, shaded 95% confidence intervals) or 20-year (short-dashed line) windows. A half-life

[10] This analysis is based on around 250 observations per ‘window,’ thus very similar in that respect to the twenty-year moving window in our analysis of Chinese prefectures. Note however that price analysis and the dynamics of time series more generally are known to depend on the time span of the sample, which is our motivation to provide alternative estimates for 10- and 20-year windows throughout this appendix.

estimates of 2.4 months in the early and late sample periods can be computed from a -0.25 convergence coefficient in these monthly data, which is slightly larger than in the weekly data.

We present two rolling window estimates for our Belgian wheat price data in Figure I-5: the solid line with 95% confidence interval is for the 10-year window, the dashed line for the 20-year window. Both results indicate a high and relatively stable level of market integration in the second half of the 18th century. On average the half-life amounts to merely 1.5 months, which comparable to or *even shorter* than in our monthly English county data.

The finding that, based on these results for monthly price series, Belgian market integration was seemingly superior to that of England in the late 18th century may appear suspect. Two issues are worth noting in this context: first, those regions where agriculture was not well developed, namely Limburg and Luxembourg, where subsistence farming dominated and market efficiency was likely lower than in the rest of the country, are not part of our Low Country sample; second, our comparison here investigates the rather *compact* region of the Southern Low Countries (East-West expanse from Tienen to Nieuwpoort around 100 miles, North-South expanse from Antwerp to Binche around 50 miles), with that of English counties where the distances involved are substantially larger (East-West from Norfolk to Cornwall around 350 miles, North-South from Northumberland to Devon around 320 miles). When we restrict the English sample to the 15 counties of the South-East (all counties to the East of the quarter-circle from Norfolk to Hampshire, comparable if still larger in size than the Austrian Low Countries), the convergence rate among these markets is *on par* with that of our Belgian sample (results available on request).

The results for our French sample of 85 departments are presented in Figure I-6. We focus on the 10-year rolling window of monthly observations (solid line with 95% confidence interval; first end-year 1809) but also plot the results for a 20-year rolling window (dashed line; first end year 1819). Market integration witnessed some improvement in the first decades of the sample and then stayed fairly stable at around -0.1, equivalent to a 6.6 month half-life, until the mid-1850s, whereupon it improved persistently until the end of the sample period in 1872.

This completes our analysis of monthly or weekly price series. The following results for German and cross-European markets are based on *annual* average prices. From a theoretical standpoint, we know that this is likely to induce downward (upward) bias in the estimated convergence parameters (half-lives).

Price series for rye in a number of German markets are analysed in Figure I-7 – these are annual data and the rolling window measures 60 years, with the first end year in 1559. The graph plots convergence estimates together with respective 95% confidence intervals over three centuries. The impact of the Thirty Years War is quite marked in these results, with a comparatively flat curve of convergence regression estimates beginning to rise (i.e. market integration to deteriorate) from the early 1620s onwards,[11] until around two decades after the end of the war in 1648;[12] thereafter market integration steadily increased to reach 16th century levels in the 1750s. A convergence coefficient of -0.6 during much of the early and late sample period equates to a half-life of about 9 months.

Cross-European markets for wheat are analysed in Figure I-8, suggesting almost unaltered high levels of integration throughout this 121-year period (1759 is the first end-year for our 60-year moving window). We show the rolling window speed of convergence estimates for the *unadjusted* price series (ignoring the difference between harvest and calendar year data) using dashes, which yields very similar patterns and magnitudes. An estimated speed of convergence of -0.5 implies a half-life of around 12 months.

In Figure I-9 we bring together the results for all of the above markets and samples in a single graph. Since we cannot easily compare the speed of convergence for data observed at different frequency, we instead compute the half-life in months for each of the samples. Starting at the bottom of the graph, we find the English counties, the markets with the highest level of integration, followed by the other national samples for Belgium and France. Although we see a difference between the weekly (we adopt the 5-year window) and monthly (we adopt the 20-year window) data results for England, these estimates still suggest that use of monthly data does not *vastly* overestimate the half-life of grain price integration during the late 17th and early 18th century. The results for (cross-) European markets indicate lower levels of market integration (half-life around one year) than the national markets, which is not surprising given the significant cultural, political and climatic heterogeneity, not to mention distances, reflected in our European sample.

[11] This finding of a delayed impact of the Thirty Year War is in line with the discussion in Abel (1980: 153f), though by the late 1630s parts of central, west and south Germany were severely affected by a double-blow of famine and bucolic plague, claiming more than half the inhabitants in some towns and villages.

[12] The effects of the conflict, which had cost the lives of around 40% and 30% of the rural and urban population, respectively, was felt for several decades, with farm hands in short supply and demanding high wages (Abel, 1980: 156). In Northern Germany (not in our sample), it is suggested that even as late as the 1690s over one third of the arable land prior to the war was not under cultivation (ibid: 181).

Crucially, our two Chinese samples clearly differ in their secular evolution of market integration from the other samples which were analysed using *identical* methodologies, and in case of the English (monthly), Belgian and French price series, *identical* data frequency. While the levels of market integration in the 1750s were comparable between China's North and South on the one hand and the European markets on the other, China witnessed a secular decline in market integration which reached its 'peak' in the early 19th century, when Northern (Southern) Chinese markets had estimated half-lives roughly 15 (five) times those of European markets. This contrast is even starker if we compare results for our Chinese samples with those for the national samples of Belgium, France and England. At the end of the Qianlong reign in 1795 the Southern and Northern Chinese markets had half-lives around six and 12 times those of English markets, respectively. By 1810 these already substantive ratios had further increased to half-lives roughly 22 and 78 times those of the English markets.

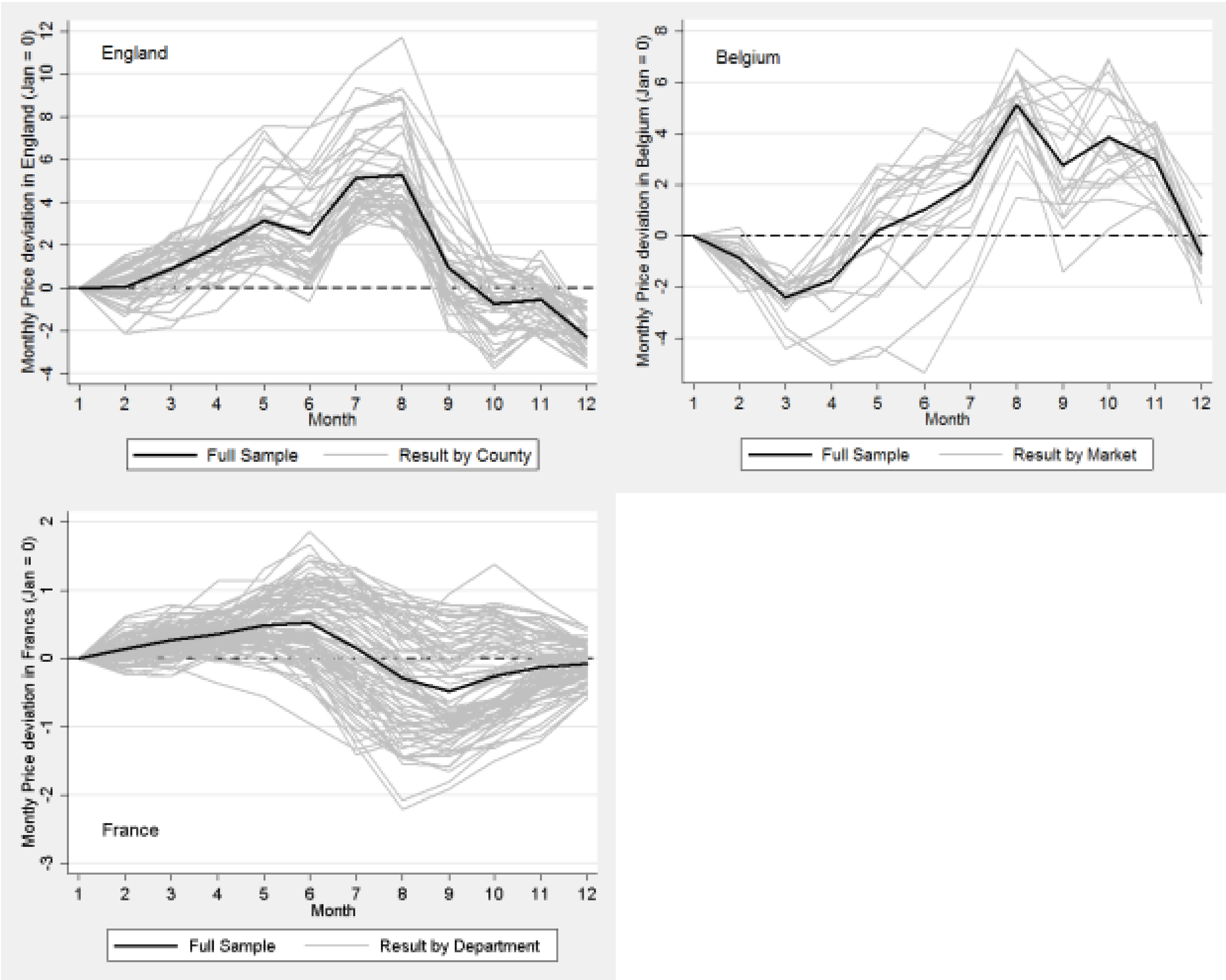
In our final illustration in Figure I-10 we compare the half-lives estimated from *monthly* national samples for wheat prices in England, Belgium and France with those for rice and wheat in Skinner (1977) macro-regions of China. In each case for China convergence is to the respective macro-region, following Pomeranz' (2000: 22) suggestion that until the 1780s "markets worked well" within these economic units. Our first observation is that the findings for the aggregate Northern and Southern regions are not an artefact of individual outlier (or outlying) regions, given that the secular decline in market integration can be see for all macro-regions analysed.[13] Further, the relative ranking of regions in terms of market integration, with Lower and Middle Yangzi macro-regions coming top at the start and end of our sample period, chimes with widespread recognition in the literature that these represent the economically most advanced regions of Qing China, whereas (at least until the 19th century) the frontier region of Northwest China has comparatively much lower levels of market integration. Finally, the evolution of the Lingnan and Upper Yangzi regions are worth highlighting: the former is unexpectedly low down the order of macro-regions in terms of half-life, while the latter tops the rankings from around 1790 to 1808. It should be noted that our Upper Yangzi (Sichuan) sample comprises only 11 prefectures, which may at least in part account for this unexpected finding. For Lingnan, we could point to Marks' (1998)

[13] This graph excludes the two prefectures of Northern China, which are not part of the North or Northwest macro-regions; it also excludes the Guizhou prefectures. which are part of the Yungui macro-region since these amount to a mere seven prefectures.

finding of no correlation between rice prices in Wuzhou and Guangzhou, despite “the documentary evidence of massive grain flows” (263) between the Guangxi trading hub and centre of the Pearl River Delta. Marks’ finding already somewhat questions the validity of the assumption/notion of an integrated market between grain surplus Guangxi and the grain deficit Guangzhou/Pearl River Delta regions of Lingnan through the Wuzhou trading hub, and so it may be for this reason of separated markets that we find a comparatively lower level of market integration for Lingnan.

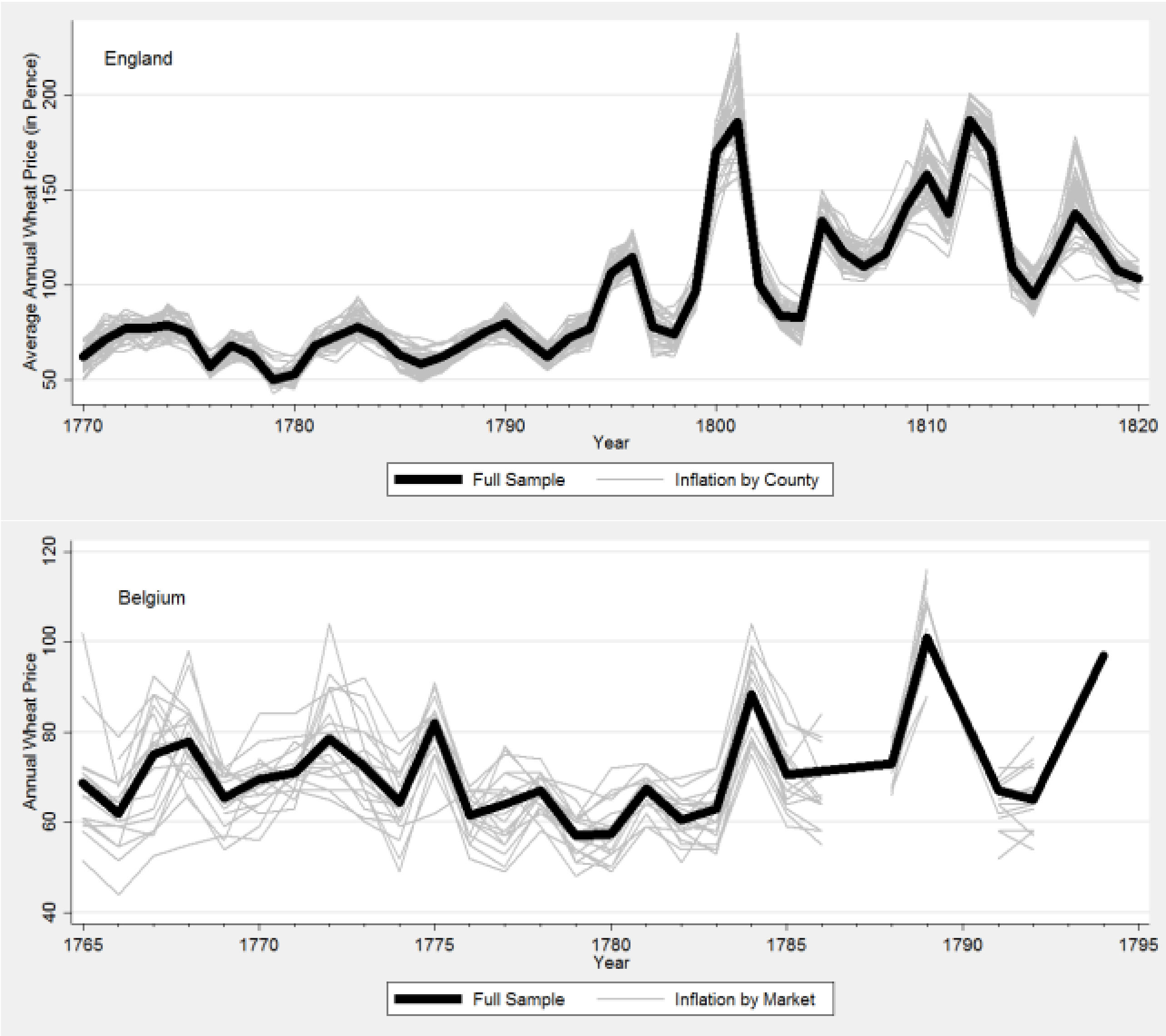
A brief comparison for 1795 and 1810 finds Lower and Middle Yangzi as well as the Southeast China macro-regions with half-lives roughly five-fold, Upper Yangzi merely four-fold, Lingnan nine-fold and Northern China in excess of 10-fold those of English counties. By 1810 these figures range from factors eight (Southeast China) to 50 (North China).

Figure I-1: Seasonality in Price Behaviour (English, Belgian and French Data)



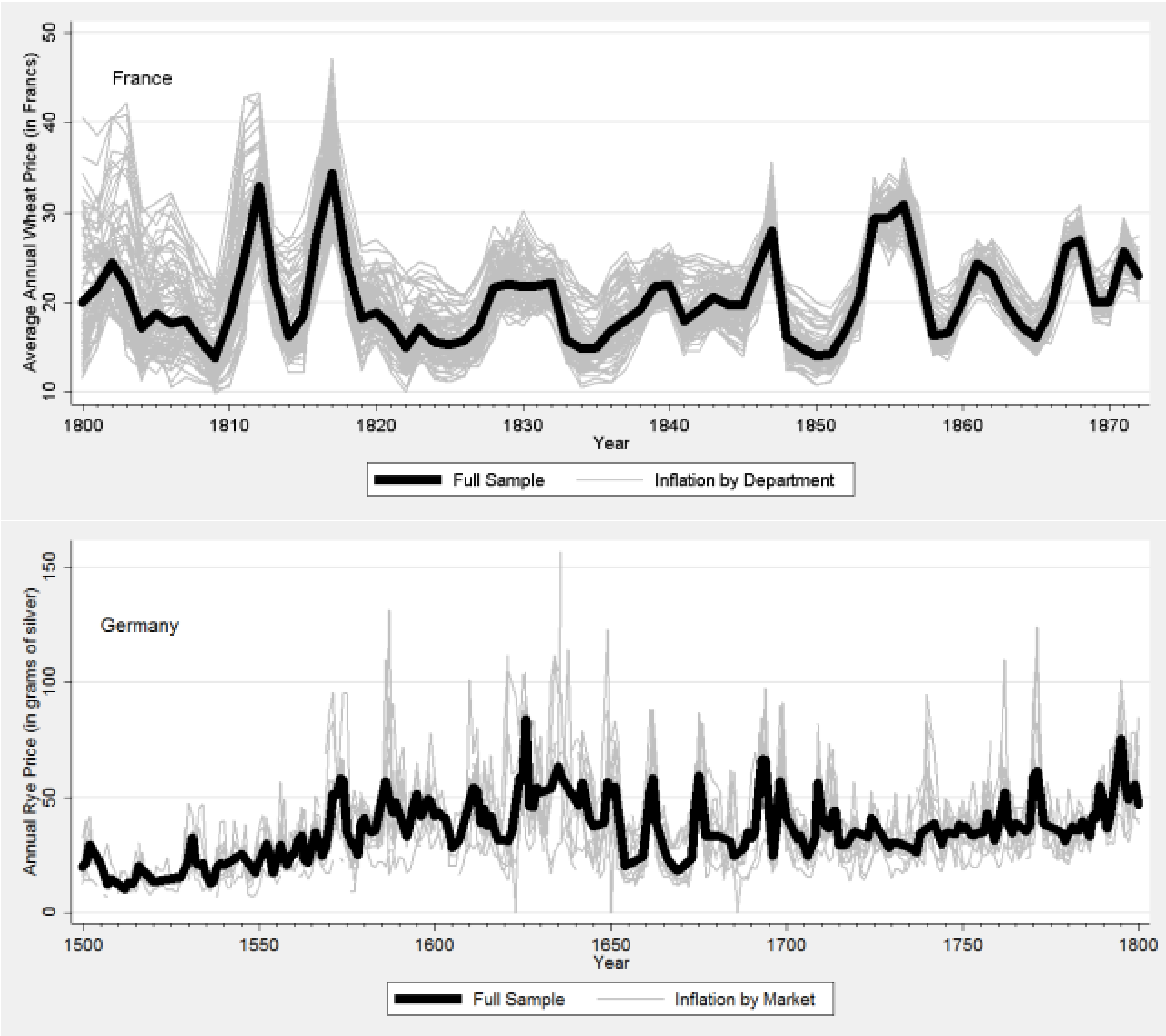
Notes: We plot the deviations from January prices in England, Belgium and France derived from prefectural regressions of monthly grain prices on dummies for the month (January is the benchmark/omitted category). We chart the pooled result for all markets in each plot using a thick black line, as well as results estimated by location/market using thin grey lines. The English results use weekly data, the Belgian and French monthly data. The mean price in England, Belgium and France over the entire time horizon used is 95.08 (pence), 70.38 (Brabantine stuivers), and 20.74 (francs) respectively. In all three countries the maximum deviation *from* the mean price is around 10%, whereas focusing on the deviation *in* the mean price we have a maximum deviation of just below 6% (England), 7% (Belgium) and 2.4% (France).

Figure I-2: Price Movements – National Samples



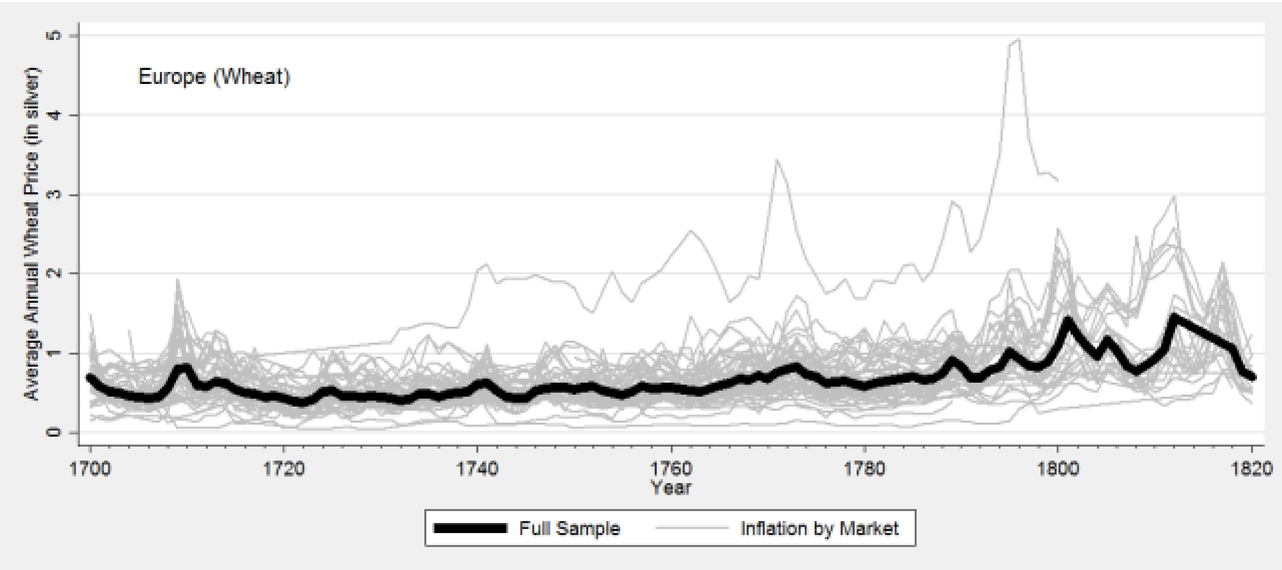
Notes: Continued overleaf

Figure I-2: continued



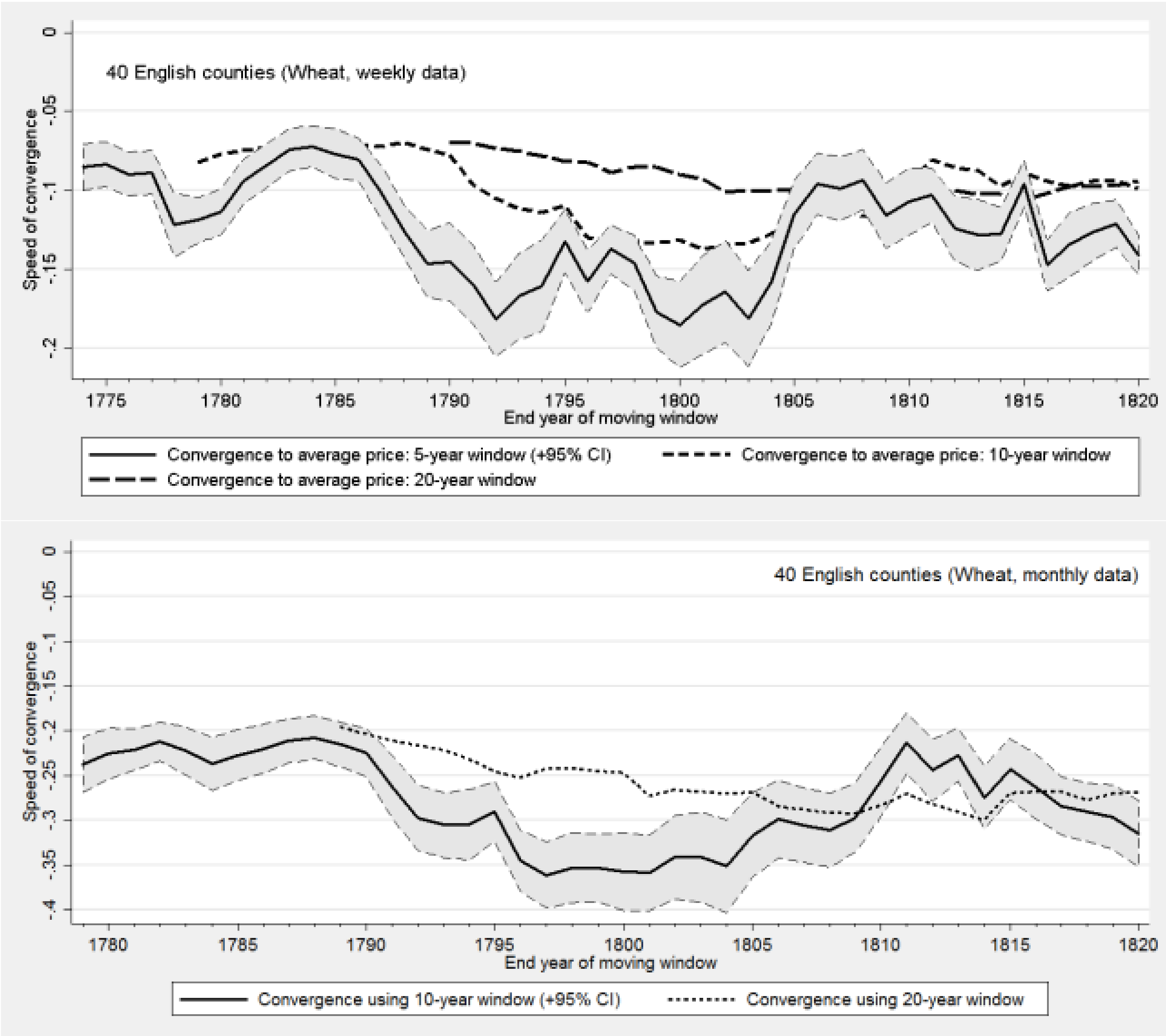
Notes: We plot the median *annual* price movement for the English (weekly), Belgian and French (monthly), and German (annual).

Figure I-3: Price Movements – European Samples



Notes: We plot the market-specific annual observed and European *median* annual prices for wheat. We omit series for Tuscany and Udine for ease of illustration.

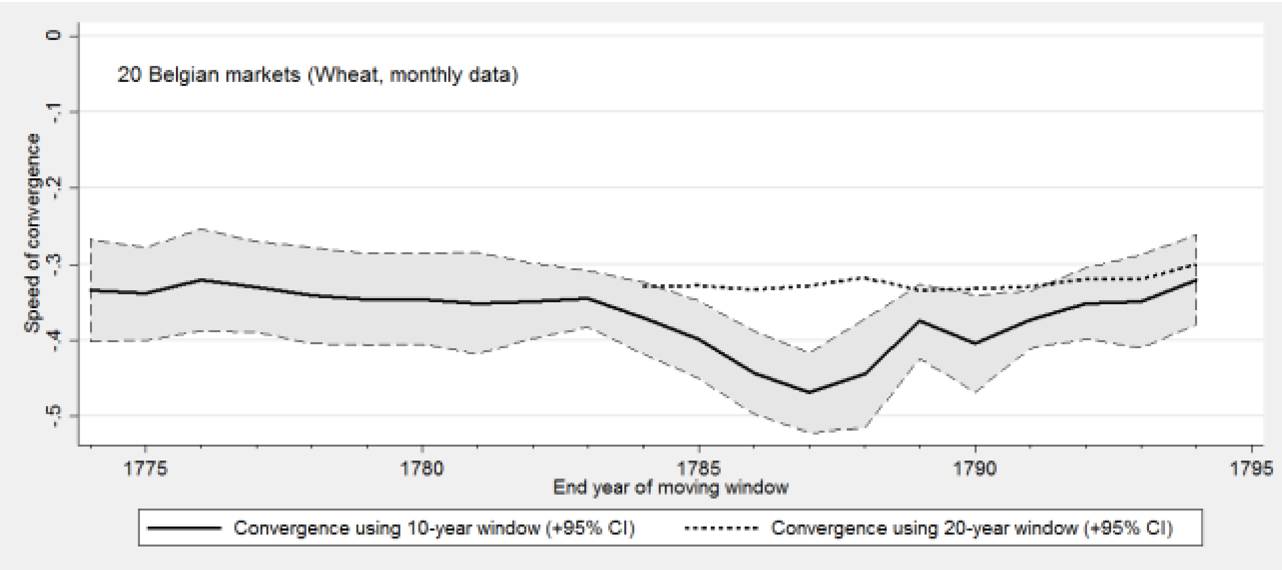
Figure I-4: National Convergence –Wheat Prices from 40 English Counties



Notes: We plot the convergence coefficients from analysis of English wheat prices from 40 counties using a 5-year, 10-year and 20-year (20-year) rolling window for the weekly (monthly) data as described in the text. The 10- and 20-year plots for the weekly data are deliberately placed in the background to indicate how they smooth out the idiosyncracies of the shorter rolling window – 5 years of weekly data amounts to around 250 observations, thus very similar to 20 years of monthly data.

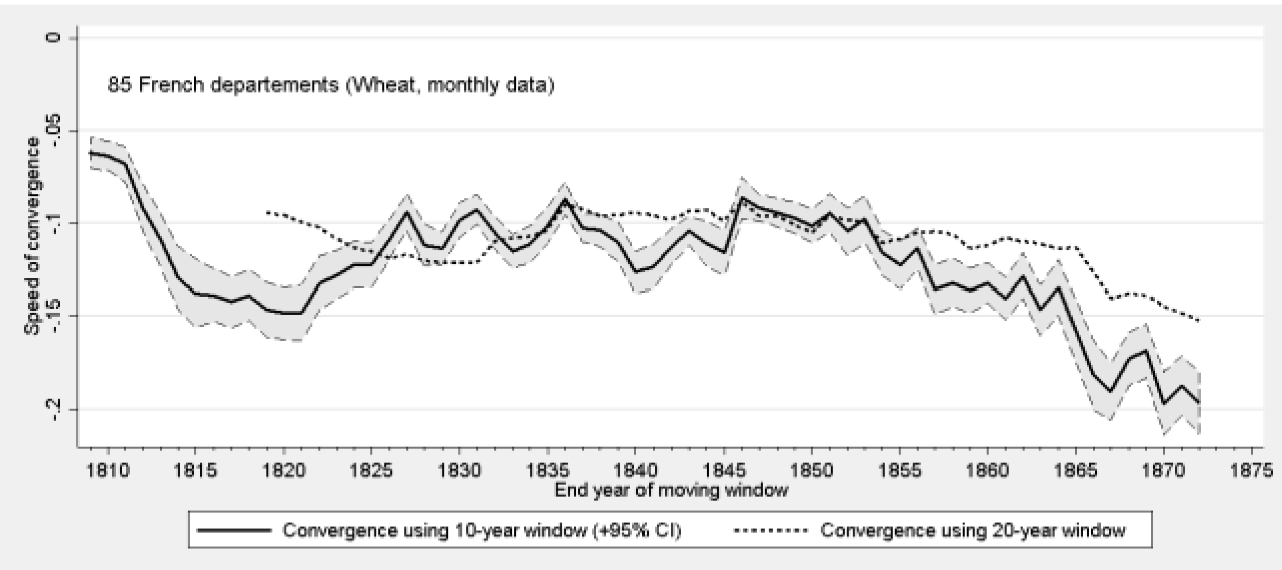
The cross-section averages (CA) employed here are computed from the wheat prices within all 40 counties. The solid line indicates convergence to this national average, 95% confidence intervals are also marked. For a convergence coefficient of -0.1 in the weekly data the estimated half-life amounts to 1.6 months; in the monthly data the convergence coefficient of -0.25 equates to a 2.4 month half-life.

Figure I-5: National Convergence – Monthly Wheat Prices from 20 Belgian markets



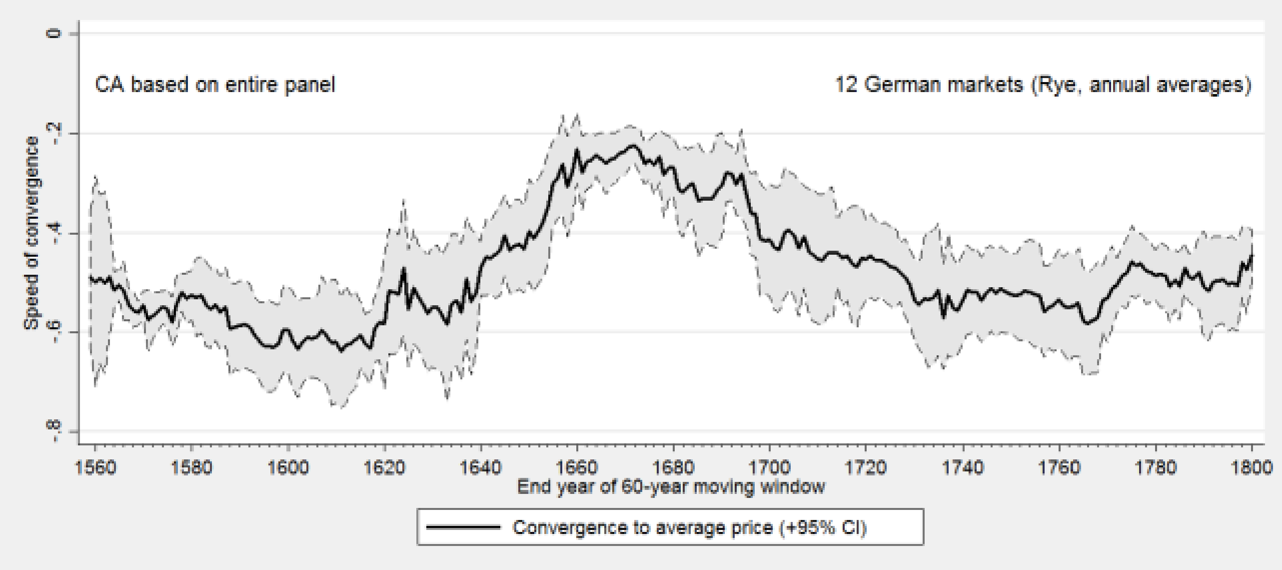
Notes: We plot the convergence coefficients from analysis of Belgian wheat prices from 20 markets using a 10-year rolling window as described in the text. End years of these rolling windows are marked on the x-axis. The cross-section averages (CA) employed here are computed from the wheat prices within all departments The solid line indicates convergence to this national average, 95% confidence intervals are also marked. For a convergence coefficient of -0.35 the estimated half-life amounts to 1.6 months.

Figure I-6: National Convergence – Monthly Wheat Prices from 85 French *départements*



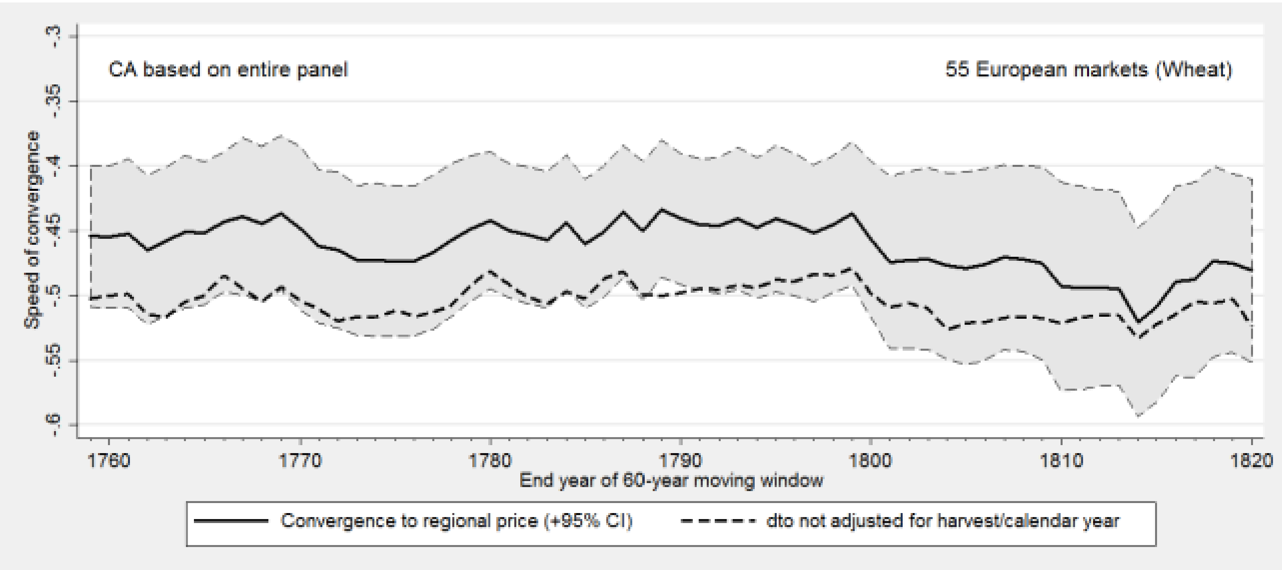
Notes: We plot the convergence coefficients from analysis of French wheat prices from 85 départements using a 10-year rolling window as described in the text (solid line), including 95% confidence intervals. End years of these rolling windows are marked on the x-axis. The cross-section averages (CA) employed here are computed from the wheat prices within all 85 departments The dashed line indicates the convergence result if we pick a 20-year window. For a convergence coefficient of -0.1 the estimated half-life amounts to 6.6 months.

Figure I-7: National Convergence – Annual Rye Prices from 12 German Markets



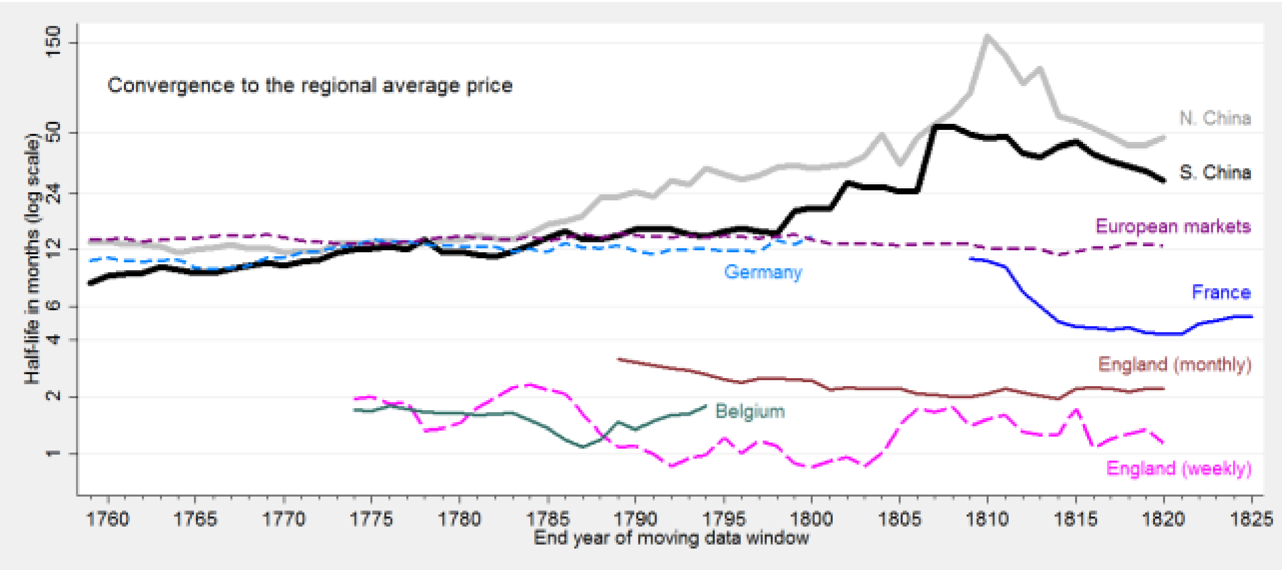
Notes: We plot the convergence coefficients from analysis of rye prices from 12 markets in Germany, using a 60-year rolling window. End years of these rolling windows are marked on the x-axis. The cross-section averages (CA) employed here are computed from the respective prices within all locations The solid line indicates convergence to the Germany-wide average, 95% confidence intervals are also marked.

Figure I-8: European Convergence – Annual Wheat Prices from 55 Markets



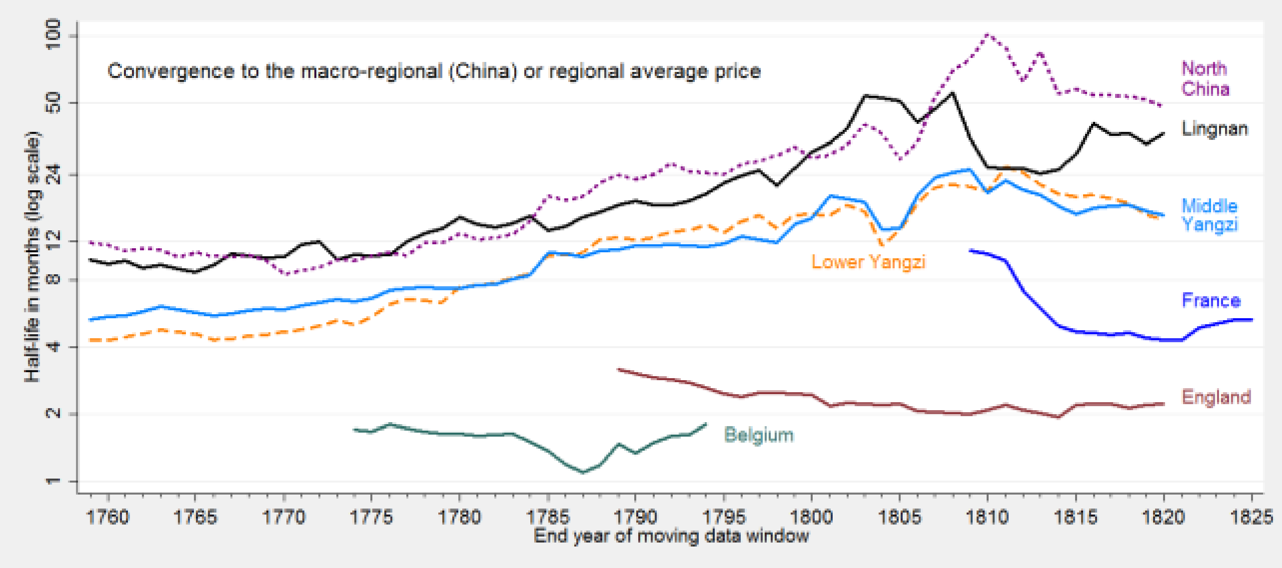
Notes: We plot the convergence coefficients from analysis of European wheat prices from 55 markets, using a 60-year rolling window. End years of these rolling windows are marked on the x-axis. The cross-section averages (CA) employed here are computed from the respective prices within all locations The lines indicate convergence to the Europe-wide average, where we distinguish results for the price series adjusted for harvest/calendar year deviations (solid line) and for the prices as reported in Allen and Unger (dashed line); 95% confidence intervals for the former are also marked. For a convergence coefficient of -0.45 with annual data the estimated half-life amounts to 13.9 months.

Figure I-9: Comparison of Chinese and European Grain Price Convergence



Notes: We plot the mean half-lives based on robust mean convergence coefficients from the analysis of eight different samples (we have results for weekly and monthly English county data). This graph combines the results from the previous analysis but for illustrative purposes limits the time window to the second half of the 18th and early 19th century (our Chinese data starts in 1740, rolling window analysis thus has 1759 as the first end year). The results for Belgium, England, European markets, France, and North China are based on wheat prices, those for South China are for rice and the German results are for rye. Only the data for Belgium, Germany and Europe are for specific named markets rather than regions. Data for Belgium, England (as indicated), France, and China are monthly, German and European market series are annual. We also include results for the weekly English county series. Since the comparison of speed of convergence is difficult when data frequency differs we plot the equivalent half-life for each convergence result (note that the *y*-axis is on a logarithmic scale), indicating the length of time (here reported in years) necessary for half the impact of a shock to dissipate. Thus the *longer* the half-life, the *slower* is price convergence to the equilibrium. These results are based on rolling windows of 60 (annual German and European data), 20 (Chinese and English monthly data), 10 (French and Belgian monthly data) and 5 (weekly English county data) years. Results for alternative window length are contained in the previous plots and are qualitatively very similar.

Figure I-10: Comparison of Macro-Regional Grain Price Convergence



Notes: We plot the mean half-lives based on robust mean convergence coefficients from the analysis at the Skinner (1977a) macro-region level; each of the Chinese sub-samples is analysed separatedly for convergence to the macro-region mean. For comparison we also plot the half-lives for our English, Belgian and French wheat price series, which amount to 40 counties, 20 markets and 85 departments, respectively. For Chinese samples, all solid lines are for macro-regions in South China using rice prices: 'Lower Yangzi' (24 prefectures), 'Middle Yangzi' (MY, 43 prefectures), 'Upper Yangzi' (11 prefectures), 'Lingnan' (24 prefectures), and 'Southeast China' (16 prefectures); dashed lines are for the two major macro-regions in North China using wheat prices – these regions are called are 'North China' (49 prefectures) and 'Northwest China' (NW, 29 prefectures). Further details about the macro-regions are contained in Section A of this Online Appendix. All price series underlying the results presented in this graph are at monthly frequency. In all cases the rolling windows are 20 years long, except for France and Belgium where we adopt a 10-year window to maximise the number of estimates in our period of interest. Results for alternative window length are contained in the previous plots and are qualitatively very similar.

J Other Markets: Conclusion

We have discussed and analyzed of grain price datasets from Europe in order to compare their market efficiency with that of our samples for South and North China prefectures analysed in the main paper. The comparative analysis provide illustrate strongly both the *vast difference* between China and European levels of market integration on the eve of Western industrialization as well as the *pervasiveness* of the relative deterioration in market integration across different macro-regions of Qing China. While markets in China were progressively becoming less integrated, those in Europe were trending in the opposite direction. Thus, we find in contrast to the existing empirical literature that compares China and Europe, to rephrase the general consensus summarised in Sng (2014), *all was not well and good* with regards to market integration in eighteenth century China. Markets were disintegrating.

K Common Correlated Effects Estimation

We can provide the intuition for the Pesaran (2006) CCE approach in three simple steps, assuming for illustration a single factor f_t and the absence of serial correlation (a simplified version of equation (2) in the maintext):

$$\Delta\tilde{p}_{it} = \beta_i\tilde{p}_{i,t-1} + \gamma_i f_t + \varepsilon_{it}, \tag{2'}$$

First, at each point in time we take the cross-section average of equation (2'): $\Delta\bar{\tilde{p}}_t = \bar{\beta}\bar{\tilde{p}}_{t-1} + \bar{\gamma}f_t$, with $\bar{\varepsilon}_t = 0$ since ε_{it} is white noise. Next, we solve the resulting equation for the common factor: $f_t = (1/\bar{\gamma})[\Delta\bar{\tilde{p}}_t - \bar{\beta}\bar{\tilde{p}}_{t-1}]$. Finally, we plug this back into equation (2') to yield:

$$\Delta\tilde{p}_{it} = \beta_i\tilde{p}_{i,t-1} + (\gamma_i/\bar{\gamma})\left[\Delta\bar{\tilde{p}}_t - \bar{\beta}\bar{\tilde{p}}_{t-1}\right] + \varepsilon_{it}$$
$$\Leftrightarrow \Delta\tilde{p}_{it} = \beta_i\tilde{p}_{i,t-1} + \phi_i\Delta\bar{\tilde{p}}_t + \varphi_i\bar{\tilde{p}}_{t-1} + \varepsilon_{it}. \tag{3'}$$

It can be easily seen that we were able to account for the unobservable common factor f_t with heterogeneous factor loadings γ_i by a combination of cross-section averages of observable variables $[\Delta\bar{\tilde{p}}_t, \bar{\tilde{p}}_{t-1}]$, and heterogeneous parameters ϕ_i and φ_i.

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