The secular decline of market integration during Qing China's Golden Age[*]

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Abstract: Past studies of market performance in China in the eighteenth century show a high level of integration comparable to Europe – the middle of the Qing Dynasty was a 'golden age' of prosperity. Contrary to this consensus, we use monthly grain prices to show a secular decline in market integration for rice in South China (as well as in advanced sub-regions) and wheat in North China, rather than a static high level. Results are confirmed using pairwise cointegration and a new panel convergence approach. Our findings suggest that the Great Divergence between China and Europe began well before 1800.

Keywords: market integration, eighteenth century, China, cointegration, panel convergence

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The eighteenth century in Qing China is commonly described as a "flourishing age" (*shengshi*) of prosperity, a 'golden age' over which the Qianlong emperor ruled between 1736 and 1795.[1] Commerce and trade flourished. Population grew rapidly, new land came under cultivation, and grain yields rose. Economic historians reckon grain markets were highly integrated (von Glahn, 2016: fn100; Wang, 1992: 52) and their performance "comparable" to Europe "in the late eighteenth century" (Shiue and Keller 2007: 1189); "long-distance trade in China operated more efficiently than in Europe" (von Glahn, 2016: 334) and "a national market for grain had formed" (Wang and Huang, 1989: 159). Pomeranz (2000: 17) in *The Great Divergence* went so far as to claim European markets as late as 1780 "were on the whole probably *further* from perfect competition… than those in most of China."

These descriptions of a prosperous late eighteenth century China sit awkwardly with the widespread agreement that by sometime in the early nineteenth century the performance of markets in China had become inferior to those in Europe (Wang, 1992: 54; von Glahn, 2016: 361). The historical literature is silent on any large-scale structural break in the early decades of the nineteenth century which is required to reconcile the flourishing late Qianlong era narrative with the weakened China of the middle decades, defeated by Britain in the First Opium War and faced with widespread internal rebellion. The literature, though, does have many accounts that suggest the shine of the golden age had begun to dim well before. Most recently in this journal new estimates of per capita GDP show a 60 percent decline between 1700 and 1800 (Broadberry et al, 2018). The economy and markets were on the wane. Our empirical question then is: when did China's market performance really begin to deteriorate?

Despite many studies of commerce and trade in China during the eighteenth century, the past literature has had little to say on the *secular trends* in grain market integration in China or in direct comparison of China with markets in Europe. Early studies of Chinese grain markets are mostly descriptive, reporting patterns of grain trade, estimates of trade volume and scattered price series. Quantitative analysis is limited. Most studies use the correlation in prices between selected cities and ports or the coefficient of variation of prices to analyse market integration, and usually for a short time frame. Major studies include those on rice prices in South Chinese

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[1] The term *shengshi* is translated "flourishing age" or "prosperous age". The reign title Qianlong means "Heaven's Flourishing" or "Cosmic Prosperity" that seemingly carries over into an uncritical nationalistic enthusiasm for the period in the many hundreds of popular Chinese volumes published on the Qianlong Emperor.

markets by Chuan and Kraus (1975) and Wang (1986, 1992, 2003); by Marks (1991, 1998) on Lingnan, and by Wong and Perdue (1992) on Hunan; as well as those on wheat and millet in Zhili by Li (1992, 2000, 2007) and Gansu and Xinjiang by Perdue (1992, 2005).

Shiue and Keller (2007) took the study of early modern grain markets in China to a new level of quantitative sophistication. Their study compared European markets with those of Southern China adopting a common empirical methodology: they used pairwise cointegration to estimate the degree of integration for the period 1742-95 using semi-annual rice prices for 121 Southern Chinese prefectures. The result of this pooled data analysis is a single period estimate for market pairs at different distance intervals over the entire time horizon. Their China estimate is then directly compared with a similar estimate for wheat prices in selected European cities over varying time spans in the eighteenth and nineteenth centuries. Several Chinese studies have also used more sophisticated regression methods to estimate market integration (Peng 2006; Yan and Liu, 2011), but none of these studies have captured *dynamic trends* in the performance of markets in China because they have relied on annual or semi-annual price data.

This paper makes three contributions to the literatures on early modern China and on the empirical analysis of market integration. First, we bring together a large quantity of qualitative evidence from the economic and social history literatures on early modern China to show that the economic decline was already under way in the second half of the eighteenth century. This forms a revisionist argument against the 'golden Qianlong era' narrative which dominates the literature, and which sets the date for China's fall in the nineteenth century.

Second, we employ monthly grain price data from 211 Southern and Northern Chinese prefectures over the 1740-1820 period. The use of such high-frequency data allows us to demonstrate that market integration declined from the mid-eighteenth century onwards, which empirically speaks to the narrative that emerges from our review of the historical literature. This decline is evident in the most advanced regions of China as well as in the Southern rice and Northern wheat-growing areas on a whole. This decline is also evident in comparison to the secular trends in English and Belgian grain markets during the late eighteenth and early nineteenth centuries.

Thirdly, we contribute methodologically to the literature on market integration. We uncover a decline in market integration whether we adopt the pairwise cointegration approach of Shiue and Keller (2007) or a novel panel convergence analysis, which is based on the

insights of the recent panel time series literature. Our novel approach using monthly price data estimates the speed of convergence in grain prices following a shock, presenting half-life estimates measured in months. This approach overcomes the known time series constraints associated with using cointegration analysis to measure integration of markets for commodities such as grain (Deaton and Laroque, 1992). The panel convergence approach also enables us to control for unobserved common shocks, such as weather events, which may result in similar co-movements in prices that have nothing to do with market connectedness and trade arbitrage, and the network effects on trade between a market pair from third markets that might influence estimates of market integration for a pair.

Our study of secular change in market integration in China and Western Europe builds on monthly price data, which allow us to implement the panel convergence and time series cointegration approaches using a 20-year rolling window incremented one year at a time over 81 yeard from 1740 to 1820. In contrast to the existing literature, which compares pooled data period estimates for various time horizons, we produce an estimate of the degree of integration for each 20-year period interval, which offers a *dynamic* complement to existing research. We do this for rice prices in South China and wheat prices in North China, England and Belgium, and for selected subregions in China.

Our major empirical finding and contribution to the economic history literature is to show that Chinese market integration began to decline from the 1760s. The pace of disintegration accelerated in the 1770s before a minor improvement began around the turn of the century to 1820, which is known as the Jiaqing revival (Rowe, 2011). These secular patterns were observed for rice markets in South China and wheat markets in North China, and also for the most advanced region of China, the Lower Yangzi River. Market integration in Belgium and England, in contrast, is shown to be high and comparatively stable.

To the extent that the level of market integration might explain potential drivers of the Great Divergence between China and Europe, the reversal in market integration in China points to divergent trajectories emerging in the economies at either end of Eurasia. The performance of China's market was unequivocally falling behind that of Europe well before 1800 as indeed were per capita incomes (Broadberry et al, 2018). The GDP data point to the onset of the Great Divergence in the first half of the eighteenth century, contrary to Pomeranz's original claim that advanced parts of Europe and China were similar in income until after 1800. Our findings for the trend in market integration similarly supports an earlier turning point in the fortunes of Qing China.

The remainder of the article is structured as follows. We begin by probing the popular view of the eighteenth century as one of unprecedent prosperity in China. Next, we briefly describe the data and our conceptualisation and methodology. The results section presents the findings for panel convergence and cointegration approaches, including a summary of extensive robustness tests. We conclude with a brief summary of findings and contribution.

Historical Background

What was happening in the economy, government and society during the second half of the eighteenth century that could have influenced market integration? In this section we review the existing historical and social literature on Qing China from this perspective and conclude that economic decline had begun three to four decades before Qianlong's death in 1799.

Factors that might influence the development of markets and their integration in Qing China can be grouped broadly into three categories: political economy, especially state capacity and policy to manage a hugely expanded empire; population, environment and transport infrastructure; and the dynamics of regional economic development. All factors share varying degrees of interdependence.

The historical consensus is that Qing Dynasty China was transformed during the reigns of the emperors Kangxi (1662-1722), Yongzheng (1723-35) and Qianlong (1736-95): the population tripled, there was massive migration from the settled core to the periphery, commercialisation and long-distance trade expanded hugely, and Qing control was extended to Central Asia (Pomeranz, 2000; Perdue, 2005; von Glahn, 2016). These pervasive changes were not accompanied by significant technological change in agriculture, industry or transport. The absence of technology breakthroughs that could overcome transport constraints in places distant from waterways blocked the potential for increased marketing (Rawski, 1972: 5-6, 97-8; von Glahn, 2016: 361-74). Many past historians have observed evidence in the later years of Qianlong that "the elements of ultimate ruin [of the Qing] were already present" (Hsu, 1990: 41, 42). Spence (2013: 108-14) argues "a series of crises" in the late eighteenth century erupted from the state's "failure" to address financial, administrative and social needs, bungled military campaigns, increased official corruption, and widespread resentment and civil unrest. "In the midst of Qianlong's many glories, signs of decay and even collapse were becoming apparent" (ibid: 99). A study of the Qing granary system found increased bureaucratic and economic constraints in the late eighteenth century impaired the effectiveness of the system to provide

for civilian needs (Will and Wong, 1990). Recent authors in particular have pointed to the decline in the capacity, effectiveness and integrity of the Qing state from the 1760-70s along with increased local level abuse and corruption (Elliot, 2009; Purdue, 2005; Sng 2014; Wang, 2014). A Chinese historian recently observed that proponents of the 'flourishing age' narrative "deceive themselves and others (*zisi siren*)" (Yang, 2011: 12).

In his history of China's conquest of Central Asia, Perdue (2005) redefines the flourishing age to the period 1670 to 1760, four decades before Qianlong's death. He dates it from the year the boy emperor Kangxi took personal control to the completion of Qianlong's conquest of Xinjiang and the obliteration of the Zunghar Mongols. From the late Ming Dynasty (1368-1644) in the early seventeenth century to the mid-eighteenth, the Qing had engaged in innovative state-building processes as it expanded, first from the Manchu homelands in Northeast China, to China proper, and finally into Central Asia. The 1760 victory in Xinjiang would eventually overstretch state capacity and ultimately became the undoing of the Qing, which Perdue says was recognized as early as the 1780s.

According to Perdue this frontier expansionism stimulated economic and administrative innovation. The Qing had "built an increasingly centralised and coordinated bureaucracy which used mercantile and agrarian resources actively for economic development to secure its security needs" (Perdue, 2005: 549-50). Yet despite its powerful capabilities, the Qing state was "losing control of many aspects of the economic exchange by the end of the eighteenth century" (ibid: 548). Famine relief measures vested in the granaries were failing, corruption and local oppression were on the rise, and central supervision of local authority became slack or inept. The "key turning point" in the effectiveness of the bureaucracy coincided with the end of military expansion in 1760, which sapped the bureaucracy of dynamism, and diminished the incentive to innovate and the will to control abuse (ibid: 549). Corruption, maladministration and slackening of control at local levels increased.

These failings permeated many aspects of state and society, not least the institutions affecting food supply, such as the massive system of state, community and charity granaries, which were important for social order and market stability. These granaries disbursed grain in times of famine, loaned food to the needy in the lean months before the harvest and stabilised prices through purchases and sales. At the zenith of the system in the mid-eighteenth century

grain reserves were estimated at 30 million *shi* (Will and Wong, 1990: 21, 24).[2] By the 1780s and 1790s, "the capacities of the granary system and the commitments of officials to state food supply intervention were both in decline" (ibid: 76). This decline is linked to the rise of Heshen, who became Qianlong's closest adviser, perverting administrative processes and fomenting a huge rise in corruption.[3] Promotion of officials no longer depended on their performance in the provinces, but on their ties to the political cliques in a court controlled by Heshen. Will and Wong argue the years 1775-80 were "an inflection point along the curve of state strength and power" (ibid: 90; also, Jones and Kuhn, 1978: 161-62).[4]

The increase in corruption and incompetence produced a "loss of faith" in Qianlong's rule, which "combined with unprecedented population growth and the consequent social, environmental, and economic pressures, gave rise to numerous populous uprisings large and small" (Elliott, 2009: 143). The White Lotus Rebellion (1796-1804) was an acute sign of accumulated changes that had begun to chip away at economic prosperity and the quality of Qing administration (Wang 2014). A millenarian Buddhist lay movement, the revolt spread from the Han River uplands of western Hubei to Henan, Shaanxi, Sichuan and Gansu. The earlier influx of migrants to these "internal" frontier regions had soon overwhelmed resources (Wang, 2014: Chapter 2). Their impoverishment was made worse by the predation of officials.

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[2] The *shi* (bushel) is a measure of volume equivalent to 103.55 litres. *Shi* is also read as *dan* (picul), a measure of weight. One *shi* of unhusked rice weighed an average of 185 lbs (range 175-195 lbs) or 83.92 kg. The weight measure *shi* (picul) equalled 100 *jin* (catty) equivalent to 133.33 lbs (60.45 kg) in the Qing Dynasty. 100 litres of wheat is equivalent to 79kg. See Chuan and Kraus, 1975: 79-98; Shiue and Keller, 2007: 1192, n5.

[3] Heshen was an imperial bodyguard, but at 25 years of age Qianlong appointed him to the Grand Council in 1775, and he thereafter dominated the bureaucracy. When he was executed after the death of Qianlong in 1799, he was found to have amassed 800 million tales of property, equivalent to more than 20 years of annual state revenue (Elliot 2009: 156-7).

[4] In her study of North China, Li (1992: 98) argued the simultaneous decline in the effectiveness of the granaries and the correlation of grain prices within Zhili province suggest "the eighteenth century integration of prices was probably more a function of the granary system than of the market system." These predominantly stocked millet rather wheat, though the price of both grains were highly correlated. The coefficient of variation rises from 1738 with a marked jump around 1800 and plateaued thereafter with no trend (Li 2000: 674-5).

The revolt exposed how weakened the Qing army had become since 1760 and its suppression depleted the Qing treasury (Jones and Kuhn, 1978: 141, 144; von Glahn, 2016: 361-62).

Other uprisings had already showed the increasing fragility of the dynasty. These include the White Lotus-inspired Wang Lun uprising in Shandong in 1774; Muslim revolts in Gansu in 1778, 1781, and 1784; the Lin Shuangwen rebellion in Taiwan and Fujian in 1788; the Miao revolts (1795-1806) on the Hunan-Guizhou border in response to Han settlers invading the uplands; and the proliferation of piracy in South China (Jones and Kuhn, 1978: 132-38; Elliott, 2009: 157-9; Spence, 2013: 110-12; Wang, 2014: 17-21; Chapter 2).

The uprisings and faltering capacity of the bureaucracy stemmed from the profound economic and social change over the eighteenth century, of which none was more important than the unprecedented population growth and internal migration (Elliott, 2009: ix, 146; Brandt et al, 2014: 50-2; von Glahn, 2016: 330, 647). The population increased from 138 million in 1700 to 341 million in 1800; between 1690 and 1840, the population grew at 0.7 percent a year compared with 0.3 percent during the Ming (Broadberry et al, 2018). The consequences of this population growth were many, and had far-reaching impact on the development and integration of markets.

In the early part of the eighteenth century, increased population fuelled Smithian-type economic development, opened up new land, and encouraged commercialisation, regional specialisation, and regional and long-distance trade. However, in the absence of comparable increase in cultivated land per capita and grain yields, or technological break throughs, extensive growth would run out of momentum, and incomes and livelihoods could only decline despite the apparent commercial prosperity: "[s]ubsistence crises… tended to increase in number and gravity, but at an even more accelerated rate because of rapid population growth and a general drift towards pauperization that had probably begun as early as the mid-eighteenth century" (Will, 1990: 312).

The rapid growth of population induced large scale migration from the densely populated core to the periphery. Migrants moved first from the North China plains, the Lower Yangzi and the Southeast Coast into the Middle Yangzi and later into the western provinces of Sichuan and Shaanxi. Sichuan's population increased six-fold from 3 million in 1673 to 23 million in 1820 (von Glahn, 2016: 329). Migrants opened up vast swathes of land, encroached on the flood plains of lakes and rivers, and pushed into the forested upland watersheds.

Their activities had adverse environmental effects. Deforestation in the uplands depleted resources – Chinese junk building, for example, shifted to Southeast Asia for the lack of wood (Marks, 1998: 168; Pomeranz, 2000: 226). The erosion from upland swidden farming silted rivers, and along with enclosure of river flood plains and lake edges increased flooding downstream and damaged the fragile hydraulic infrastructure such as canals that regulated flood waters and enabled transportation (Elvin, 2004; Perdue, 1982). Silting increasingly hampered the operations of the Grand Canal and increased the costs of its maintenance. The water control systems at "the heart of farming" in China and its transport network, which were "inherently unstable", began to fail (Elvin, 2004: 115, quote; 120; 125, 128, 460; Pomeranz, 2000: 215, 228; von Glahn, 2016; 329, 361-63). As a consequence, the transport of grains could not but have been adversely affected and in turn the performance of local, regional and interregional markets that depended on access to waterways.

Population growth overstretched the Qing capacity to govern: there were too few officials. Yet there was no appetite to expand the 25,000 posts in the formal bureaucracy, equivalent to one official for every 100,000 inhabitants in the mid-eighteenth century (Elliott, 2009: 15, 152-53). The population rise added to their administrative tasks and swelled those who had passed one or another level of the imperial examination, which qualified them for government service. These "expectant officials" awaiting posts were employed in local government to do the menial tasks of administration, record keeping, collection of taxes and local enforcement. Paid from local resources, they engaged in all sorts of abuse and extortion that ignited local protests we discussed above and increased directly the cost of trade, such as higher local fees levied on market transactions and grain vessels (Jones and Kuhn, 1978: 110-12; 119-23 passim).

A consequence of the population growth and the filling up of the interior provinces was significant change in the internal dynamics of the periphery economies, affecting trade within and between region. Von Glahn (2016: 372) argues that outmigration from the Lower Yangzi Jiangnan region to the Middle and Upper Yangzi over the century had a "centripetal" effect, which led to regionalisation and domestic import substitution in the periphery. In Hunan, for example, rice output and yields increased sufficiently to sustain consumption and exports, but marketed grain exports declined because people chose to use their labour differently, to produce handicraft goods in the lowlands and tea in the uplands (Pomeranz, 2000: 246; Rawski, 1972: Chapter 4, 143). Demand changed: "As the market for Jiangnan textiles in the interior dried up, the flow of rice, timber, and other raw materials down the Yangzi ebbed" (von Glahn, 2016: 372). These developments for Pomeranz (2000: 22; 251) put China on the pathway to an

"economic cul de sac" of separate cells by 1780, for Huang (1990) an "involution" of the economy, and for von Glahn (2016: 335, 372) an autarkic cellular economy aligned with the pattern of the Skinner (1977) macro-region model for the mid-nineteenth century. Regional economic development that flourished in the early eighteenth century had paradoxically weakened interregional long-distance markets by the closing years of the century.

The cumulative effects of these changes that affected interregional trade and market integration – population growth and migration; degradation of the environment and water-control and transport systems; and the state capacity and performance of officials – pushed down the standard of living. Population growth was insufficiently offset by the increase in per capita cultivated land and the rise in grain yields. In 1800, per capita GDP was 60 percent of the level in 1700 (Broadberry et al, 2018). These new income estimates have overturned the past view that the tripling of population had occurred without any evidence of an adverse effect on the standard of living. No longer tenable are claims that "[m]assive population growth with stable long-run living standards is the defining feature of the Ming-Qing economy" (Brandt et al 2014: 52, quote; also, Pomeranz 2000, von Glahn 2016). Incomes in China had fallen well behind Europe by 1800, including the advanced Lower Yangzi (Broadberry et al, 2018). The process was gradual. Indeed, Pomeranz (2011: 24) later acknowledged he probably "did overstate the lateness and suddenness" of the Great Divergence.

There is no evidence of cataclysmic economic change in either the qualitative or quantitative data for Qing China during the late eighteenth or early nineteenth centuries. Spikes or troughs are episodic, not cataclysmic-societal in scale. Were some sort of downward shift not underway in at least the second half of the eighteenth century – or even the first half, as argued by Broadberry (2018) – then it is hard to reconcile the consensus that China was very poor in the early nineteenth century and got poorer by the mid-century rebellions. To continue to hold up the mid-Qing as an age of unprecedent and undifferentiated prosperity would mean we need to rewrite the history of commercial and urban development in the Song, which had the world's highest standard of living in the eleventh century, and the Ming. The alternative, a gradual decline during the second half of the eighteenth century, represents the more viable option we argue for on the basis of the above evidence. We now turn to the empirical analysis of grain market integration to confirm this revisionist narrative and to provide comparative estimates for Western European economies at the forefront of the Industrial Revolution.

Data and Sources

Monthly grain prices from China and Europe are used to compare the trends in market integration. Data for China are prices for rice in South China and prices for wheat in North China. European data are wheat prices from England and Belgium.

Qing China

China price data are for rice from 131 prefectural markets in 11 provinces of South China, and for wheat from 80 prefectures in six provinces of North China between 1740 and 1820. These comprise the monthly reported minimum and maximum prices in each prefecture. In our main analysis we follow the literature in adopting the average between these two. The distinction between South and North China reflects the different staples and agro-climatic systems (Buck, 1937). South China is a wet-field rice zone with tea production in the hills and North China is dry-field wheat, along with millet, sorghum (*gaoliang*) and coarse grains. Our data cover most prefectures in the 18 provinces of Qing China Proper with the exception of Yunnan.

The Qing state collected these data as part of an elaborate commodity price reporting system, initiated during the reign of the Kangxi Emperor, which became a nation-wide system at the start of the reign of the Qianlong Emperor. Twenty or more commodities were often reported for a prefecture. We mainly use the subset of medium-grade rice and wheat prices, recorded in taels (*liang* [ounces]) of silver per granary bushel (*cang shi,* about 104 litres). These reports, which survive in archives in Beijing and Taipei, were compiled by Wang Yejian [Yeh-Chien] and collaborators.[5] Such price reports were important for the emperor and officials to monitor the prices and supply of grain, vital information that was crucial to maintain social stability and ultimately to ensure the legitimacy of the dynasty. Slackness of local officials in reporting them incurred reprimand from the emperor.

Historians agree these price data are reliable and comparable across locations (Wang 1978; Chuan and Kraus, 1975; Marks, 1991, 1998; Shiue, 2002, 2015; Shiue and Keller, 2007). No historical price data are ever free from errors of omission, neglect or sometimes even manipulation. At times the same price may recur for several months. In the South China sample

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

the share of rice prices that changed monthly are on average 76 percent in the first 40 years and 64 percent in the final 41 years of our sample. For the Lower Yangzi region, the shares are 81 percent and 68 percent respectively. This performance is comparable to wheat markets in the United States for 1800-39 where monthly prices changed for 47 to 81 percent of the sample (Jacks, 2006). Our sample end date, 1820, marks the beginning of a period when data quality rapidly deteriorates. More details on data veracity are provided in the Online Appendix.

<Insert Figure 1 about here: prefecture distribution>

We further adopt Skinner's (1977) influential model of 'physiographic macro-regions'. Each of these macro-regions was centred on major river drainage basins, divided and isolated from one another by mountains except where rivers cut between, which geographical shaped local economies.[6] Although not without its critics the framework provides heuristic power in the conceptualisation of sub-national regions bigger than and distinct from provinces (Bai and Jia, 2020). Our data coverage is shown in Figure 1 and the Online Appendix lists all prefectures according to their macro-region classification.

European Markets

Wheat prices for Belgium (the Austrian Low Countries) are from 20 cities between January 1765 and November 1794 on the first market day of the month (Vandenbroecke, 1973). Central government customs officials converted measurements to a common unit, the Brabantine *stuivers* per *razier* from Brussels (about 49 litres). These markets "compose a representative sample of all large and medium-sized grain markets in the Austrian Low Countries" (Buyst et al, 2006: 188).

For England, we use the *Corn Returns*, a weekly price series for selected grains published in the *London Gazette* between 1700 and 1914. Our analysis uses the weekly wheat prices

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[6] Within each region there was a rural-urban marketing hierarchy of settlements that extended from the density populated lowland core to the lightly populated upland periphery. This spatial organisation characterised local social life and the regional economies; 30-40 percent of agricultural output might have been sold in local and region markets but probably less than 10 percent would have entered into long-distance trade (Brandt et al, 2014: 53; Xu and Wu, 2007: 207-20 passim). China's long-distance inland water-borne grain trade was at least 62 million shi (5.2 million tons) a year, which dwarfed traded grain volumes anywhere else in the world. (Fang et al, 2007: 656-57; von Glahn, 2016: 331).

covering 40 counties (all of England excluding London) from November 1770 to September 1820 (Brunt and Cannon, 2013, 2014). The prices are in shillings and pence per Winchester bushel of wheat (about 35.2 litres), the average county prices for the previous week. To obtain an equivalent monthly price, we take the prices for the first week of every month instead of a monthly average of weekly prices. These are therefore comparable to the Belgium data and both Belgium and English data have the same data frequency as that of the Qing grain prices.

These represent the only European economies, to the best of our knowledge, for which *monthly* grain price data during the second half of the eighteenth century are available for a large number of markets.[7] Annual price series over longer time horizons are available, such as the Allen and Unger's *Global Commodity Prices Database*[8] but monthly price series are preferred over semi-annual or annual data to reduce biases from temporal aggregation on estimates of integration (Taylor, 2001; Brunt and Cannon, 2014). Additional material for all three countries is contained in the Appendix.

Conceptual framework and methods

> "One knows what economists mean by a market… an entire territory of
> which the parts are so united by relations of unrestricted commerce
> that prices take the same level throughout with ease and rapidity."
> Cournot (1838) *Recherches sur les principes mathématiques de la théorie des richesses*

Market integration can be evaluated by a variety of measures: price correlations, reduced volatility in prices over time, price co-movement between markets, and the pace of the return to price equilibria after exogenous shocks (Bateman, 2011; Chilosi et al, 2013). In the view of Federico (2012, 2018), co-movements or coordination of price changes is about the issue of market *efficiency*, whereas market *integration* is about equality or convergence of price levels. These criteria were first anticipated in Antoine-Augustin Cournot's 1838 masterpiece we quote from above: "that prices take the same level throughout" and that price movements occur "with ease and rapidity". Although the main focus is our contribution to the empirical analysis of

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[7] Bateman (2011) is a potential alternative, but the monthly wheat price series she adopts for parts of the eighteenth century cover only ten European cities.

[8] *Allen–Unger Global Commodity Prices Database* at www.gcpdb.info or www.iisg.nl/hpw/data.php.

market integration in the form of a panel convergence methodology, we also assess the co-movement criterion motivating the pairwise cointegration approach.

Our first innovation relative to the existing literature is to take advantage of the high frequency monthly data available to us and to employ a rolling window implementation for our analysis. The length of our data for Chinese prefectures is more than 700 monthly observations, which permits us to use a 20-year rolling window to analyse price convergence instead of a single regression model over the entire time period. The choice of 20 years is arbitrary. The results are qualitatively identical for 30-, 15- or 10-year windows. The window moves one year at a time, resulting in 61 windows for the 81 years between 1740 and 1820. Our results hence capture the *dynamic evolution* of markets over the sample timeframe and are presented in graphical form: we depict the time-paths of (i) average half-life estimates from the convergence approach, and (ii) average ADF *t*-statistics from the cointegration approach. We introduce these methodologies in the remainder of this section.

Cournot spoke of an integrated market as spatial locations "united by relations of unrestricted commerce", which is personified by profit-seeking agents engaged in arbitrage activities. Their activities dissipate price differences that result in a non-arbitrage equilibrium condition. In early modern grain markets, trade frictions influence the trade costs between two locations *i* and *j* and hence lead to persistent price differences. Trade frictions include the cost of transport; trade distance and topography that influence transport mode; the quality of the institutions and political barriers to the movement of goods; and more. Many factors are not directly observable though they will affect price levels and price integration between markets.

The price convergence approach to measuring market integration postulates markets are more integrated the quicker prices return to their equilibrium level after a shock. The 'return to equilibrium' relates to the change in the nominal price P_{it} in location *i relative to* an 'equilibrium proxy' $\bar{P}_t$, defined as $\tilde{p}_{it} = \left(\ln P_{it} - \overline{\ln P_t} \right)$, which is elaborated below. We model price convergence as:

$$\Delta \tilde{p}_{it} = \beta_i \tilde{p}_{i,t-1} + \boldsymbol{\gamma}_i' \boldsymbol{f}_t + \varepsilon_{it}, \tag{1}$$

where the dependent variable is the change in the relative price between $t - 1$ and t. The first term on the right-hand side contains our parameter of interest, β_i, which is the location-specific speed of convergence. If there is no convergence, a shock will have a permanent effect on relative price movements and β_i will be zero. Price convergence implies that β_i will be negative and the magnitude of β_i measures the convergence speed. The larger β_i (in absolute

terms), the faster prices converge. More integrated markets are associated with more arbitrage activities and faster price convergence. Below we report the speed of convergence in 'half-lives': the number of months until half the effect of a shock has dissipated. This is calculated as $\ln(0.5)/\ln(1 + \hat{\beta}_i)$ for $\hat{\beta}_i$ estimated from equation (1). Half-lives thus have an intuitive and economically meaningful interpretation and are readily comparable across samples.

The second term in equation (1), $\boldsymbol{\gamma}'_i \boldsymbol{f}_t$, accounts for changes in relative prices from location-specific responses to common shocks. This term $\boldsymbol{\gamma}'_i \boldsymbol{f}_t$ combines 'unobserved common factors' $\boldsymbol{f}_t$ with market-specific 'factor loadings' $\boldsymbol{\gamma}_i$. A non-zero loading in both markets i and j would induce cross-sectional dependence: if, for example, the component f_t^k relates to common weather shocks affecting multiple locations then the corresponding factor loading γ_i^k captures the location-specific impact of these shocks. A weather event such as excessive rainfall will affect markets in low-lying locations near flood-prone rivers differently from markets on a plain or at an elevation. Our empirical implementation is robust to localised shocks as well as shocks that affect all locations in the entire sample (Chudik et al, 2011).

Prices are also affected by the network structure of trade, the influence of other locations (third markets) on the prices between a specific market pair. The combination of $\boldsymbol{\gamma}_i$ and $\boldsymbol{f}_t$ in (1) captures the relative trading costs for each market with its neighbors or more distant markets. The relative magnitude of factor loading γ_i^k across locations is driven by many determinants including remoteness, river access, terrain, local climate, security of roads, and availability of porters. A defining feature of our framework is that it allows us to remain agnostic about which of these determinants are present in the data (see Eberhardt and Presbitero, 2015).

Implementation of equation (1) requires an 'equilibrium proxy' $\bar{P}_t$ to which a prefectural price is assumed to converge. Our main results focus on the average grain price in each physiographic macro-region (Skinner, 1977). We define the relative grain price $LPR_{it} = ln(P_{it}/\bar{P}_{rt})$, where P_{it} is the price in prefecture i and $\bar{P}_{rt}$ is the average price in the respective macro-region at time t. Our main estimating equation is a Dickey and Fuller (1979) regression:

$$\Delta LPR_{it} = \alpha_i + \beta_i^{LPR} LPR_{i,t-1} + \sum_{\ell=1}^{p_i} \delta_{i,\ell} \Delta LPR_{i,t-\ell} \tag{2}$$

$$+\phi_i \overline{\Delta LPR}_t + \varphi_i \overline{LPR}_{t-1} + \sum_{\ell=1}^{p_i} \xi_{i,\ell} \overline{\Delta LPR}_{t-\ell} + e_{it},$$

where β_i^{LPR} is the speed of convergence parameter. α_i captures permanent price wedges across locations. We further include monthly dummies to account for the effect of dissimilar harvest

seasons. The last term on the first line of (2) contains lags of the dependent variable, which capture short-run behavior as is standard in augmented Dickey-Fuller regressions.

This first line of equation (2) is identical to the implementations in Parsley and Wei (1996), Goldberg and Verboven (2005), and Fan and Wei (2006). The second line contains cross-section averages of the dependent and independent variables following Pesaran's (2006) Common Correlated Effects (CCE) approach. This can capture the heterogeneous impact of common shocks and the trade network. The cross-section averages ($\overline{\Delta LPR}, \overline{LPR}$) are constructed by physiographic macro-region, since unobserved heterogeneity due to weather patterns, flooding, and so on, are better captured within larger geographic units. Using cross-section averages for the entire staple-crop region (South, North) or by agro-climatic region (Buck, 1937) produces qualitatively identical results. The $\overline{\Delta LPR}$ and $\overline{LPR}$ terms capture unobserved common factors; the prefecture-specific parameters (ϕ_i, φ_i and $\xi_{i,\ell}$) allow for heterogeneous factor loadings.[9]

Equation (2) yields N convergence estimates (one for each location) and following transformation into half-lives via the above formula we report $\hat{\beta}_{MG}^{HL} = \sum_{i=1}^{N} \omega_i \hat{\beta}_i^{HL}$, the Mean Group estimate (Pesaran and Smith, 1995).[10] We use robust regression to estimate weighted averages, which are robust to outliers (Hamilton, 1992). Theoretical work and simulations have shown that the augmentation with averages is extremely powerful, providing consistent estimates of $\hat{\beta}_i^{LPR}$ in the presence of non-stationary factors, structural breaks, and cointegration or non-cointegration of the model variables (Kapetanios et al, 2011; Chudik and Pesaran, 2015). Below we present the secular convergence patterns in the rice (South) and wheat (North) staple regions of China as well as in individual Skinner macro-regions; we discuss the various robustness checks we conducted for different crops, quality, geographical regions, etc.

We also study price co-movement, which motivates the literature on the Law of One Price (LOOP). We do this for two reasons: first, because the seminal work by Shiue and Keller (2006) on grain markets in China and Europe adopts the pairwise cointegration approach to study price co-movement; and second, because this enables us to highlight the rigid assumptions made in this approach, which are relaxed in the panel convergence method we introduced above.

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[9] An intuition for this approach using simple algebra is shown in the Appendix.

[10] Standard errors are computed nonparametrically based on equation (58) in Pesaran (2006). These simply reflect the variation of the estimates around their (robust) mean.

In an environment where arbitrage activities by profit-seeking agents take place the LOOP can be formulated as $P_i - P_j = z(d_{ij})$, where P_i and P_j are the prices at locations i and j and $z(\cdot)$ is some trade cost function with bilateral distance d_{ij} being a measurable trade cost factor. When over time the prices between two markets equalize or (more weakly) co-move this defines a stable non-arbitrage equilibrium at the pair level. Cointegration is then the econometric equivalent of a stable long-run relationship between the prices in two markets; the prices between market pairs at time t, P_{it} and P_{jt}, cannot move far apart where arbitrage prospects are present. The test for the presence of a market in Cournot's sense is then whether over time the price gap can become arbitrarily large (nonstationary process) or not (stationary process). If prices diverge in the long run, then arbitrage opportunities remain unexploited and the two markets are not integrated.

The empirical implementation of this principle follows Engle and Granger (1987) as applied in Shiue and Keller (2007), whose specification and implementation we follow below. We first enter the price pairs i and j into a linear cointegrating regression:

$$\ln(P)_{it} = \alpha + \beta \ln(P)_{jt} + \varepsilon_t. \tag{3}$$

Our specification includes monthly dummies to capture seasonality. We add outlier dummies to the Engle-Granger regression in (3), defined to capture those time periods in which the growth rate of the grain price in i or j exceeds the long-run standard deviation of the respective log levels series.

In the second step, we test for cointegration between the market pairs. The pair-specific residual ε_t from equation (3) needs to be stationary for market pairs to be cointegrated. To test for this, we use an augmented Dickey-Fuller (ADF) regression (Dickey and Fuller, 1979):

$$\Delta\hat{\varepsilon}_t = \theta\hat{\varepsilon}_{t-1} + \sum_{m=1}^{p} \psi_m \Delta\hat{\varepsilon}_{t-m} + u_t, \tag{4}$$

where θ is the parameter of interest. The stronger the evidence that $\theta < 0$, the more likely the price series for i and j are cointegrated, whereas $\theta = 0$ implies a nonstationary residual series and thus *permanently diverging prices* in i and j. The magnitude of the t-statistic for θ is taken as a measure for the degree of market integration between the pair of markets.

The bilateral distance d_{ij} between locations i and j is expected to influence the degree of market integration: the greater the distance between market pairs the less likely are prices to converge quickly or even at all. We partition our sample into distance classes and estimate (3) and (4) for all $N(N-1)$ market pairs in each distance class. The unweighted average of the

ADF *t*-statistics is then the measure of the degree of market integration that captures "general patterns" present in the data (Shiue and Keller, 2007: 1200, n13). We further study the lowest distance class (0-150km) in two important sub-regions, namely along the Middle and Lower Yangzi River, and in the Yangzi River Delta (Jiangnan).

Two critical assumptions underpin the Engle-Granger framework. First, the estimates are robust to dynamic misspecification and omitted variable bias if and only if the underlying price series follow a random walk, i.e. are nonstationary. Dobado-Gonzalez et al (2012) suggest nonstationarity of grain prices is a pre-requisite for the existence of market clearing. Shiue and Keller (2007: 1198) are less sure: "the random walk hypothesis is not fully satisfactory." Deaton and Laroque (1992: 3) find a random walk for price series "very implausible, at least for commodities where the weather plays a major role in price fluctuations" because it implies the permanent impact of shocks, but they concede "in practice,… it is hard to reject the most parsimonious [unit root] model." Our panel convergence approach does not require a firm stand on price stationarity or nonstationarity (Kapetanios et al, 2011).

The second assumption requires the absence of strong cross-section dependence in the price series, such as spurious co-movement in price pairs arising from common shocks (e.g., weather events) rather than the arbitrage activities of traders or the network effects of third markets. This issue is widely recognised in the literature (Fackler and Goodwin, 2001: 992f; Shiue, 2002: 1407; Federico, 2012: 481f; Brunt and Cannon, 2014: 115). Our panel convergence approach to the best of our knowledge represents the first empirical methodology which addresses the distorting effect of common shocks and trade networks in the analysis of market integration.

Empirical Results

The results of our econometric analysis show that China's markets became less integrated in the late eighteenth century whereas those in Europe did not. Below we first report the results using a panel convergence approach, providing details of a large number of robustness checks conducted. Results from pairwise cointegration analysis in a rolling window implementation provide a close match with the Shiue and Keller (2007) approach but qualitatively very different outcomes to theirs. Lastly, we use both approaches to compare selected regions in China, including the economically advanced Yangzi Delta, with England and Belgium, the only two Western European economies for which there are comparable monthly data.

Panel convergence results

The panel convergence approach overcomes methodological concerns with the pairwise cointegration approach that can impair the reliability of estimates. It also accounts for common factors and third market effects. The results are reported in half lives, the number of months for a market to reduce by half the difference in price from equilibrium after a shock (see the methods section). Market integration is interpreted to be higher (lower) at shorter (longer) half-lives because prices readjust more quickly (slowly) after a shock. There are few previous studies of grain markets for North China, including for Zhili (equivalent with modern-day Hebei), Gansu and Xinjiang (Li, 1992, 2000, 2007; Perdue, 1992, 2005). None have a large sample covering the six wheat-growing northern provinces of Qing China proper.

<Insert Figure 2 about here: panel convergence rolling windows>

Figure 2 presents the outlier-robust average half-lives from our panel convergence analysis for the two staple-crop regions: South China, based on rice prices, and North China, based on wheat prices (note the logarithmic vertical scale). These graphs represent regression estimates, not plots of the averaged data, and the estimation window start year is indicated along the horizontal axis. The top panel of Figure 2 confirms past narratives that market integration in South China was higher than in the North: for each 20-year rolling window period the average half-life in months in South China is lower than in North China. During the late eighteenth century, the North China markets took three times or longer to readjust compared with the average for South China. The primary explanation for the South-North difference is the advantage of water transport in the South over land modes in the North (Rawski, 1972; Elvin, 1973; Eastman, 1988; Evans, 1984; Kim, 2008). Lack of navigable waterways in North China created land transport zones where "self-sufficiency was of necessity the dominant economic reality" (Evans, 1984: 296).[11] The stark difference is captured in the proverb, *nan chuan bei ma* – take a boat in the South, a horse in the North (Elvin, 1973: 136). Our convergence results further indicate that market integration in North and South China regions

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[11] Land transport costs were 1.5 to 5.5 times those of inland waterways, which in turn were up to 2.7 times costlier than sea transport (Evans, 1984; Shiue and Keller, 2007: 1192). Even in the southern provinces such as Hunan, a major source of interregional rice exports in the eighteenth century, "the most important factor in determining the commercial growth potential of an area was its access to water" (Rawski, 1972: 106).

followed a similar secular pattern: the half-lives increase from the 1760s onwards with a notable reversal for windows from the late eighteenth century onwards.[12]

The bottom panel of Figure 2 geographically disaggregates the sample into macro-regions, the regional systems concept (Skinner, 1977) discussed earlier. In the 1740s we can see clear differentiation in the estimated half-lives of each macro-region. The lowest was the Lower Yangzi, the most developed and richest region in China. This was followed by the Middle Yangzi, the Southeast Coast (Southern Zhejiang and Fujian), Lingnan (Guangdong and Guangxi) and lastly the North China macro-region. Estimated half-lives were relatively unchanged into the 1760s and thereafter rise for all geographic sub-regions.

Market disintegration was pervasive across all macro-regions presented, but the degree of disintegration differed. The half-lives of the economically advanced Lower Yangzi region more than quintuple from 4.3 months in 1740-59 to 25.9 in 1792-1811, ending at 15 months in the last window of 1801-20. This evolution is closely mirrored in the Middle Yangzi region, the main grain supplier for the Lower Yangzi during the Qing. For the Lingnan region, "an area second only to the Lower Yangzi in commercial development and population density" (Pomeranz, 2000: 222), the respective half-lives are 9.8, 55.9 and 36.3 months, though the peak here is reached earlier in the 1789-1808 window. Market disintegration is gravest in the North China macro-region. Its half-lives peaked around 100 months for the 1790-1809 window, about four times longer than the lower Yangzi peak, and settled around 50 months at the end of our sample. In North China by this time there was little if any functional arbitrage taking place, a finding that agrees with studies for Zhili (Li 2000, 2007).

These panel convergence results show a secular market disintegration in the larger rice and wheat staple-crop region samples as well as in the macro-region sub-samples. Market disintegration began in the second half of the eighteenth century and accelerated in the last three decades. Even two decades before the death of the Qianlong emperor in 1799, the estimated half-lives reported in Figure 2 had already *doubled* in both Northern and Southern prefectures compared with the mid-century.

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[12] The notable jump in the South China average half-life in 1788 is driven by the evolution in the Upper Yangtze macro-region, where the average estimated half-life *quadrupled* from 12 to 50 months in that year.

Alternative specifications and sensitivities

Our focus is on the integration of markets for the two major staples of China, rice that is primarily grown in the south and wheat in the north. Wheat is also grown in parts of the South, while wheat and rice are traded in both regions. There were different grades and varieties of traded rice and wheat, and also many other grains. These variations offer many opportunities to test the robustness of results from our novel panel convergence approach. The results presented above are only a fraction of the setups and specifications we considered. Additional robustness checks can be grouped into six categories and the respective results (available on request) support our main finding of secular market disintegration in Qing China.

Firstly, we examined alternative crops. We studied millet prices for 72 prefectures of the North; first and third grade rice prices for 110 and 108 Southern prefectures, respectively; and we separately analysed the reported monthly series for the high and low price of medium grade rice instead of their mean. Secondly, we considered whether the sample of prefectures analysed altered the results, examining wheat prices for 156 prefectures from both North and South China.

Thirdly, we used alternative reference prices in the convergence analysis. Instead of the macro-region or staple crop region averages we used (a) the price in Suzhou, the primary rice market in China, as the Southern reference price, (b) average prices in respective macro-regional *cores* in North and South China as reference prices, and (c) the Guangzhou price as reference for Lingnan. Fourthly, we allowed for more complex price convergence processes, namely nonlinear as opposed to linear convergence. [13] Fifthly, we examined alternative specifications for our cross-section average-augmented convergence regressions.[14]

And finally, we explored concerns over data availability – in particular missing observations – that might influence the reliability of estimates. We varied the rolling window length, to estimate each window with a similar number of observations instead of fixed number

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[13] We allow for nonlinear convergence in the spirit of Taylor (2001) by adopting the exponential smooth transition autoregression framework of Kapetanios et al (2011), extended to the panel and robust to cross-section correlation based on Cerrato et al (2011).

[14] We use information on wheat prices in Southern prefectures to help identify the common factors driving rice prices, following the approach described in Pesaran et al (2013). We include further lags of the cross-section averages to the model following Chudik and Pesaran (2015), along with the bias-correction in form of a half-panel jackknife suggested by these authors.

of years, to ensure our estimates are comparable over time. We find that in periods when sample coverage declines the speed of convergence estimates for prefectures with fewer observations are actually higher (in absolute terms) than for those with more observations. Hence missing observations cannot drive our finding of secular market disintegration. We conclude our main results are not driven by sample size, data availability or other idiosyncracies.

We also explored an alternative interpretation of the empirical setup. This adopts a unit root test for relative price movements, LPR_{it}: if the null of a unit root is rejected, prices do converge (without any concern over the predicted time horizon for convergence). Using simulated critical values for the averaged *t*-statistics on $\hat{\beta}_i^{HL}$ (following Pesaran, 2007), we were unable to reject a unit root for the relative price series for North and South China from the time windows 1766-85 and 1771-90 onwards, respectively (10% level of significance). The results for this sharp empirical test confirm our above findings that grain markets in North and South China were *already fragmented from at the last decade of the Qianlong reign*. Since the time span rather than frequency or length (*T*) of a time series drives the power of the unit root test (Shiller and Perron, 1985), we are reassured that a 30-year time window similarly points to market fragmentation before 1800.

Are our estimates of decline too big to be credible? Above we provided a rich revisionist argument which questions the narrative of the late Qianlong era representing a continuation of the 'flourishing age' of prosperity. We can also provide a more technical response. In econometric terms, as the speed of convergence approaches zero, the implied half-life approaches infinity: once markets become fragmented, the half-life mathematically *has* to explode. In economic terms, the issue revolves around the prospects for arbitrage actually taking place. In this regard, it is immaterial whether the estimated half-life is 50 or 100 months, since such estimates imply there is no price arbitrage taking place. This is not to say that these estimates, 50 versus 100 months, do not matter; however, a sharper test and hence interpretation of *market integration versus disintegration*, as provided in the above panel unit root tests, can allow for a more straightforward conclusion: China's markets were *functionally disintegrated* from the 1770s/80s onwards, well before the end of the Qianlong reign.

Cointegration results

Our panel converge estimates represent our empirical contribution to the literature on market integration in early modern China. In the following we discuss results from the pairwise

cointegration approach adopted by Shiue and Keller (2007) to demonstrate that a rolling window implementation yields qualitatively identical result to our convergence regressions, namely secular market disintegration.

In Figure 3 we report the results for the pairwise cointegration analysis from 20-year rolling windows for the data set covering 131 South China rice markets between 1740 and 1820.[15] The top panel shows the secular trend of the averaged ADF t-statistics from our sample divided into seven distance classes: this is the dynamic counterpart to the estimation for the entire period 1742-95 in Shiue and Keller (2007: Figure 4, p.1202). Recall that these authors interpret a large negative average t-statistic as stronger evidence of cointegration and thus widespread market integration. Lower average t-statistics point to markets being less integrated. Each coloured line in the top panel presents the average t-statistics for each of seven distance classes for each of the 61 separate 20-year year rolling windows from 1740 to 1801 (window start year). The number of market pairs for each distance class are shown in the legend.

<Insert Figure 3 about here: pairwise cointegration with rolling windows>

As we would expect, the degree of market integration decreases with distance and averaged t-statistics are largest (in absolute terms) for markets close to each other (<150km) and become smaller for markets further apart. Our first finding is that this distance ordering is fairly consistent over time.[16] A more important finding is that the rolling window approach shows the average t-statistics decline over time. The decline quickens for windows starting in the 1760s and more so for windows from 1772-92 to 1784-1803. We interpret these result as showing that the degree of market integration *declines* throughout the second half of the

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[15] In the Online Appendix we use data for 121 South China rice markets (excluding Sichuan) and estimate pairwise cointegration over the entire 1742 to 1795 period, that is, without a no rolling window. This exercise mimics the Shiue and Keller approach, their sample and time period. The results are qualitatively similar to the All China results reported in Figure 4 of the Shiue and Keller paper and the interpretation is the same. Generally, the lowest (largest negative) average ADF t-statistic is found for the shortest distances, 0-150 km, which is what one would expect.

[16] The second half of our sample period sees some minor changes in the distance ordering, with the highest distance class showing higher levels of integration than the next lower class. We are unable to establish whether results for these distance classes are statistically significantly different. Such a reversal is not theoretically impossible where intermediate trading posts drop out as overall market integration declines.

eighteenth century before picking up again after the turn of the century, albeit never reaching the levels attained in the first half of the eighteenth century.

The bottom panel of Figure 3 presents the results for the first distance class of rice markets less than 150km apart. Three series are reported. The first is the full South China sample as reported in the top panel, the second is the Yangzi River sample and the third is the Yangzi Delta sample (the latter two follow the definitions in Shiue and Keller). As expected, in the 1740-50s the Yangzi Delta and the Yangzi River prefectures are more integrated than South China on average. During the 1760s the level of integration is similar for all three samples. From the 1770s, market integration in the Yangzi zone deteriorates compared with short-distance markets in the rest of South China. Results are qualitatively identical for the longer distance classes: 151-300km, 301-450km and 451-600km (not shown).

Market disintegration reported in average ADF *t*-statistics thus follows the same secular trend as shown for half-lives in Figure 2. Since unlike our estimates for half-lives the *relative* magnitudes of the averaged ADF *t*-statistics have no economic meaning, we cannot make any statements about the relative magnitude of market disintegration and therefore merely emphasise the clear pattern of disintegration deriving from this approach.

Comparison of China with England and Belgium

Well-functioning and integrated markets – and their supporting institutions – have long been regarded as a necessary condition for industrialisation, if insufficient alone, and have therefore been studied in the context of the Great Divergence,[17] one of the seminal questions in economic history: why did the world's then largest economy, China, fail to industrialize during the eighteenth and nineteenth centuries, whereas Western Europe embarked on modern economic growth? Shiue and Keller (2007) were the first quantitatively to analyse the cross-continental difference in the *levels* of grain market integration, by comparing China and Europe, to explore the role of market performance in addressing this puzzle.[18]

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[17] The literature on the Great Divergence is large. The work seminal to the current debate is Pomeranz (2000), along with critiques by Brenner and Isett (2002), Huang (2002), among others. See Vries (2015) for a survey and critique of the debate.

[18] The Shiue and Keller (2007) comparative analysis used grain prices from 15 European cities between 1770 and 1794 (Figures 3 and 4), and European Cities for 1742-95, 15 European Cities for

In this section we conduct a similar exercise using monthly price data and our rolling window implementation to compare the *secular change* in market integration for China and Western Europe. We use monthly price data from England for 1770-1820 and Belgium 1765-94[19] and conduct panel convergence and pairwise cointegration analyses. These European economies are said to have experienced relatively high levels of market integration on the eve of industrialisation (Shiue and Keller, 2007; Buyst et al, 2006) and *a priori* we should not expect even the advanced Yangzi Delta region to have achieved *comparable* levels of integration. Belgium is small in area compared with the China regions; England is a more comparable in scale for selected China macro-regions.[20] The selection of these economies is driven by data availability, but as the secular patterns emerging from our below analysis illustrate they represent suitable benchmarks for Chinese market integration.

<Insert Figure 4 about here: comparative results >

Figure 4 presents the comparative results for China and Western Europe. The top panel presents the results for the panel convergence analysis reported in half-life months.[21] Belgium rather than England is the most integrated economy in this analysis, with a half-life below two months. This might reflect its high-quality road network and also the sample, which excludes markets in underdeveloped Eastern regions for which price data are missing (Buyst et al, 2006:

1825-49, and 41 English counties for 1770-94 (Figure 5). The 15 European cities for 1770-94 are: Aalst, Antwerp, Boizenburg, Brussels, Cologne, London, Luxembourge, Munich, Nijmegen, Rostock, Ruremonde, Schwerin, Toulouse, Utrecht, Vienna (Table 1). The later sample (1825-49) used eight of the above and another seven European cities (Table 1). Their European cities sample for 1742-95 in Figure 5 is not defined. They compared the European sample estimates with their sample for South China (121 prefectures) and various subsamples.

[19] Without monthly data for England or Belgium for the 1740s, 50s and most of the 60s, we cannot estimate their levels of market integration corresponding with China in that period.

[20] The average distance between market pairs for the English counties is 202km. This compares with 213km in the Lower Yangzi, 429km in the Middle Yangzi, 260km in the Southeast Coast and 366km in the Lingnan macro-regions. Note that in our cointegration analysis, like Shiue and Keller, we focus on distance intervals (in our case the lowest category of 0-150km – there are insufficient market pairs in any other category for Belgium) and therefore by definition we estimate integration for market pairs in comparable geographic classes in China and Europe.

[21] For European markets, we investigate convergence to the national average price and adopt cross-section averages for the respective full sample in estimating the CCE.

193). Belgium's market integration is stable, England becomes slightly more integrated over time. Although the grain price series for China and Europe have different start years, the respective first year of the estimated half-live series show the level of market integration in the economically advanced Lower Yangzi macro-region during the 1740s was *broadly similar* to that in England during the late 1760s: the half-lives for the respective first 20-year window are 4.3 months for the Lower Yangzi and 3.2 months for England.[22] After this initial period they steadily diverge until the turn of the century. At the peak of divergence in the period 1792-1811, the Lower Yangzi region half-life (25.9 months) is about 12 times that of English markets (2.2 months), declining to a factor of eight by the end of the sample under the reign of the Jiaqing Emperor (1796-1820).

The bottom panel shows the results for cointegration analysis in the distance class of less than 150km. The average *t*-statistics for the respective starting years of the rolling windows for the Yangzi Delta prefectures, English county and Belgian city samples again are of *similar magnitude* – the level of market integration is broadly comparable. England is more integrated than Belgium or the Lower Yangzi, but the latter two have next to identical starting levels. Over time, market integration in the Belgian sample deteriorates marginally, whereas English integration oscillates around a relatively stable level; as reported before, Southern Chinese integration collapses and recovers somewhat during the Jiaqing reign.

Conclusion

The findings of this paper contradict the consensus of earlier scholars that the mid-Qing period of the eighteenth century was a golden age of flourishing and integrated markets. Earlier studies of market performance portray a static view that grain markets in China were highly integrated at a level comparable or even superior to Europe (Wang, 1992; Pomeranz, 2000; Shiue and Keller, 2007). Insofar as the methods and data constrained these studies, we agree that at one point in the eighteenth century – around the middle of the century – the actual performance of markets in terms of market integration was probably comparable to Europe. Where we differ is that our dynamic approach to modelling the price data shows the level of integration began

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[22] For detailed comparison, the estimated half-lives for the first windows are: Lower Yangzi, 4.3 months; Middle Yangzi, 5.3 months; Southeast, 7.9 months; Lingnan, 9.8 months; North China, 11.8 months (all for the 1740-59 window); Belgium, 1.7 months (1765-84 window); and England, 3.2 months (1770-89 window).

to deteriorate in the second half of the eighteenth century. While some markets continued to function, arbitrage had all but ceased in others. The prosperity of the High Qing so often recounted in the historical literature had paradoxically spawned the growth of regional economies that were increasingly autarkic by the late eighteenth century (von Glahn, 2016: 372). Incomes had also declined (Broadberry et al, 2018). The golden age of Qing Dynasty was fading rapidly.

Our major contribution is to provide robust estimates of the secular trend in market integration for China between 1740 and 1820, which we compare with markets in England and Belgium. Previous studies have derived single point estimates for integration based on annual or semi-annual mean prices. We instead use high-frequency monthly price data with a 20-year rolling window, which allows the computation of estimates for 61 separate time periods from 1740-59 to 1801-20. The rolling window is implemented with both a panel convergence approach and a cointegration approach. The former avoids the conceptual constraints of cointegration analysis and allows us to control for common shocks and trade network effects that otherwise bias estimation. Our results support the view that the Great Divergence between China and Europe had begun long before 1800.

If the remarkable high level of market integration comparable to Europe that we and other scholars have identified (Shiue and Keller 2007; Wang, 1992, among others) is a sign of prosperous development during the earlier decades of the eighteenth century, then our identification in this article of a secular downward trend in the level of integration provide a quantitative measure of the deep challenges facing the Qing economy and society in the later decades of the century. Qianlong's successor, the Jiaqing Emperor, momentarily halted the slide with various reforms and even produced a slight recovery in market performance, but the decline resumed from the later 1810s (Rowe, 2011; Wang, 2014).

Our review of the historical and social literature on Qing China and quantitative analysis of grain prices in China and Western Europe reveal a gradual process of market decline over the second half of the eighteenth century. These findings solve the apparent puzzle in the existing literature of high levels of integration around 1800, followed by low levels only two dozen or so years later, and, crucially, in the absence of any cataclysmic decline in the intervening years. Decline set in during the 1760s, it was substantial, as well as pervasive across advanced core and peripheral regions of Qing China proper.

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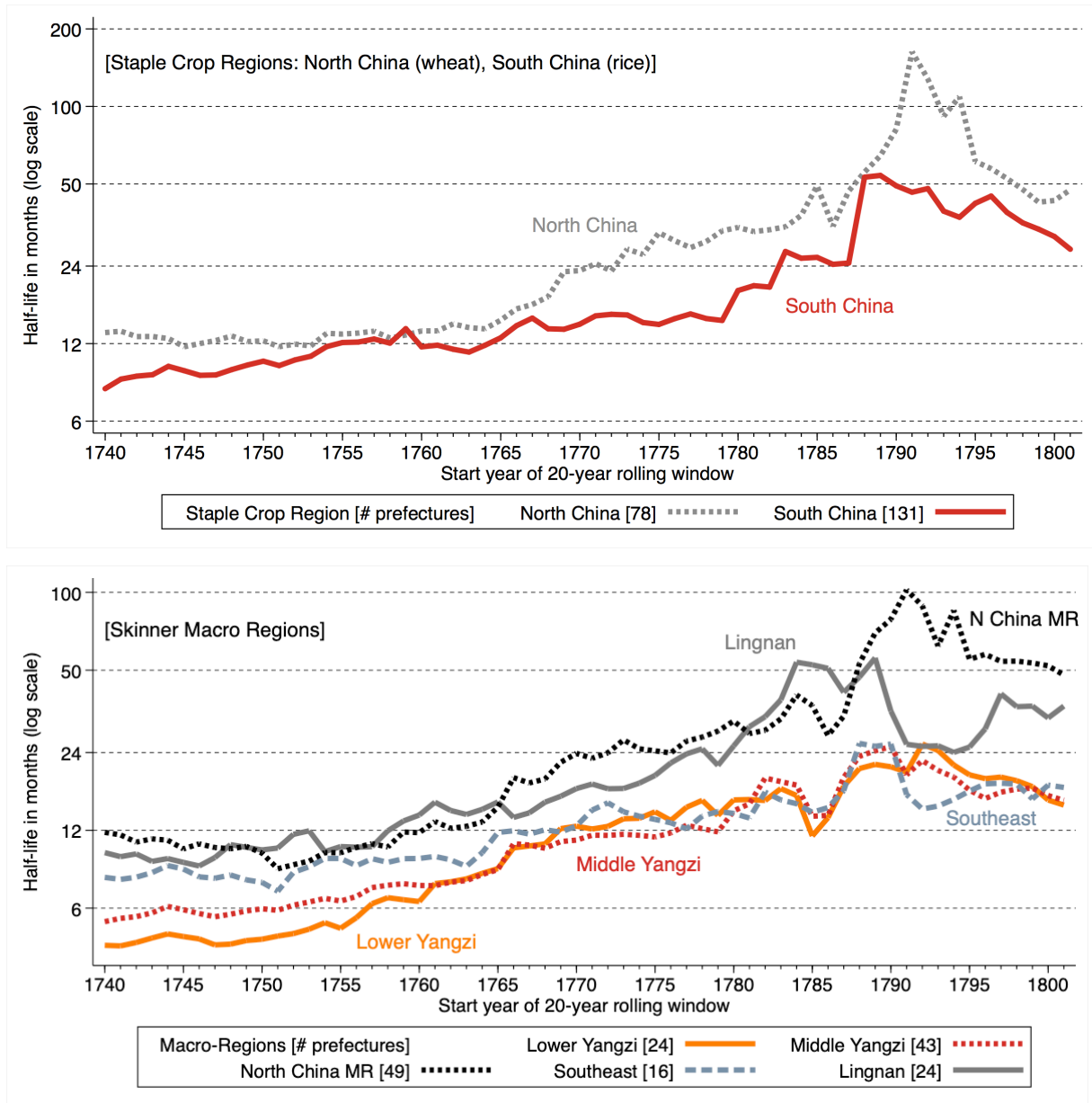
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Figure 1: Sample of Prefectures for North China (top) and South China

Notes: The prefectures included in our samples are those numbered. Those without data are un-numbered and blank. The North China sample is shaded. The thick black lines are the provincial borders and the thin grey lines the prefectural borders. All borders are for 1820.

Source: GIS Boundary Data from the China Historical GIS project (CHGIS, Harvard), Ver 4.

Figure 2 – Market Integration in South and North China: Panel Convergence Analysis


Notes: Panel convergence estimates are expressed in half-lives and presented on a logarithmic scale, hence the half-life *doubles* between each consecutive horizontal line. The top panel presents the averages for the two main staple crop regions of China; the bottom panel the averages for five of the eight macroregions of Qing China proper. We exclude results for the peripheral Upper Yangtze, Yun-Gui and Northwest China macro-regions for ease of presentation. Prefecture counts are reported in the legend of each graph.

Figure 3 – Market Integration in South China: Cointegration (Rolling Window)
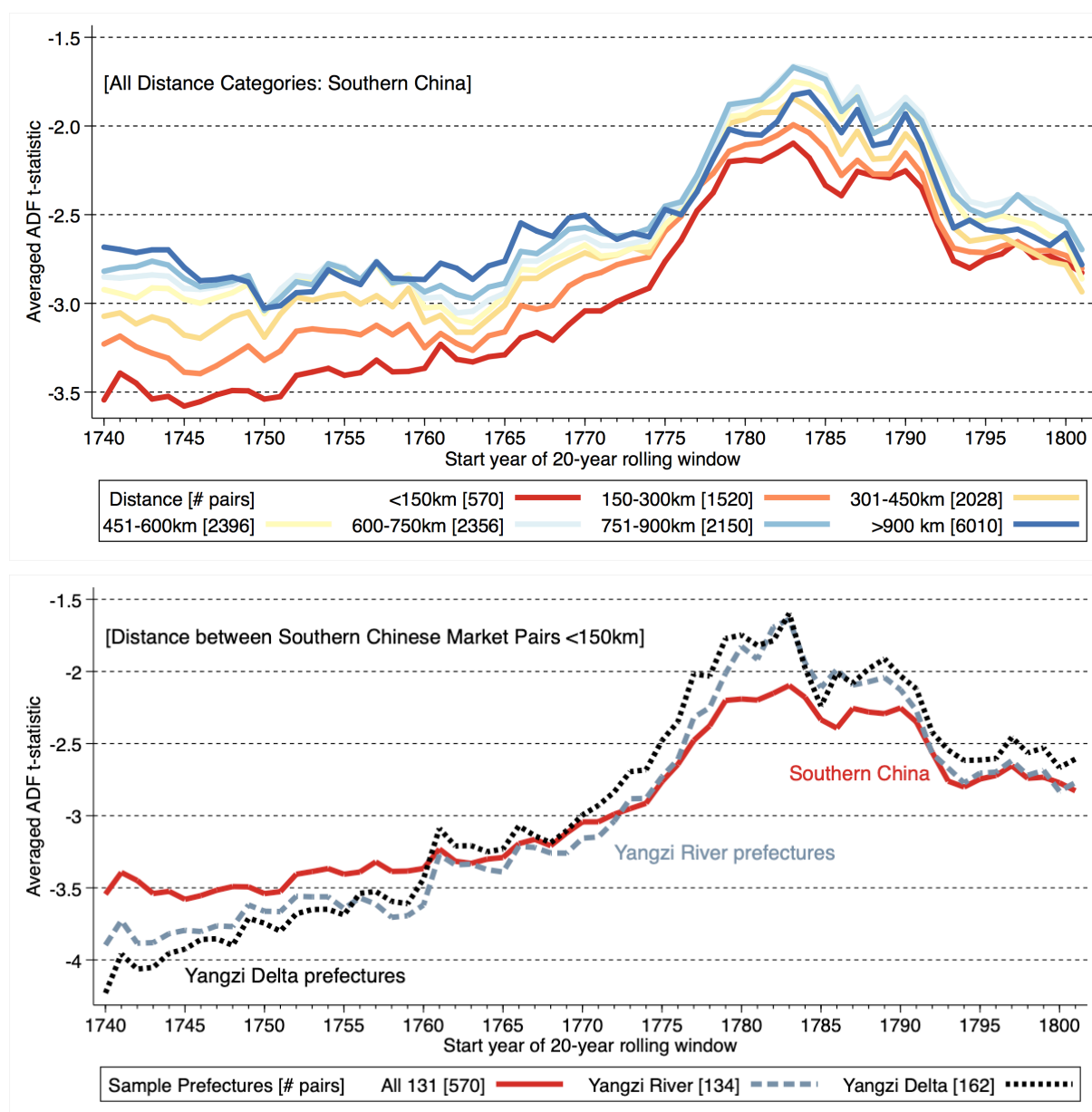
Notes: A smaller (in absolute terms) negative average ADF *t*-statistic is evidence for lower cointegration and for less integrated markets. The top graph reports all 131 prefectures by distance class. The bottom graph reports only first distance class (<150km apart) for (a) all of South China, (b) the Yangzi River, and (c) the Yangzi Delta region – following the definitions in Shiue and Keller (2006). The *x*-axis shows the start year of each 20-year rolling window. The parentheses in the legend of each graph reports the number of market pairs.

Figure 4 – Market Integration in China and Western Europe: Comparative Analysis
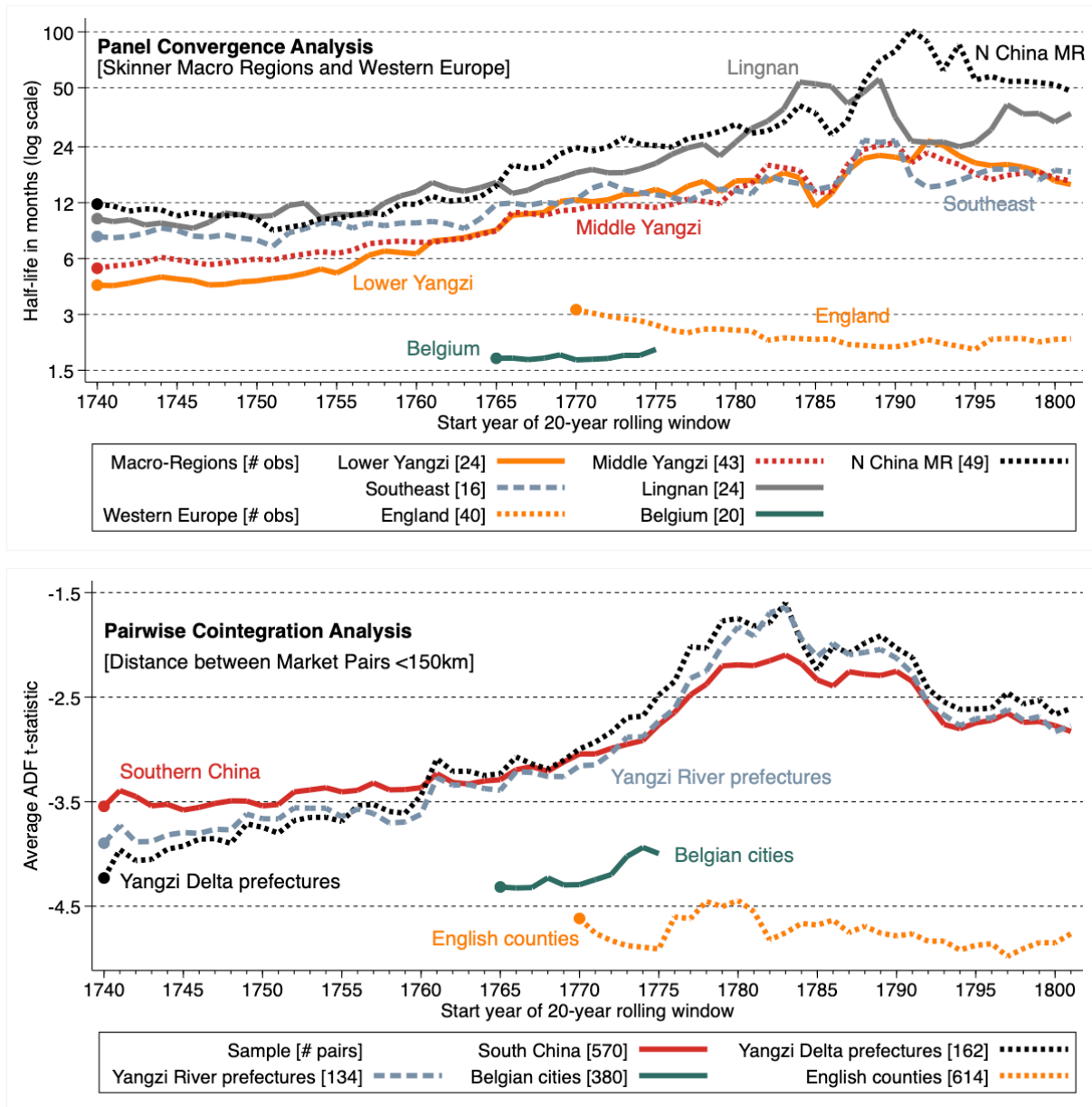
Notes: The European data start later than our Chinese data. There are no comparable monthly price data for the 1740s to the mid-1760s. In the upper panel the half-lives are on a logarithmic scale, hence the half-life doubles between each consecutive horizontal line.