INDIA AND THE GREAT DIVERGENCE:

ASSESSING THE EFFICIENCY OF GRAIN MARKETS IN 18\textsuperscript{TH} AND 19\textsuperscript{TH} CENTURY INDIA*

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Abstract

By analysing a newly compiled data base of grain prices, this article finds that prior to the 19\textsuperscript{th} century the grain trade in India was essentially local, while more distant markets remained fragmented. It was in the second half of the 19\textsuperscript{th} century that these pre-modern structures were transformed rapidly, so that by the end of the century a national grain market had emerged. In terms of the comparative Great Divergence discussion, the claim of the California School of “Asia” having reached a similar stage of economic development as Europe before the late 18\textsuperscript{th} or early 19\textsuperscript{th} century is therefore rejected for India.

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Introduction

In recent years, the *Great Divergence* has become one of the most contentious issues in economic history. The debate centres on when and why Western Europe pulled economically ahead of the rest of the world; that is, when and why the Great Divergence in terms of economic performance and structure happened.

Until recently, the widely accepted view has been that Europe’s path of economic development was unique already in early modern times. It had better institutions, a scientific culture which led to technological progress, superior commercial organisation, and more favourable social structures and demographic patterns. As a result, Europe’s economic progress was outstripping that of the rest of the World so that it had become the clear leader in terms of economic performance even *well before* the Industrial Revolution brought about far-reaching structural changes and made Europe’s supremacy even more pronounced.¹

Spearheaded by Ken Pomeranz’ *The Great Divergence*, Andre Gunder Frank’s *ReORIENT*, and Bin Wong’s *China Transformed*, recent years have seen a popularisation of a different view on this matter. According to this school of thought, which came to be labelled the *California School*, the bifurcation leading to the rise of the West only really happened towards the end of the 18th or at the beginning of the 19th century, and depended on a relatively sudden shift of relative European and East Asian economic trajectories, rather than a European take-off in the context of long-standing European dynamism versus long-standing Asian stagnation. Before, it is asserted, “Asia” – particularly China, but also India and other regions – was comparable to Europe in terms of economic performance, as measured by various indicators. Placing the divergence in the 19th century, of course, also affects explanations of the European success vis-à-vis other parts of the world. In these revisionist accounts, the explanations shift away from the traditional factors, and coal and colonial exploitation take centre stage.²

One of the features of this debate is that the comparisons are based on fragile evidence. While there is a long tradition of quantitative historical research on economic performance for most European countries, there has been no comparable tradition for Asian countries. Over the last few years, however, the lively debate has encouraged scholars in quantitative economic history to improve the intercontinental comparisons on indicators for economic performance – such as living standards, market efficiency or demography.³ This undertaking is still at an early stage and many of the broad conclusions about the efficiency of Asian economies remain to be examined in greater detail and to be tested quantitatively. Moreover, in these recent studies, China has

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attracted the bulk of attention, while the quantitative investigation for the second of
the “big two” in Asia – India – has hardly begun. Undoubtedly, the prime reason for
this shortage of quantitative studies is the paucity of historical economic data, which
is much more pronounced for India as compared with European and even some other
Asian countries. But this shortage is not limited, in the Indian case, to specific
variables, there is a pronounced scarcity of all economic data prior to the 19th
century. This, in turn, is also a symptom of a more general phenomenon which has
been plaguing Indian historiography, namely a general shortage of non-European
sources on India. It is therefore hardly surprising that quantitative studies on all aspects of Indian
economic history have mostly been confined to the time after 1860; that is, when the
British administration started to systematically collect and publish official statistics.
For what may be labelled the “pre-statistical” period – before 1860 – economic data
becomes scanty and is scattered around in numerous sources and regional studies, and
nearly no systematic efforts have yet been made to amass the economic data available
and to explore it in an all-Indian or international context. This is where the present
paper comes in. Here, grain prices stretching from 1700 to 1914 are compiled for both
India and Europe with the aim of assessing and comparing the efficiency of Indian
grain markets through time. For that purpose, correlation analysis and an error
correction approach are applied and price convergence and price volatility are
examined to gauge the relative level of and changes in grain market integration in
India throughout the 18th and 19th centuries. The contribution of an inquiry of this nature is twofold: First, as the quantitative
studies on Indian market integration are presently confined to the time after 1860,
such a study signifies a substantial extension back into the pre-statistical era that will
help to establish a much more complete chronology of Indian market integration. This
all the more as there is to date no study at all which looks at market integration in 18th
century India. Second, by performing the same tests with a new European database
and by discussing the results obtained for India against the background of recent
studies on historical market performance in Europe and China, India’s place in the
Great Divergence can be ascertained. Grain market efficiency has featured as one of
the prominent indicators for economic sophistication and potential in the Divergence
debate. This is understandable as most economists and economic historians would
agree that efficient market structures are both a testimony of economic sophistication
and prosperity as well as prerequisites for further economic growth.
As a consequence, determining the efficiency of Indian grain markets vis-à-vis their
European counterparts will help to assess the accuracy of the contradictory claims
made by both camps in the debate, positions that ultimately determine the
explanations as to why Europe industrialised first. Does the Indian case support the
traditional line of argument in that Indian market efficiency was already substantially
lower on the eve of the Industrial Revolution? Or are the results in line with the
revisionist California School argument contending that the extent of trade and the

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4 See for instance Kumar, “South India”, p. 358.
5 There are various possible reasons for this shortage, the most convincing being that general literacy,
and hence written culture, was much lower in India compared to contemporary Europe. See David
Landes’ short speculative discussion on this matter in Wealth and Poverty of Nations, pp. 163-64.
6 The various methods used all have their strengths and weaknesses, so that applying all of them should
increase the reliability of the results. Also, the slightly varying data requirements of the methods are
beneficial for the analysis as the data at hand is very heterogeneous.
efficiency of grain markets remained comparable in India until the end of the 18\textsuperscript{th} and the beginning of the 19\textsuperscript{th} centuries?

Before looking into this issue, we first need to become acquainted with the sources of evidence and the background to the question.

**Grain Prices and Grain Trade in India**

For the intended investigation, grain price quotations for India, which encompass the period from 1700 to 1914, have been collected from a variety of sources, including government papers, old statistics journals and the secondary literature. The early series are normally based on information from civil or military authorities (both Indian and English), Indian revenue functionaries (mamlutdars), or wholesale traders. Only the two most widely recorded grains – wheat and rice – were included, and the price series represent annual average prices, either for calendar years or for harvest years (June-May). In total, 54 price series for 35 different cities could be compiled for the pre-statistical era, of which 10 cities or market places are located in eastern India, 16 in western India, 8 in northern India and only one in Madras in the south (see Figure 1).

**Figure 1: Location of Markets with pre-1860 Price Series**

\[\text{[Map showing locations of markets]}\]

\[\text{[Caption:} \text{Figure 1: Location of Markets with pre-1860 Price Series}\]

\[\text{[Footnote:} \text{It needs to be said, however, that many sources do not indicate exactly how many observations were used to calculate averages. The prices are (with the exception of one series from Madras) always for one town or market. Also, almost no interpolations have been used: price series with gaps have generally been omitted.}\]

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For reasons of temporal comparison, some additional markets for the period after 1860, for which an abundance of price data is available, have been included in the study, so that the final database for the present investigation consists of 70 different price series (36 for wheat and 34 for rice) for 46 cities, which are spread all over the subcontinent. In many senses, this dataset is quite limited and heterogeneous, the latter not only in respect to the wide variety of sources it draws upon. The markets, for which data was available, vary greatly in their economic importance – from local to metropolitan – as do the time periods that the various price series cover. The average number of years a price series continuously covers is 47, the minimum number and maximum numbers being 19 and 160, respectively. And while a majority of the series were recorded under British rule, many were not and several price series even pre-date British arrival in that particular part of the country by half a century or more.\footnote{For more details about the price series and their sources please consult the appendix.}

To further acquaint the reader with the data, Figure 2 presents wheat price series for the different major regions in India between 1750 and 1914. These long price series already reveal some general features of the grain prices in 18th and 19th century India. For and foremost, Figure 2 reveals that the comparative price pattern before the 1850s looks fundamentally different from the post-1850 pattern.

**Figure 2: Convergence of Wheat Prices**

In the pre-1850 period, the price levels in all regions remained fairly stable, but there were shorter periods of rising or falling prices that can be observed. While prices fluctuated massively from year to year in all parts of India, prices were higher in the west than in Bengal or in the north. These year-to-year price movements seem in this early period completely unrelated between these distant places; even the massive price spikes did not coincide. The enormous price inflations are also an impressive testimony of the severity of the harvest failures that led to the Bengal famine of 1770 and to famines in the north (1783) and the west (1804) of the country. The fact that the magnitude of the price rises during these crises was even massively higher than
the ones during the terrible famines of 1876/77 and 1896/97 bode ill for the social and demographic impacts of the earlier famines, about which little is known.

In the post-1850 period, prices rose permanently in all regions until the outbreak of the World War. Not only did prices inflate similarly in all three regions during this later period, but the short-term variations also looked very similar. This feature contrasts starkly with the totally asynchronous price movements observed for the early period.

As this newly compiled grain price database shall primarily serve the purpose of assessing Indian grain market efficiency in the 18th and 19th centuries, some basics about grain production and grain transport are first sketched out before making use of the new database.

The spatial and temporal growing patterns of rice and wheat – as with all Indian agricultural products – were (and to some extent still are) above all determined by the monsoon, in particular the southwest monsoon (June-September), which supplies India with most of its annual rainfall. Rice, as a crop with a high water requirement, was the dominant crop in regions with high annual rainfall, such as Bengal, the eastern Indo-Gangetic plains, the coast of Konkan, Malabar, Tamil Nadu and the Krishna-Godavari delta. It was grown in the summer or ‘kharif’ growing season, which coincides with the southwest monsoon. Wheat, with a considerably lower water requirement (a ‘rabi’ or dry-season crop) was planted in the post-monsoon season (October-November) and harvested in February-March. The most important wheat growing regions were the Punjab and the western Indo-Gangetic plains.

But in pre-railway India, the monsoon not only shaped production of food grains but also their transport. As the heavy rainfall rendered road, river and sea transport virtually impossible, trade was predominantly carried out in the dry winter months from November to April.

Historiography contends that grain, as other goods, was traded on three different levels in pre-British India: local, regional, and long-distance, and much of that trade was in the hands of special merchant communities such as the Vanjari or the Banjara. Of the food grains traded, rice and wheat were certainly the most important. While the qualitative picture – what was traded, by whom and when – is well known, the quantitative aspect – how much grain (and other goods) was traded on the different levels and how efficient the markets for various products were on the subcontinent – is largely unknown, and is an issue of debate due to the aforementioned shortage of economic data for the period preceding the British takeover in 1858.

In the absence of widespread statistics on the volume of trade or on transport costs and transport capacities, such an assessment (of the efficiency and extent of grain trade) can arguably only be gauged using price data. The comparative analysis of grain prices from different markets has proved to be a valuable and reliable means for

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10 Divekar, Prices and Wages, p. 24.
11 In some parts of the country, millet production surpassed wheat and even rice production. However, the different types of millets, low quality but relatively drought-resistant food grains, were mostly consumed locally and not widely traded.
12 Comparing Roy, The Economic History, p. 26, 31-33, and Rothermund, Economic History, p. 3, on the one hand with Frank, ReORIENT, pp. 176-182, on the other side, illustrates the massive discrepancies in the estimated extent of trade in grain and other goods.
inferences about the extent of trade, the efficiency of markets, and the processes of integrating or disintegrating markets, and it has been applied for many countries in numerous studies.\(^\text{13}\) This makes sense as prices of widely consumed and traded goods – and grain was the most important in all pre-industrial economies – show several characteristics in integrated markets that they do not in fragmented markets, while the processes of increased (decreased) integration also exhibit characteristic price patterns. As a consequence, there are various formal methods for using grain prices for determining both the extent of market integration as well as the processes of integration or disintegration, and we now begin by determining the former.

### Gauging the Extent of Grain Market Integration

When market areas expand and formerly separated market places become part of one single market, the way prices are determined in these markets fundamentally changes. In totally unconnected markets, the local price of a product is determined by its local demand and supply. In the case of grain, it is the supply side – the annual harvest – which is by far the most important factor to have affected prices in pre-industrial societies. Demand, by contrast, was very stable in the short term, as grain dominated the diet of the people and was difficult to substitute. It modern terms, it was an inferior good with a low price elasticity. At the other extreme, when markets are perfectly integrated, the domestic price is independent of the local harvest: if the domestic market is small relative to the rest of the “world”, local harvest fluctuations only change the volume of imports or exports, while the domestic price equals the world price plus a transport cost. It should be noted that “world” should not be taken literally; it simply stands for the geographical extension of the single market, of which the domestic market constitutes a small part.

Over the last centuries, most places on earth have witnessed a dramatic change from a situation of nearly complete isolation to a state of close integration into a global market. This secular trend has not been without setbacks, and it has varied greatly for different products. Grain markets, with which this paper is concerned, became integrated considerably later than markets for many other products. This is because grain has a very high bulk-to-value ratio, and therefore requires a much more effective transport infrastructure than goods with a low bulk-to-value ratio such as fine cloth or spices.

Turning to India, we will be looking at such a transition towards more integrated markets when examining the grain trade in the 18\(^{\text{th}}\) and 19\(^{\text{th}}\) centuries. As a consequence, we will often be confronted with “partial integration” of two markets, meaning that the domestic price of grain is influenced by the local harvest and the “world” grain price. Hence it is appropriate to gauge both the importance of the local harvest and of the world price on the domestic price.\(^\text{14}\) However, as only price data and no harvest data is available, it is only possible to gauge to what extent the domestic price is connected to the world price; that is to say, how much the actual situation resembles the polar case of perfect integration. In perfectly integrated markets, it is the “law of one price” that determines the domestic price. The underlying logic of this so-called “law” is that once trade participants in two markets

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\(^{13}\) To name a few examples, there is for China: Li, “Integration and Disintegration”; for the Atlantic Economy: Jacks, “Intra- and International Commodity Market integration”; for Mexico: Dobado and Marrero, “Corn Market Integration”; for Europe: Persson, Grain Markets.

\(^{14}\) For a study which does exactly this, see Allen, “The Effect of Market Integration”.
share the same information and transport costs become small, price differentials between markets offer opportunities for arbitrage up to the point that prices are either the same in the two markets or reach a stable ratio where the difference in price equals transport costs. As a consequence, the two price series are expected in the long-run to show a linear relationship, while small local price shocks, which temporarily create disequilibria in this stable relationship, are quickly corrected for by arbitrage. Testing to what extent the newly compiled grain prices show these two characteristics therefore serves as the basic means for gauging the extent of grain market integration in India before 1914.

We begin by scrutinising the first characteristic of prices in integrated markets, which is whether they show a stable linear long-term relationship. The tool that is often applied to test for the presence of a linear relationship between stationary data series is correlation analysis, as it is a method to measure the strength or degree of linear association between two variables.\(^\text{15}\) Contrary to the related regression analysis, correlation analysis treats any (two) variables symmetrically, so that one single number, the so-called correlation coefficient, describes the association between these variables.\(^\text{16}\) Correlation coefficients indicate the quality of the binary relationship, because the higher the coefficient, the stronger the association between the variables. Hence higher coefficients suggest a more integrated market, and they are expected to decrease with the distance between two markets as transport costs rise. This interpretation of correlation coefficients is, however, not without problems. High correlations of price series from two markets might also result from sources other than an integrated market. The most likely other source of high correlation is very similar weather conditions in the two places, which would – also assuming similar production methods – lead to similar variations in yields. Consequently, as prices in fragmented markets are largely determined by local harvests – which, in turn, are heavily dependent on local weather – one would expect similar price movements in these two markets, even though they might be totally unconnected. As we will see, the correlation coefficients obtained make such an explanation highly unlikely. The problem of spurious correlation gets amplified if one were to use monthly data instead of annual data, as in this case part of the correlation may stem from the fact that seasonal price patterns are often very similar over large geographical areas, irrespective of how closely markets are linked.\(^\text{17}\)

The results of the correlation analysis are presented in Table 1, and they have been grouped and aggregated into three different time periods and according to the distance between the two markets. For the period from 1750 to 1830, 25 markets could be analysed, while prices from only 15 cities were available for the years 1825-1860. In the later years from 1870 up to World War I, even though there is an abundance of

\(^{15}\) As many of the price series, in particular all the post-1870 series, were non-stationary, all price series have been differenced for the analysis.  
\(^{16}\) It may rightly be objected that – especially in the process of expanding markets – price ratios are not expected to be stable over several decades. Price correlations are, especially when using annual data, an imperfect indicator for the extent of market integration – as are other indicators.  
\(^{17}\) Monthly data for correlation analysis is for instance used in Shiue and Keller, “Markets in China and Europe”, NBER paper, pp. 16-20, tables 2a and 2b, so that their results may be influenced by spurious correlation.
data, the analysis was restricted to 20 different markets. Combining the price series of these cities with each other, 450 binary relations (correlations) were examined in total, of which 83 for the first period under consideration, 74 for the second and 293 for the third. For various reasons, the number of binary relations (n) actually analysed is – in particular for the pre-1860 periods – far below the potential number of binary relationships that could be analysed combining prices from the respective numbers of markets in a sample. As mentioned before, the years covered by the individual series vary a lot, in particular for the earlier series. For instance, for the examination period from 1750-1830, none of the price series covers the entire period, and many price series do not overlap sufficiently to allow a reliable statistical examination. Also, for some markets only wheat or rice prices are at hand, and wheat (rice) prices were only compared to wheat (rice) prices. The same applies to the unit of measurement, which was harvest years in some cases and calendar years in others. Moreover, only “sensible“ relationships were included, meaning that very unlikely connections (such as a tiny market in the western hinterlands and an eastern trading centre) were dropped for the early period, which might bias the coefficients upwards compared to other studies.

Table 1: Price Correlations in India

<table>
<thead>
<tr>
<th></th>
<th>1750-1830 [n = 83]</th>
<th>1825-1860 [n = 74]</th>
<th>1870-1914 [n = 293]</th>
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<tbody>
<tr>
<td>&lt;-35 km</td>
<td>0.91 (0.07)</td>
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<tr>
<td>35-70 km</td>
<td>0.46 (0.30)</td>
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<tr>
<td>70-150 km</td>
<td>0.33 (0.16)</td>
<td>0.48 (0.18)</td>
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</tr>
<tr>
<td>150-300 km</td>
<td>0.26 (0.25)</td>
<td>0.35 (0.30)</td>
<td>0.75 (0.19)</td>
</tr>
<tr>
<td>300-600 km</td>
<td>0.02 (0.16)</td>
<td>0.14 (0.30)</td>
<td>0.73 (0.16)</td>
</tr>
<tr>
<td>600-1000 km</td>
<td></td>
<td>0.15 (0.28)</td>
<td>0.66 (0.19)</td>
</tr>
<tr>
<td>1000-1500 km</td>
<td></td>
<td>-0.01 (0.26)</td>
<td>0.56 (0.20)</td>
</tr>
<tr>
<td>&gt;1500 km</td>
<td>-0.06 (0.19)</td>
<td></td>
<td>0.41 (0.21)</td>
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n: total number of market pairs examined; standard deviations in parenthesis.
Distance ranges with n≤3 are not reported.

The results of the correlation analysis reveal above all a story of fundamental change. For the second half of the 18th century and the beginning of the 19th century, the law of one price is confirmed only in a local context; neighbouring villages or cities less than 35 km apart clearly exhibit a common price regime. But already the mean coefficient for the next distance range, spanning from 35 to 70km, is drastically lower (0.46), while the variation between the coefficients (summarised by the standard deviation) shoots up compared with the local level (0.30 compared to 0.07). This suggests that the prices of some market pairs in this distance range were still closely connected, while for others, such a connection was already very weak. The connection of prices becomes very weak for markets which are 70 to 300km apart from each other, while for prices in cities that are separated by more than 300km, no mutual influence is discernible.

18 Of which there are 5 for each major geographical region (north, south, east, and west). The choice of markets to include also had to be made so as to ensure that there was a good distribution of the distances between markets places in order to be able to detect differences according to distance.
19 The minimum number of years used for an analysis was 19.
Only a cautious interpretation can be attempted about how this situation of highly fragmented and localised markets changed over the next decades (1825-1860). Since prices from fewer cities were available for this period, and none were located closer than 100km of each other, the local and regional situation escapes our view. Judging from the slightly increased coefficients at all distance levels for which data is available for both periods, one might draw the conclusion that there was some, albeit very limited, progress.

The pace of market integration, however, increased dramatically in the period of the railway construction after 1860. The coefficients for the years from 1870 to 1914 increased for all distances to such an extent that one could already talk about a national market in which the prices in two cities, no matter how far apart, were interconnected. Over a century, progress was so far-reaching that price patterns of places that are 1000-1500km apart appear to be more similar to each other than prices in cities within a very close range of 35-70km had been 100 years before.

We now turn to the comparative aspect motivated by the Great Divergence debate to assess India’s relative economic performance. For this purpose, a database of wheat and spelt prices has been collected for Europe, which – in order to assure a maximum degree of comparability – shares some of the features of the Indian database. It consists of 20 markets, which like in the Indian case also vary greatly in their economic importance, but which again are spread over the whole continent while yielding information for all distance ranges. Also, most markets are not located on the coastline but are as in the Indian case in landlocked territories. Prices are also annual rather than monthly, even though the latter type of data is widely available for Europe and has often been favoured for studies on European market integration. Finally, the dataset encompasses like the Indian one the period 1700-1914. However, as sources on grain prices for Europe are much more abundant than in the Indian case, the coverage is much more complete, so that the average number of years covered by a price series is now 170 years, the maximum and minimum number being 205 and 45.\footnote{The cities in the European dataset are Amsterdam, Antwerp, Basle, Berlin, Bern, Krakow, Geneva, Lausanne, Lisbon, London, Lucerne, Milan, Munich, Paris, Schaffhausen, St Gall, Toulouse, Ueberlingen, Vienna and Zurich. Please consult the appendix for more information on the data and the sources.}

As a consequence, the correlation analysis could be extended back to 1700, while the first examination period used in the analysis for India (1760-1830) could be subdivided into two separate periods. The later examination periods, 1825-1860 and 1870-1914, are the same. Over the whole period 1700-1914, 547 binary relations (correlations) were examined in total, and the numbers of market pairs examined in each sub-period are again indicated in square brackets. While the presentation of the correlation results for Europe in Table 2 is identical to the one for India in Table 1, the results themselves are far from it.\footnote{As most prices series show longer periods of price increases, I have again worked with differenced series throughout to avoid spurious correlation.}

In the first half of the 18\textsuperscript{th} century, regional markets in Europe were already closely connected as indicated by a correlation coefficient of 0.73 for a distance range of 35-70km. Also, prices up to 300km show a considerable amount of co-movement. Yet
long-distance trade in grain must still have been very limited, as the connection between prices becomes very weak for all markets that were more than 300km apart. This picture of fragmented long-distance markets does not alter over the next decades. Regional and intra-regional markets, however, become more and more integrated; for the period 1750-1790 prices in markets up to a distance of 300km were clearly heavily influenced by the same market forces. At around the turn of the 19th century, the geographical expansion of markets started to extend to the long-distance trade; in the 1790-1820 period the correlation coefficient is 0.5 or higher for markets up to a range of 600km.

Table 2: Price Correlations in Europe

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<tbody>
<tr>
<td>&lt;35 km</td>
<td>0.73 (0.10)</td>
<td>0.78 (0.24)</td>
<td>0.83 (0.20)</td>
<td>0.83 (0.21)</td>
<td>0.75 (0.11)</td>
</tr>
<tr>
<td>35-70 km</td>
<td>0.76 (0.16)</td>
<td>0.78 (0.17)</td>
<td>0.65 (0.07)</td>
<td>0.58 (0.28)</td>
<td>0.74 (0.18)</td>
</tr>
<tr>
<td>70-150 km</td>
<td>0.51 (0.08)</td>
<td>0.60 (0.18)</td>
<td>0.71 (0.15)</td>
<td>0.76 (0.15)</td>
<td>0.76 (0.15)</td>
</tr>
<tr>
<td>150-300 km</td>
<td>0.27 (0.17)</td>
<td>0.25 (0.28)</td>
<td>0.50 (0.35)</td>
<td>0.48 (0.22)</td>
<td>0.72 (0.14)</td>
</tr>
<tr>
<td>300-600 km</td>
<td>0.35 (0.19)</td>
<td>0.14 (0.17)</td>
<td>0.44 (0.38)</td>
<td>0.36 (0.30)</td>
<td>0.60 (0.08)</td>
</tr>
<tr>
<td>600-1000 km</td>
<td>0.26 (0.19)</td>
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</tr>
</tbody>
</table>

n: total number of market pairs examined; standard deviations in parenthesis.
Distance ranges with n<3 are not reported.

The difference to India is striking: There, correlation coefficients of 0.5 or higher were restricted to local markets closer than 35km during the first examination period (1760-1830). Meanwhile, in Europe many markets even up to distance of 1000km were now (1790-1820) reasonably connected, as can be deducted from the large standard deviation (0.38) for the distance range of 600-1000km. An encompassing integration of the long-distance trade in grain, however, needed decades more of steady market expansion, driven by the emergence of modern transport and information systems and less protective trade policies. By the late 19th century there seems to have been a truly European grain market, depicted in Table 2 by consistently high correlations coefficient and low standard deviations for all distance ranges in this period (1870-1914). When comparing these numbers for the last period with the results obtained for the first examination period, it becomes apparent how far-reaching the changes in the 18th and 19th centuries have been in terms of economic integration: correlation coefficients that were in the early 18th century typical of regional markets within a range of 35-70km where by the late 19th century typical of markets as far apart as 1000-1500km. This was a truly revolutionary development.

The comparative picture emerging from Tables 1 and 2 is one of similar trends but stark differences in terms of the timing and level of market integration. In both Europe and India, the extent of trade and the degree of market integration in 1900 were radically different from what they had been in 1700 or 1750. By the turn of the 20th century both regions had grain markets that spanned their entire continent or sub-continent respectively and both were closely integrated into the world markets for grain.
Yet the level of market integration was higher in Europe throughout the entire examination period. Moreover, this difference varied greatly over time. Europe started at a considerable higher level of market integration than India; the correlation results suggest that Europe’s level at the beginning of the 18th century already surpassed the one India attained in the late 18th and early 19th centuries. By the latter time period, due to an early and steady expansion of European markets during the 18th century, the extent of trade and the efficiency of markets were radically different in these two regions. This early expansion of European markets compared to India continued through the first half of the 19th century and made the differences even more pronounced. India’s economic integration only gathered pace in the second half of the 19th century, but then it proceeded at a very fast pace, so that in comparative terms, this was a period of rapid catch-up for India. Nevertheless, the improvements were not quite far-reaching enough to close the gap; market efficiency as measured by correlation coefficients remained higher in Europe still.

Another relevant comparative aspect is how these new results for Europe and India compare with existing studies using correlation analysis to gauge the extent of trade and market integration. One of the most extensive studies using this technique is by Carol Shiue and Wolfgang Keller, where they focus on comparing Europe and China in the 18th century. Their results are reproduced in Table 3, and they are based on a sample of monthly grain prices for 34 Chinese and 15 European markets.\(^22\)

Table 3: Price Correlations in China and Europe

<table>
<thead>
<tr>
<th>Distance Range</th>
<th>Europe 1770-1794</th>
<th>1831-1855</th>
<th>China (Yangzi River) 1770-1794</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 105)</td>
<td>(n = 105)</td>
<td>(n = 561)</td>
</tr>
<tr>
<td>&lt;150 km</td>
<td>0.83 (0.09)</td>
<td>0.96 (0.03)</td>
<td>0.81 (0.09)</td>
</tr>
<tr>
<td>150-300 km</td>
<td>0.65 (0.15)</td>
<td>0.94 (0.03)</td>
<td>0.74 (0.12)</td>
</tr>
<tr>
<td>300-450 km</td>
<td>0.55 (0.21)</td>
<td>0.85 (0.07)</td>
<td>0.68 (0.10)</td>
</tr>
<tr>
<td>450-600 km</td>
<td>0.53 (0.17)</td>
<td>0.83 (0.06)</td>
<td>0.66 (0.09)</td>
</tr>
<tr>
<td>600-750 km</td>
<td>0.39 (0.15)</td>
<td>0.78 (0.08)</td>
<td>0.64 (0.10)</td>
</tr>
<tr>
<td>750-900 km</td>
<td>0.33 (0.16)</td>
<td>0.74 (0.02)</td>
<td>0.61 (0.11)</td>
</tr>
<tr>
<td>900-1050 km</td>
<td>0.30 (0.09)</td>
<td>0.72 (0.04)</td>
<td>0.57 (0.08)</td>
</tr>
<tr>
<td>&gt;1050 km</td>
<td>0.30 (0.10)</td>
<td>0.57 (0.12)</td>
<td></td>
</tr>
</tbody>
</table>

\(n\): total number of market pairs examined; standard deviations in parenthesis.

All the figures are taken from Shiue and Keller, “Markets in China and Europe”, NBER paper, tables 2a and 2b.

Clearly, Shiue and Keller’s results depict a very similar trend for Europe to the one shown in Table 2. Yet their coefficients are systematically larger across distances and time, hence suggesting a higher level of market integration than the one proposed by Table 2. The main factor accounting for these discrepancies surely is the very different sample of market used. While the large majority of cities used in the present study are located in landlocked parts of Europe, Shiue and Keller’s data is mostly for places with either direct or nearby access to the sea.\(^23\) Since in the pre-railroad era,


\(^{23}\) In their 18th century sample, 11 out of the 15 markets either have a harbour or are situated in or at the edge of the lowlands of northern Germany, Holland, and Flanders where they were typically on a bank
water transport was far cheaper and faster than overland transport, it is hardly surprising that Shuie and Keller find a higher degree of market integration for a sample where the option of shipping goods on the sea or on rivers was much more commonly available.24

What the present results and their comparison to recent studies on European market integration thus suggest is that the overall extent has probably sometimes been overestimated. Landlocked Europe, which lacked Britain’s or the Low Countries’ endowment of natural waterways do indeed seem to have had well integrated grain market on a regional and inter-regional scale of up to, say, 300km. Yet the present evidence does not corroborate popular views on long-distance trade, such as Karl Gunnar Persson’s claim of an “emerging integrated European wheat market” in 18th century Europe.25 The expansion of commerce that included the widespread long-distance trade in bulky goods and led to the formation of a European grain market clearly seems to have been a 19th century development. Such a conclusion does, of course, underline the importance the railways for the economic integration of Europe.

Let’s conclude the correlation analysis by briefly looking at Shiue and Keller’s results for China. Quite surprisingly, the coefficients are actually slightly higher than for Europe, suggesting that markets were at least as integrated in that part of China as they were in Western Europe and much more so than on the Indian subcontinent. Yet some caution is again recommended when making comparisons to the present landlocked samples, since the Chinese sample – “Yangtze River” – is by definition biased towards markets with an exceptional natural endowment for cheap river transport.26

An Error Correction Approach

While correlation analysis served the purpose of detecting linear long-term relationships between prices, the error correction (EC) approach enables us to test for both the co-movement of prices and adjustment processes between two markets. The basic idea underlying this method is that if price series in two markets show a linear relationship, short-term shocks which break down this stable price ratio cannot persist permanently as arbitrage between the markets prevents this. The higher the efficiency of the markets, that is, the more integrated the markets are, the faster this error in the equilibrium price ratio is re-established. A simple version of an ‘error-

24 A very nice literature overview on the European transport infrastructure in the pre-railway era including estimates of transport costs for various modes of transport is provided in Weber, Untiefen, Flut und Flauten, pp. 15-110.
25 Persson, Grain Markets, p. 100. Another recent study on European market integration that is using correlation analysis and finds very well-connected distant markets in 18th century Europe is David Jacks’ “Market Integration in the North and Baltic Seas”, pp. 292-4 and Figures 4-6. Again, Jacks’ focus is also on regions that are particularly well-endowed with natural waterways.
26 Shiue and Keller also provide results for a sample of provincial capitals. These coefficients are then somewhat lower than the ones for Europe. However, they are still far higher than any from the analysis on India. Shiue & Keller, “Markets in China and Europe on the Eve of the Industrial Revolution”, NBER paper, 2004, Table 2a.
The "error correction model" (ECM) therefore relates the price in one city to an equilibrium error term, which is defined as the extent to which the stable price ratio between the two price series was in disequilibrium in the preceding time period. The more two markets are integrated, the faster the stable relationship will be re-established, hence the bigger the coefficient on the error term will become. Accordingly, the degree of co-movement of the price series is also expected to rise with the level of market integration.

Since little information about transport costs and markets structures is available, only a very simple model can be estimated;

\[
\Delta \log P_{1,t} = \theta_1 (\log P_{1,t} - \log P_{2,t})_{t-1} + c_1 + \varepsilon_{1,t} \quad (1)
\]

\[
\Delta \log P_{2,t} = \theta_2 (\log P_{2,t} - \log P_{1,t})_{t-1} + c_2 + \varepsilon_{2,t} \quad (2)
\]

where \( P_1 \) and \( P_2 \) are the prices in locations 1 and 2, while \( \theta_1 \) and \( \theta_2 \) are the error correction coefficients which indicate how fast each market adjusts to shocks. The degree of co-movement of the prices in \( P_1 \) and \( P_2 \) is measured by the correlation, \( \rho \), between the error terms \( \varepsilon_{1,t} \) and \( \varepsilon_{2,t} \), which are assumed to be normally distributed with mean 0. Finally, the constants \( c_1 \) and \( c_2 \) capture the long-run differences in the price levels, and they have been left unrestricted to allow for different transport cost according to direction. As a consequence, all the parameters in equations (1) and (2) are unrelated so that the equations can be estimated by simple OLS regressions. To eliminate problems arising from the non-stationarity of price series, the series used were differences in the logs of prices and gaps between the logs of prices.

A bivariate model is being used to allow for adjustments in both markets. Not doing so would imply that one of the prices is exogenous, that is to say that only one market responds to price disequilibria. In other words, one would impose an assumption that one of the two markets is always dominating, and such an assumption can, given the scant information about the market structures in earlier periods, not be justified for our sample of markets. As the terms \( (\log P_2 - \log P_1)_{t-1} \) and \( (\log P_1 - \log P_2)_{t-1} \) represent the price gaps at time \( t-1 \), \( \theta_1 \) and \( \theta_2 \) therefore indicate the percentage of the price differential at \( t-1 \) that is corrected for in one period \( t \). In functioning markets, we expect \( \theta_1 < 0 \) and \( \theta_2 > 0 \), and we interpret higher estimates of these coefficients as a sign of more efficient markets.

Since we are primarily interested in the speed of the adjustment and not so much in the market structure between two cities, we also estimate the so-called marginal model of the system above. This enables us to estimate the total adjustment, \( \gamma \), which combines the adjustment process in both markets, together with the significance level of the total adjustment. To derive the marginal model, we subtract (2) from (1):

\[
(1) - (2): \Delta \log P_{1,t} - \Delta \log P_{2,t} = (\theta_1 - \theta_2) (\log P_{1,t} - \log P_{2,t})_{t-1} + (c_1 - c_2) + (\varepsilon_{1,t} - \varepsilon_{2,t})
\]
By substituting

\[ q_t = \log P_{1,t} - \log P_{2,t}, \]
\[ \alpha = c_1 - c_2, \]
\[ \gamma = \theta_1 - \theta_2, \]
\[ u_t = \varepsilon_{1,t} - \varepsilon_{2,t}, \]

we get

\[ \Delta q_t = \alpha + \gamma (q_{t-1}) + u_t \]

(3)

The total adjustment between markets 1 and 2 is represented by \( \gamma \), which is invariant to the choice about which market of a market pair we label \( P_1 \) and \( P_2 \), and we expect \( \gamma < 0 \) in functioning markets. The bigger the value of \( \gamma \), the faster the overall adjustment process. Hence a larger \( \gamma \) points to more efficient markets. We also want to test the hypothesis of whether the total adjustment, \( \gamma \), really is significant, which is to say that we test whether \( \gamma = 0 \). Since the appropriate test statistic for this is Dickey-Fuller distributed rather than standard normal, the critical value at a 95\% confidence level (one-sided test) is -2.86 instead of -1.64.\(^\text{27}\) Again, equation (3) can be estimated by OLS regression.

A short example will illustrate the use of this simple error correction model and the interpretation of its results. By using annual rice prices from the cities of Pune and Ahmedabad, both located in western India some 660km apart, we estimate first the system given by equations (1) and (2), and afterwards the marginal model given by equation (3). From equations (1) and (2), we get estimates for \( \theta_1 \) and \( \theta_2 \), for \( \rho \)- the correlation between the error terms \( \varepsilon_{1,t} \) and \( \varepsilon_{2,t} \), and for \( R^2 \). Also, if either \( \theta_1 \) or \( \theta_2 \) are not statistically significant, we detect a weak exogeneity, meaning that only one of the markets adjust to price gaps. From equation (3), we get an estimate for \( \gamma \), i.e. for the total adjustment to price gaps in the two markets combined. When doing this for two time periods, from 1825 to 1860 and from 1870 to 1914, we obtain the results shown in Table 4.\(^\text{28}\)

<table>
<thead>
<tr>
<th>( \theta_1 )</th>
<th>1825-1860</th>
<th>1870-1914</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.09 (-0.82)</td>
<td>-0.44 (-2.38)</td>
</tr>
<tr>
<td></td>
<td>0.28 (1.88)</td>
<td>0.39 (1.77)</td>
</tr>
<tr>
<td>( \gamma )</td>
<td>-0.37 (-2.92)</td>
<td>-0.83 (-5.48)</td>
</tr>
<tr>
<td>Correlation, ( \rho )</td>
<td>0.56</td>
<td>0.73</td>
</tr>
<tr>
<td>Weak exogeneity</td>
<td>Pune</td>
<td>Ahmedabad</td>
</tr>
<tr>
<td>( R^2 ) (system)</td>
<td>0.20</td>
<td>0.43</td>
</tr>
</tbody>
</table>

\( P_1 = \) Pune, \( P_2 = \) Ahmedabad; test-statistics in parenthesis

During the earlier period, the degree of co-movement of the prices in Pune and Ahmedabad was only moderate (\( \rho = 0.56 \)), while the speed of adjustment to price differentials was still very slow: In any given year, only 37\% of an emerging price gap was adjusted for in total (\( \gamma = -0.37 \)). This total adjustment is largely accounted for

\(^{27}\) Hendry and Nielsen, \textit{Econometric Modeling}, p. 249.

\(^{28}\) For all the estimations in this section, PC Give of the OxMetrics software package has been used.
by the adjustment happening in Ahmedabad ($\theta_2 = 0.28$), while the adjustment process in Pune is actually not even statistically significant at a 90% level, so that we speak of a weak exogeneity in Pune, meaning that prices in Pune were not influenced by the prices in Ahmedabad. The explanatory power of the simple system of (1) and (2) is fairly limited ($R^2$ of the system $= 20\%$). In the second period (1870-1914), the synchronisation of prices was considerably stronger ($\rho = 0.73$), while also the speed of adjustment increased, so that on average 83% ($\gamma = -0.83$) of a price gap arising at time $t$ was corrected for at time $t+1$. Also, the t-values of the adjustment coefficients have increased, even though one of them ($\theta_2$) is still not significant at a 90% level. At the same time, the explanatory power increased as well ($R^2 = 43\%$). Since both coefficients of interest – the correlation, $\rho$, as a measure of the co-movement of prices and $\gamma$ as the coefficient capturing the annual adjustment to emerging price differentials – increase from the first to the second period, we conclude that the market mechanisms between these two cities have become more efficient.

This procedure was repeated for other market pairs as done in the previous section on correlation analysis, and the estimates for the indicators of interest (correlation, $\rho$, and the total error correction term, $\gamma$) have again been grouped according to distance and time period. In total, this estimation process was repeated for 262 market pairs – 83 of which cover the period 1750-1830, 74 the period 1825-1860, and 105 the period 1870-1914. The results are shown in Table 5.

**Table 5: Error Correction Models**

<table>
<thead>
<tr>
<th>Distance Range</th>
<th>1750-1830 ($n = 83$)</th>
<th>1825-1860 ($n = 74$)</th>
<th>1870-1914 ($n = 105$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\rho$</td>
<td>$\gamma$</td>
<td>$\rho$</td>
</tr>
<tr>
<td>&lt;35 km</td>
<td>0.96</td>
<td>-0.77 (79%)</td>
<td>0.67</td>
</tr>
<tr>
<td>35-70 km</td>
<td>0.67</td>
<td>-0.92 (91%)</td>
<td>0.58</td>
</tr>
<tr>
<td>70-150 km</td>
<td>0.34</td>
<td>-0.89 (79%)</td>
<td></td>
</tr>
<tr>
<td>150-300 km</td>
<td>0.31</td>
<td>-0.74 (80%)</td>
<td>0.47</td>
</tr>
<tr>
<td>300-600 km</td>
<td>0.18</td>
<td>-0.54 (100%)</td>
<td>0.25</td>
</tr>
<tr>
<td>600-1000 km</td>
<td></td>
<td></td>
<td>0.18</td>
</tr>
<tr>
<td>1000-1500 km</td>
<td></td>
<td></td>
<td>0.19</td>
</tr>
<tr>
<td>&gt;1500 km</td>
<td>-0.01</td>
<td>-0.28 (0%)</td>
<td></td>
</tr>
</tbody>
</table>

$n$: total number of market pairs examined; distance ranges with $n \leq 3$ are not reported.
Percentage of test statistics of $\gamma$s significant at a 95% level in parenthesis.
(Critical value of -2.86 from Dickey-Fuller distribution)

The general picture that arises from this summary table is strikingly similar to the picture that correlation analysis yielded. The estimates for both the correlation as well as the adjustment terms generally decrease with distance and increase over time. In the present case, however, more caution is needed as the interpretation of the coefficients is not as straightforward as for the correlation analysis. The prime reason for this is that the processes of co-movement and *inter-annual* adjustments are not independent. First, it has been mentioned above that the equilibrium error-correction mechanism assumes a presence of an equilibrium price. Consequently, equilibrium error correction without co-movement – hence without equilibrium price – is hardly a sign of efficient market structures, but more likely an effect of uncorrelated local shocks that peter out over time. Second, the speed of adjustment influences the degree
of co-movement of prices. This is of particular relevance because of the low-frequency data (annual) that is used here. If there is intensive year-round trade between two places, the co-movement between these prices will be higher than in a place where trade is limited. Moreover, the price differences after a shock in one place will in such cases not be fully detectable in an annual data series, as part of this difference will be corrected for by *intra-annual* arbitrage. This means that one could encounter a high degree of co-movement together with a moderate degree of inter-annual adjustment.

Turning to the results for India, this last distortion is not very likely to have affected the results for the late 18th century and early 19th century. Trade was restricted to a few months, as the monsoon inhibited transport on a very poor transport network for many months of the year. When looking at Table 5, we do indeed not see high co-movement of prices with relatively low adjustment. What we do see, is a very low degree of co-movement for distances in excess of 70km, together with still fairly substantial adjustment terms. As mentioned above, such a combination is hardly a sign of well-integrated markets. For large distances, both the co-movement of prices and the adjustment to shocks becomes low and insignificant for the early period.

When moving to the second period, a joint interpretation of correlation and adjustment suggests that the reach of market forces has spread beyond the local sphere, up to distances of 300km, where we now find high and often significant adjustment terms alongside substantial co-movement. For larger distances, co-movement and adjustment are still very low and mostly insignificant.

As with correlation analysis, the picture changes radically when moving to the late 19th century. Now the co-movement of prices becomes very strong, not only for shorter distances, but even for places further apart then 1500km. At the same time, annual adjustments are now nearly always significant for all distances ranges. However, the adjustment coefficients have not increased, but are only moderate for all distances.29 It seems that we encounter exactly the case outlined above, where *intra-annual* adjustment drives up the annual co-movement of prices, while not really increasing or even lowering the degree of *inter-annual* adjustments. Such an interpretation seems perfectly compatible with the emergence of a modern transports network in the late 19th century that for the first time made year-round trade of bulky goods possible.

One last factor worth considering in this respect is that the size of the price shocks present in annual data, whose correction we are measuring, have not remained constant over time, but have decreased a lot, especially in the late 19th century.30 And an error correction of 50% of a massive price differential is not the same thing as a 50% correction of a small error. Small errors are much more likely to persist, even in well integrated markets, as at some point the price difference might be lower than the total transaction costs, therefore providing no incentive for arbitrage anymore.

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29 What the aggregate figures hide is that the estimates of all indicators for period 1870-1914 show quite a high degree of variation. Probably the prime reason for this is the uneven development of market connections in this period, the likely cause of which was that the British were above all interested in connecting the big ports by railway with their hinterland in order to boost exports. The connection of the interior of the country that called for the establishment of cross-connections was not of immediate concern for the Crown. Kulke and Rothermund, *A History*, p. 263.

30 We will shortly look at this process when determining the extent of price convergence.
Clearly, while it seems perfectly fine to use annual data for estimating error correction models for the late 18th century and the early 19th century, the limitations of such an approach for analysing adjustment processes in late 19th century India become very apparent. A good part of the adjustment process seems now to fly below the radar provided by annual data.

For these reasons, applying the same procedure to Europe will – given the considerably higher degree of integration throughout the period – yield results that suffer from these shortcomings even for earlier periods. European markets have been analysed by other scholars who estimated error correction models with higher frequency (e.g. weekly or monthly) data. Comparisons to, and among, these studies are not straightforward and not always very transparent. Not only do the data frequencies vary, but these models also come in many different specifications. Nonetheless, it is certainly possible to make a rough assessment of comparative market efficiency. Indeed, great precision is unnecessary because Europe and India were dramatically different. Already for late 17th and early 18th century France, O’Grada and Chevet find for cities of up to a distance range of about 250 km both co-movement of prices and fairly quick adjustment processes. For very distant markets, however, the adjustment processes were still extremely slow up to the 19th century. This changes in the 19th century, and the “emergence of a truly international market for wheat” has recently been dated at around 1835. For this period, a moderate degree of co-movement and fairly fast adjustment processes are in India still restricted to distance ranges below 300km. Meanwhile in Europe, markets seem to have functioned pretty efficiently even during famine conditions. In the course of the revolutionary developments in transport and communication from the 1870s onwards, the pace of the integration increased yet more: By the late 19th century, adjustment processes to price differentials even between distant markets were down to a couple of weeks, not just across Europe but even between US export centres and European cities.

Concomitants of Integrating Markets: Price Convergence and Decreasing Price Volatility

In the process of market integration, domestic prices that were formerly independent of the world price are becoming more and more determined by the latter. It logically follows from the law of one price that in the process of such a transition there has to be a convergence of the prices towards a single price or – due to transport costs – to a stable price ratio. Unsurprisingly, commodity price convergence is considered a reliable indicator for expanding markets, and history offers plenty of examples of convergence as a consequence of increased trade opportunities. Long grain price series for the major regions of India from 1760 to 1914 confirm this and offer a powerful illustration about the timing and extent of grain market

32 Persson, Grain markets, p. 100.
34 O’Grada, “Markets and Famines”.
35 Ejrnæs, Persson and Rich, “Feeding the British”, pp. 22-29”.
integration on the Indian subcontinent. Long wheat price series have already been shown in Figure 2, and the corresponding rice price patterns are shown below in Figure 3.

Figure 3: Convergence of Rice Prices

![Figure 3: Convergence of Rice Prices](image)

When looking at the course of the prices depicted in those two graphs, it can be said that price levels seem to have remained more or less stationary in all regions until about 1850, while prices for the same grain in different markets seem to have been totally unconnected: prolonged and massive differences in price levels were normal, price movements were asynchronous and big price spikes did not coincide. This strongly suggests that distant grain markets remained fragmented until the 1850s.

In the following decade, price movements in different markets started resembling one another, while the differences in the price levels were still rather big, a fact that can be explained by the persistence of fairly high freight rates in these years. Around 1890 this situation changed as prices began to converge and price differentials began to disappear. This suggests that at the turn of the 20th century, a national grain market seems to have evolved. Price patterns after 1850 also differ from earlier times in that price levels did no longer remain stationary, but were persistently rising until World War I.

This process of price convergence is depicted even more persuasively when it is condensed into one single series, either into the coefficient of variation or into the so-called sigma convergence, i.e. the trend rate of decline of the coefficient of variation over time (Figure 4). For both indicators of convergence, the same regional rice prices as for Figure 3 have been used. Indeed, even for as long a period as 150 years, the

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37 Fairly high freight rates impeded the full utilisation of the railway network during the first decades of its existence. Subsequently, freight rates were reduced by one third between 1880 and 1900; the shipment of grain for export increased from 3 million to 10 million tons annually over these twenty years. Rothermund, *Economic History*, p. 36.
Sigma convergence yields highly significant coefficients, underlining the robustness of this trend of price convergence across India. As for the timing of the convergence, the coefficient of variation provides us with more precise information than Figure 3: A first drop in the price variation across regions is visible during the first two decades of the 19th century, while a second one starting in the 1870s and lasting up to the turn of the 20th century lead to a near equalisation of prices across the subcontinent.

Looking at the bigger international picture it appears that the Indian national market for grain emerged around the same time as India became integrated into the Asian (or world) rice market. The levelling of prices in the Asian rice market is illustrated in Figure 5, which presents long price series from different locations in Asia. Throughout the 18th and the first half of the 19th century, differences in price levels were pronounced and short and medium-term price movements were independent in India, China, Japan and Indonesia. Rice in Bengal was mostly cheaper than in Indonesia, and much cheaper than in the Yangtze valley. Rice prices in Japan started at a very high level, but then decreased in the 1720s and remained mostly the lowest thereafter until the mid-nineteenth century. This is also when price gaps within Asia began to decrease substantially and from the 1870s onwards, a time of rapid market expansion, price movements also started to resemble each other. Consequently, the interpretation suggested by this graph is that at the end of the 19th century the extent of the rice trade in Asia was for the first time sufficient to have a clear effect on prices across the region. Judging by the extent of co-movements of prices, the degree of international integration was, however, not quite comparable to the national development.

38 For the market expansion in late 19th century Asia, see Latham and Neal, “The International Market”.
39 Note here that these two developments, the integration of the Indian national market and the integration of Asian markets, mutually influenced each other. On the one hand British India became a major exporter of grain. On the other hand, the international market served as an incentive for further market integration within India and clearly influenced the course of it. See also footnote 29 on this issue.
A second concomitant of an expanding market is a decrease in the single-market price volatility. Price volatility is normally higher in fragmented markets compared to integrated markets; in the latter case, large variations in the local harvest (predominantly determined by local weather conditions) translate into only limited price shocks as they are damped by the possibility of geographical arbitrage between surplus and deficient regions.\(^{40}\) The measure used here for price volatility in a market is the coefficient of variation, which is defined as the standard deviation divided by the mean.\(^{41}\) The Indian markets, for which grain prices are at hand for several decades at the end of both the 18th and the 19th century, are markets that were amongst the most important at the time: the Mughal capital Delhi, the Maratha capital Pune and Calcutta, the raising centre of British power.

Table 6 shows that the wheat price volatility in these centres was massive in the second half of the 18th century, with an average annual price fluctuation of between 34% and 78% of the mean price. In the 19th century this changed dramatically so that the coefficients of variation fell below 20% in all three markets, suggesting a fundamentally different market structure. From the same table it becomes equally apparent that the situation in Europe at the time was very different. At the end of the 18th century, the wheat price volatility in Indian markets was about 2 to 4 times higher than in a selection of big European markets.

\(^{40}\) When working with historical price series one has to be aware that low price volatility might also be a result of poor data quality. Contract prices and regional averages especially tend to show lower volatility and it is thus important to check whether the data used reflect proper market prices.

\(^{41}\) For non-stationary data, one needs to account for the fact that the mean is changing. As a consequence, the coefficients of variation for the 1870-1910 period has been calculated as the average of the coefficients calculated for each of the four decades.
### Table 6: Coefficients of Variations

<table>
<thead>
<tr>
<th></th>
<th>1764-1794</th>
<th>1870-1910</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wheat Prices</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pune</td>
<td>0.34</td>
<td>0.19</td>
</tr>
<tr>
<td>Calcutta</td>
<td>0.79</td>
<td>0.14</td>
</tr>
<tr>
<td>Delhi</td>
<td>0.77</td>
<td>0.18</td>
</tr>
<tr>
<td>Paris</td>
<td>0.16</td>
<td>0.14</td>
</tr>
<tr>
<td>London</td>
<td>0.16</td>
<td>0.14</td>
</tr>
<tr>
<td>Berlin</td>
<td>0.19</td>
<td>0.14</td>
</tr>
<tr>
<td>Milan</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Amsterdam</td>
<td>0.17</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>Rice Prices</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcutta</td>
<td>0.38</td>
<td>0.18</td>
</tr>
<tr>
<td>Pune</td>
<td>0.29</td>
<td>0.12</td>
</tr>
<tr>
<td>Yangtze Valley</td>
<td>0.19</td>
<td>0.18</td>
</tr>
<tr>
<td>Osaka</td>
<td>0.20</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Comparing these findings with David Jack’s analysis of pre-modern European market integration suggests two things: First, the volatilities calculated for Europe and shown in Table 6 are comparable to the price volatilities he found for 18th century Europe and – second – not at any time after 1500 was the wheat price volatility in major European markets as high as in late 18th century India. However, as the price volatility only decreased modestly in 19th century Europe, volatilities in India and Europe had become comparable at the end of this century, even though prices in Pune and Delhi still fluctuated more than in any other city included in the sample. An analogous comparison of the price volatility of rice in India versus China and Japan shows a similar pattern. The coefficients for India are on average about 70% higher than the ones in Osaka and the Yangtze valley in the late 18th century. But as volatility declined much more sharply in India than in the other places thereafter, rice price volatilities in Pune and Calcutta are by the late 19th century comparable to the ones in Osaka and the Yangtze valley.

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42 Jacks, “Market integration”, pp. 291-92 and Figure 2.
43 When attempting such geographical comparisons, one should bear in mind that factors other than the degree of market integration can affect the level of price volatility. Especially when comparing over large distances, higher (lower) climatic variability might explain higher (lower) price volatility. Therefore, higher single-market grain price volatility in India might partly be explained by higher climatic variability, which seems very reasonable in view of the erratic monsoon climate which dominated most of Indian agriculture (and still does). So at a comparable degree of market integration, single-market price volatility might be higher in India than in Europe. Another blurring effect might stem from price controls by authorities. In China, for instance, intervention had been frequently practised in the 18th century so that the low volatility in the Yangtze valley may partly be a result thereof rather than of high market efficiency. The same applies also to Europe and Japan, where interventionist policies were common in times of dearth. I would like to thank Ken’ichi Tomobe for pointing this out to me with respect to Japan. Finally, consumer habits influencing short-term changes in demand can influence price volatility over time, across space, and between different grains.
The results from the quantitative investigations presented in the preceding two sections tie in well with both the general history of India and as with may be labelled the traditional or mainstream qualitative accounts of Indian market integration. Other than the revisionist accounts of Frank, Pomeranz, or Chaudhuri, this mainstream view contends that the emergence of integrated commodity markets in India – as opposed to markets for luxury or high-value goods – was a process that only really started in the second half of the 19th century. Before, it is argued, the markets for most products – for grain as a good with a high bulk-to-value ratio in particular – remained largely isolated due to high transportation costs and political fragmentation. 44 A very brief account on these issues will help to illuminate the grounds upon which these mainstream conclusions rest, and it will supply a historical narrative supporting the quantitative analysis.

In the century following the accession of Akbar (1556), most of India experienced an epoch of relative peace, political stability and prosperity, in which trade expanded and urban centres grew everywhere. This situation started to change, however, when under Aurangzeb’s reign (1658-1707) the Mughal empire expanded so much that it could hardly be ruled any longer. To finance his southern conquest, which had the aim of uniting northern and southern India under his rule, Aurangzeb’s demand for revenue became increasingly oppressive. This, in turn, initiated widespread peasant revolts that added to an ever more rebellious climate in a situation of already decaying political stability. After Aurangzeb’s death, the short succession of weak Mughals aggravated the situation further and led to a rapid erosion of Mughal central power. In the 1730s, the Marathas raided both Delhi, the Mughal capital, and Surat, which subsequently lost its role as the great port of the empire within a few decades. While Mughal power was rapidly diminishing, a struggle of regional powers for supremacy over parts of India emerged, with the Afghans, the Marathas, and several Mughal governors being the main contenders. The Europeans, meanwhile, remained still very marginal to the Indian political scene until the middle of the 18th century. Not surprisingly, this decay of political stability and insecurity of life and property resulted in a dwindling trade. Merchants became an easy target for robbers and government officers alike, while trade routes became increasingly unsafe or were disconnected altogether. Long-distance trade seems to have suffered most, and some regions were far more affected than others. 45 Moreover, political regionalisation led to the introduction of new duties, thus further lowering incentives to trade. A related

44 For the mainstream view, see for instance Rothermund, Economic History; Kulke & Rothermund, A History; Roy, The Economic History, p. 30-31; Banerjee, Internal Market; Kessinger, “North India”; Bhattacharya, “Eastern India I”; Kumar, “South India”; Divekar, “Western India”; Divekar, Prices and Wages; McAlpin, “Railroads, Prices and Peasant Rationality”. As already mentioned in the introduction, there is a revisionist view on this matter, which asserts that markets in pre-British India were efficient and comparable to European markets, and that grain was a widely traded good. This view has recently been popularised by Andre Gunder Frank’s ReORIENT (see especially pp. 178-185) and Ken Pomeranz’ The Great Divergence (p. 34 and Appendix A). Pomeranz’ focus is, however, on China and he devotes only very limited space to India. Similar arguments are also made in Chaudhuri, Trade and Civilisation.

45 The south was badly affected in the second half of the 18th century. Kumar, “South India”, pp. 352-353; see also Chaudhuri, “Eastern India II”, pp. 295-332. While some routes for luxury and commodity trade were cut, it seems that in some cases local trade even benefited from prolonged warfare. Kessinger, “North India”, p. 251
development arising from this political fragmentation was the deterioration of the transport infrastructure – a factor crucial to any market structure.

In the 17th century, the Mughals built and maintained a long-distance road network, which served both military purposes and commercial interests. This system of built roads, already rather limited in geographic coverage and density, gradually started to decay with the decline of Mughal power. With the rise of the Marathas, the state of the road network deteriorated even further, as they were primarily fighters and not so much concerned with the development of infrastructure. As a consequence, even the few built roads were in a terrible condition by the mid-18th century; old highways were overgrown by jungle, and Mughal works like bridges, wells, and caravanserais were in ruin. Because of this lack of adequate roads, the use of bullock carts for transporting goods was impossible in most cases, and all the goods for inland trade had to be transported on the back of pack animals, such as bullocks, donkeys, camels, horses, and elephants. Inland trade was in the hands of specialised merchant communities such as the Vanjari and the Banjara, who traded throughout India with large bands of pack animals. In some regions not even bullock paths existed, so that all produce had to be carried on the head. Moreover, during the rainy season, all this overland transport was put to a halt, and the internal traffic came to an almost complete stand-still. Given the extremely poor state of inland transport, the prime way to transport goods over longer distances was by ship – either on navigable inland rivers or on the Indian Ocean. Though naturally navigable rivers provided by far the cheapest available transport, these were not abundant in India. Inland navigation was mostly confined to the Ganges river system and the Sind. In South India, there was very little inland navigation, while in western India, there were no navigable rivers at all. Also, river transport was "directional", with downstream transport heavily outweighing upstream transport, and was highly seasonal due to the monsoon.

The extent of the Indian maritime trade is debated but seems to have been rather limited compared to the situation in Europe before, say, the mid-19th century. At Surat, the great port of the Mughal empire, which experienced its greatest phase of

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46 It seems that in some parts of India, such as in the whole of western India, there were practically no built roads up to about 1850. See Divekar, Prices and Wages, p. 9; Divekar, “Western India”, p. 339.
47 A very rich and detailed account on the transport infrastructure in pre-British India is provided by the Jean Deloche in Transport and Communications in India Prior to the Steam Locomotion. For accounts on the extremely poor state of the transport system, see also Kessinger, “North India”, p. 258; Bhattacharya, “Eastern India I”, pp. 270-72; Divekar, “Western India”, pp. 339-340; Kumar, “South India”, pp. 353-55; McAlpin, “Railroads, Prices and Peasant Rationality”, pp. 673-74.
48 These bands could contain more than 10,000 bullocks. This led Kenneth Pomeranz to speculate that the transport capacity in northern India around 1800 was considerable and comparable to Europe. See Pomeranz, The Great Divergence, p. 34 and Appendix A. However, partly because of seasonality the actual annual transport capacity of such herds seems to have been rather limited. See McAlpin, “Railroads, Prices and Peasant Rationality”, p. 673. According to Kessinger, the Banjara trade was “because of slowness of movements and poor information a form of speculation rather than a response to demand”, Kessinger, “North India”, p. 248. Certainly the Great Mughal could afford to hire thousands of pack animals to transport grain to distant battle fields. In general, however, grain only was of minor importance in this long-distance trade, as the banjaras understandably traded predominantly goods with a low bulk to value ratio. When roads started to improve and cart transport became common and railways opened at the same time, these specialised animal carriers, who had dominated the Indian inland trade for centuries, were fast driven out of business. Divekar, “Western India”, p. 341; Rothermund, Economic History, p. 4.
49 For instance in parts of Western India. See Divekar, “Western India”, p. 339.
expansion at the end of the 17th century right before the collapse of Mughal power, about 50 ships arrived every year during this period. In the same period, Amsterdam – one of the major ports in Europe – received about 3,000 ships each year. \(^{51}\)

Some authors have come up with estimates of shipping capacity for Mughal India. While Moreland puts it at 52,000 to 57,000 tons for annual long-distance trade in the Indian Ocean at the beginning of the 17th century, Bal Krishna’s corresponding estimate is 74,500 tons. The comparative figure for European shipping capacity is between half a million and one million tons. \(^{52}\)

Given this very poor transport infrastructure, which resulted in very high transport costs and very limited transport capacities, it is hardly surprising that that grain markets are widely believed to have been highly fragmented, and that inland grain trade was essentially local, so that “grain rarely reached the next regional markets, even in the presence of famines or rising prices”. People predominantly consumed local products, and only high value and luxury goods were transported over longer distances. \(^{53}\) Even on ships, grain seems to have played only a minor role, as merchants primarily transported high value goods such as spices, cotton and silk piece goods, ivory, or sugar. Wheat and rice regularly supplemented such freights, mainly because grain as a saleable bulky good was the most efficient ballast to stabilize sailing ships, and as it also served as a means to protect the more valuable cargo. \(^{54}\)

Political and economic fragmentation, lack of security and regular warfare in some parts of the subcontinent characterised the socio-economic climate for the rest of the century – hence the term “crises of the 18th century”. \(^{55}\) It was not until the battle for the supremacy in India had been decided that the political and economic stability on the subcontinent as a whole started to improve. The winner of this battle was, of course, the British East India Company, and it secured this position once it had decisively beaten the Marathas in their capital Pune in 1818, as the Marathas were by then the only serious contender left.

Having established their military supremacy on the subcontinent, the British slowly started to unite it politically and economically to a degree that went beyond any previous unification, which eventually led to a level of commercial activity

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\(^{51}\) The figure for India is from Kulke and Rothermund, A History, p. 226; the one for Amsterdam from De Vries and Van der Woude, The First Modern Economy, p. 492.

\(^{52}\) This overview is taken from Frank, who himself dismisses the comparison as inadequate as “the weight of traded cargoes versus shipping capacity are hardly commensurate measures”. Frank, ReORIENT, p. 182.

\(^{53}\) Citation from Rothermund, Economic History, p. 4. Similar conclusions can be found in Roy, The Economic History, pp. 26, 30-31; Banerjee, Internal Market, p. 63; Kessinger, “North India”, p. 251; Bhattacharya, “Eastern India I”, pp. 279-281; Kumar, “South India”, p. 355-55. Typical goods to be transported over longer distances were better cloth, spices, salt, betel nuts, butter. Divekar, “Western India”, pp. 341-42; Kumar, “South India”, p. 353-55.

\(^{54}\) Hence the contemporary name “cargo rice”. Creutzberg, “Changing economy”, p. 16; Chaudhuri, Trade and Civilisation, p. 184. For examples of such shiploads see for instance Bombay Price Current, 1828, various issues.

\(^{55}\) Kulke and Rothermund, A History, p. 27. This generalising phrase needs qualification, however, as there has recently been a debate about how widespread the decline induced by the fall of the Mughal empire really was. Tirthankar Roy, for his part, concludes in his recent textbook that “evidence of general anarchy and economic dislocation is not strong”. Roy, The Economic History, p. 21. A recent compilation of different views on and contributions to this 18th century debate is Marshall’s The Eighteenth Century in Indian History.
unprecedented on the subcontinent. Of the many obstacles to a flourishing economy in India, the British eradicated some in the 1830s that are generally believed to be significant, when they abolished all inland and town duties, introduced a universal measurement system and made the silver rupee the only legal tender. So when British India officially became a part of the English Empire in 1858, the subcontinent was politically unified with an uncontested central power, a universal legal system, a single weight system, a single currency and a single official language, and was free of any internal customs.

Equally important was the dramatic improvement in the means of transportation that ensued. Although in some regions substantial progress was already achieved over the first half of the century, road construction and maintenance on a larger scale only started around 1850. Subsequently, the construction went ahead at a great speed so that at the end of the 19th century, there were about 37,000 miles of metalled roads and 136,000 miles of unmetalled roads in India. “Thus, from the roadless situation at the beginning of the British rule, India had made considerable progress to gain what was the barest minimum urgently necessary for the commercial prosperity of the country.”

The other major development that radically improved India’s transport infrastructure – and it did occur very much at the same time as the improvement of the road network – was the construction of an extensive railway network. Helped by government guarantees that provided a secure 5 per cent return on all capital invested in this construction, independently of the profitability of the respective lines, it went ahead at a very rapid pace indeed: by 1900, there were about 25,000 miles of railway tracks. Railroads reduced freight rates for food grains by approximately 80% compared to rates for carts and rendered bulk shipments for grains possible.

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56 “The surge of trade in the 1820s and 1830s brings the trade to unprecedented levels, not back to normalcy.” Kessinger, “North India”, p. 256. Roy puts forward the same conclusion, adding that this is also true for Indian exports: “[…] there is no evidence that the scale of export from India at any time during the early modern period was higher than at any time in the nineteenth century”. Roy, The Economic History, p. 33. This point about the extent of trade is stressed as Indian nationalist, as well as already mentioned recent accounts from World Theorists or the California School have suggested that the surge in internal and external trade in the late 19th century only brought India back to levels it had already enjoyed in early modern times, before it went into retreat during the rise of the British rule in India towards the end of the 18th and the beginning of the 19th century. See for instance Frank, ReORIENT, for such claims.

57 Factors said to have been impediments to an increase in trade in early modern India are poor transport infrastructure, multiplicity of weights and measures, the multiplicity of currencies, the abundance of inland transit and town duties, security duties, the extreme diversity in languages and ethnicities, the rigid caste system, political instability, an erratic climate and generally weak property rights. See Divekar, Prices and Wages, pp. 9-10; Bhattacharya, “Eastern India I”, pp. 275-278, Kulke and Rothermund, A History, p. 249, p. 267; Statistical Papers Relating to India, p. 53.

58 See Banerjee, Internal Market, chapter III.

59 In south India, for instance, the improvement of roads led to a large increase in the number of carts used so that transport costs were halved over the first half of the century. Kumar, “South India”, p. 362. Also some inland trunk roads were constructed at the time. See Statistical Papers relating to India, pp. 81-82.

60 Banerjee, Internal Market, p. 80.

61 This was certainly a very impressive achievement, but also a very costly one. The enormous bill – which arose from the fact that the Indian railways were always in the red until 1900 – had to be footed by the Indian taxpayers without being asked about their view on it, of course, while the predominantly British investors got a secured 5 per cent annual return from any investment. See Rothermund, Economic History, pp. 32-36. See also Banerjee, Internal Market, pp. 81-108.

62 See Hurd, “Railways”, p. 268. On the effect of the railway on prices and production, see in particular McAlpin, “Railroads, Prices and Peasant Rationality”.

26
Finally, shipping technology and shipping connections also improved decisively, with the quantity of shipped goods experiencing a big surge in the 19th century. In the course of this process, the volume of shipped grain not only surged greatly in absolute terms, but also increased dramatically in relative terms vis-à-vis other goods, so that grain became the leading export commodity by 1900.63

To sum up, the processes of political and economic integration during the 19th century, coupled with the rapid improvement of transport facilities in the second half of the century, fundamentally transformed commercial activity leading to an unprecedented extent of trade in general, and of grain trade in particular. Previously highly fragmented markets became unified to such a degree that by the end of the century India not only had a national market for grain, but was integrated in the world markets for both rice and wheat.64

Conclusion

With the prime aim of assessing the efficiency of grain markets, new databases of wheat and rice prices stretching from 1700 to 1914 were compiled. Four approaches were then applied to this price data to gauge the extent of market integration and to illustrate the process of integration: correlation analysis, error correction models, price convergence, and single-market price volatility. While these procedures are all complicated by uncertainties or might also indicate factors other than market integration, it is reassuring that the results obtained by all these methods support one another and lead to the same general conclusions. These conclusions furthermore find support in both the general history of India and the mainstream accounts on market integration, and they can be summarized as follows.

Prior to the mid-19th century, the grain trade in India was essentially local, while more distant markets remained fragmented. This is not to say that no grain was traded over longer distances, but the extent was very limited, as the prices from some 36 cities all over India still exhibited various characteristics of isolated markets. First, annual price fluctuations were extremely high. Second, differences in price levels between markets were very pronounced and persisted until well into the 19th century. Third, apart from neighbouring villages or cities, price series from different markets did not show co-movements at all. Forth, where prices do show co-movement, adjustment processes to spatial price differentials were slow.

It was in the second half of the 19th century that these backward structures got transformed rapidly, so that by the end of the century, price volatility had been massively reduced, prices across regions had converged, and prices for even very distant markets showed clear co-movements and adjustments to price disequilibria. Nevertheless, although it may be possible to speak of a national grain market at the

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63 External trade already experienced a substantial increase from the 1830 onwards. Rothermund, *Economic History*, pp. 37–42; Statistical Papers relating to India, p. 54.
64 On national integration see Hurd, “Railways”. On the integration into the world rice and wheat markets see Latham and Neal, “The International Market”.

27
turn of the 20th century, the formation of an integrated market was still incomplete and showed distinct regional differences.65

Turning to the comparative Great Divergence discussion, the claim of the California School of “Asia” having a similar economic potency as Europe until the late 18th or early 19th century is rejected. At least as far as India is concerned, all indicators point to lack of economic development until the mid-19th century as measured by the efficiency of grain markets. It seems safe to conclude that by the late 18th century, India was already very different from developed parts of the world such as large parts of Europe or as some advanced parts in China in terms of market performance. In view of the political history and the state of the transport infrastructure of the subcontinent, such a divergence between Western Europe and India needs to be shifted at least back to the 17th century, if not more.66

The case of India indicates that the very generalising claim about “Asia” being as economically advanced as Western Europe needs to be revised and replaced by a view that is geographically much more differentiated. Correlation analysis suggested that this may also apply for the intra-European interpretation. Instead of speaking of a “Western European” level of market integration, one may prefer to refer to “two Europes”, lowland Europe and landlocked Europe. While the former already enjoyed a fairly high degree of integration in the 18th century, distance remained in the latter much more of an obstacle until the arrival of the steam engine.

65 Also, the much improved transport facilities and the emergence of a national market did not save India from the terrible consequences of two major famines in the late 19th century. On this issue, see Maharatna, The demography of famines.

66 New evidence on real wage levels in India – another indicator for economic performance or prosperity that prominently features in the comparative discussion – comes to a similar rejection of the revisionist view. Allen “India in the Great Divergence”.
Appendix: Sources of the Grain Price Series

The list below indicates the sources and original units of all price series used in the paper, listed alphabetically and grouped according to grain type and location. If not stated otherwise, the prices series represent annual average prices. However, the sources are often not clear on exactly how many observations were used to calculate an average or typical price. In a small number of sources it does not become entirely clear whether the prices really are average prices or not. For the analyses, all the Indian data has been converted into rupees per maund. The following conversions were used for India: 1 maund = 40 seers = 640 chittacks = 3200 tola = approx. 37.3578 kg. 1 Madras Garce = 3200 measures = 3552 kg. 1 rupee = 16 annas = 64 pice. 1 rupee was worth 10.78 grams of pure silver. For conversions of non-Indian prices, please consult the explanations for the individual series.

RICE PRICES

India

Ahmedabad, 1824-1914
Source for 1824-1862: Accompaniments nos. 1 to 9, p. 118. Tolas per rupee, calendar years.
Source for 1863-1914: Prices and Wages, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.

Belgaum, 1824-1914
Source for 1824-1862: Accompaniments nos. 1 to 9, p. 118. Tolas per rupee, calendar years.
Source for 1863-1914: Prices and Wages, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.

Benares, Coomercolly, Hurripaul, Kheerpoy, Malda, Radhanagar, Santipore, Sonamooky, all 1792/3-1822/3

Bengal, 1700-1860
Source: Hussain, A.S.M.A., Quantitative Study, Appendix A.1. Rupees per maund, calendar years. This series is a compilation based on various sources and is not restricted to one single town in Bengal, but represents some kind of regional average. It has therefore only been used for complementing the rice price series in figures 3 and 4, but not for any quantitative analysis.

Bombay, 1836-1914
Source for 1836-1862: Accompaniments nos. 1 to 9, p. 118. Tolas per rupee, calendar years.
Source for 1863-1914: Prices and Wages, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.

Calcutta, 1754-1813, 1861-1914
Source for 1861-1914: Prices and Wages, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.

Chinsura, 1700-1813

Madras, 1802-1850, 1861-1914
Source for 1802-1850: Raju, Economic conditions, p. 228/29. Average prices for harvest years, mostly based on monthly prices; Rupees per Madras Garce. The price is likely not to be for Madras only but to represent some kind of average price in the region. Data is for paddy rice. White rice makes up less than three-quarters (ca. 70-71%) of the weight of a paddy rice grain, which also includes the hull and bran. Prices were therefore adjusted to make levels comparable to white rice.
Source for 1861-1914: Prices and Wages, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.

Patna, Bobul, Indapoor, Kulus, 1827-1845
Source: Sykes, W.H., “Prices of the Cerealia”, table I. Average market prices for calendar years. Local seers per rupee, which have not been converted into standard seers.
WHEAT PRICES

India

Agra, 1812-1914
Source for 1863-1914: Statistical Abstract, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.
Ahmedabad, 1824-1914
Source for 1824-1862: Accompaniments nos. 1 to 9, p. 118. Tolas per rupee, calendar years.
Source for 1863-1914: Prices and Wages, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.
Aligarh, 1804-1832
Source: Morison, T., “The instability of prices”, p. 520. Seers per rupee, average prices for calendar years. Morison used mostly settlement reports and account books of grain deals to compute his averages.
Bareilly, 1805-1914
The prices come from grain-dealers’ books and published statements.
Source for 1863-1914: Statistical Abstract, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.
Belgaum, 1824-1914
Source for 1824-1862: Accompaniments nos. 1 to 9, p. 118. Tolas per rupee, calendar years.
Source for 1863-1914: Prices and Wages, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.
Bombay, 1836-1914
Source for 1836-1862: Accompaniments nos. 1 to 9, p. 118. Tolas per rupee, calendar years.
Source for 1863-1914: Prices and Wages, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.
Calcutta, Patna, Dacca, Cuttack, Mozufferpur, Surat, Lucknow, 1861-1914
Source: Statistical abstract relating to British India, various issues. Average prices for calendar years; seers per rupee.
Cawnpore 1823-46, 1863-1914
Source for 1863-1914: Statistical Abstract, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.
Chinsura, 1700-1813
Delhi, 1763-1835, 1863-1914
Original source: Gleanings of Science, 1829 issue.
Source for 1863-1914: Statistical Abstract, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.
Faridpur, 1837-1860
Source: Morison, T., “The instability of prices”, p. 520. Seers per rupee, average prices for calendar years. Morison used mostly settlement reports and account books of grain deals to compute his averages.
Junnar, 1800-1827
Source: Divekar, V.D., Prices and Wages, table 38. Average market prices for harvest years (June-May); Seers per rupee. Wholesale prices.
Mahalunge, Wanawadi, Hadapsar, Wadki, Belsar 1808/09-1828
Source: Divekar, V.D., Prices and Wages, table 27. Average market prices for harvest years (June-May); Seers per rupee. Wholesale prices.
Muttra, 1813-1835
Source: Morison, T., “The instability of prices”, p. 520. Seers per rupee, average prices for calendar years. Morison used mostly settlement reports and account books of grain deals to compute his averages.
Pabal, 1799-1819, 1827-1845
Source for 1799-1819: Divekar, V.D., Prices and Wages, table 38. Average market prices for harvest years (June-May); Seers per rupee. Wholesale prices.
Source for 1827-1845: Sykes, W.H., “Prices of the Cerealia”, table I. Average market prices for calendar years. Local seers per rupee, which have not been converted into standard seers.
Palasdeo, 1797-1822
Source: Divekar, V.D., Prices and Wages, table 38. Average market prices for harvest years (June-May); Seers per rupee. Wholesale prices, which were about 5% higher than retail prices.
Pilibhit, 1816-1842
Source: Morison, T., “The instability of prices”, p. 520. Seers per rupee, average prices for calendar years. Morison used mostly settlement reports and account books of grain deals to compute his averages.
Pune, 1760-1914
Source for 1760-1860: Divekar, V.D and S.V. Indukar, Hundred Years, Appendix. Various original sources. Average market prices for harvest years; kilograms per rupee.
Source for 1861-1914: Prices and Wages, various issues. Seers per rupee (earlier issues) and rupees per maund (later issues); average prices for calendar years.
Pune city market, 1806-1831
Source: Divekar, V.D., Prices and Wages, p. table 27. Average market prices for harvest years (June-May); Seers per rupee. Wholesale prices.
Sewnere, Brahmunwaree, Poorundhur, Indapoor, Kulus, 1827-1845
Source: Sykes, W.H., “Prices of the Cerealia”, table I. Average market prices for calendar years. Local seers per rupee, which have not been converted into standard seers.
Europe
Amsterdam, 1700-1910
Prices in grams of silver per litre are available from the Allen-Unger database at
http://www.history.ubc.ca/unger/htm_files/new_grain.htm
This series has some whole, which were filled with regression analysis using rye prices from
Antwerp, 1772-1913
Sources: Van der Wee, H., The Growth of the Antwerp Market; Verlinden, C. and J. Craeybeckx,
Documents pour l’histoire des prix. Original prices in groats/viertel and in francs/hl or per 100kg.
Calendar years. Prices in grams of silver per kg are available from
http://www.nuff.ox.ac.uk/users/allen/studer/antwerp.xls
Basle, 1751-1797
Conversion into grams Ag/kg using a conversion of 72kg/100litre proposed by Göttmann,
Getreidemarkt am Bodensee. pp. 486.
Berlin, 1700-1914
Reichsmark/1000kg. Average market prices for calendar years, based on monthly average prices. The
mark was on a gold standard, 2790 Mark equalled 1 kilogram of gold. Silver prices were obtained
using the gold-silver price ratio given at http://www.measuringworth.com/gold/
Bern, 1739-1914
Spelt prices. Source: Pfister, BERNHIST. Average market prices for calendar years based on monthly
prices. New Swiss francs/100kg. Conversion to Grams Ag/kg: Körner, Währungsbewertung.
Geneva, 1820-1900
Source: Brugger, Statistisches Handbuch, pp. 320-1, 326-332. Swiss franc/100kg, average prices for
calendar years, based on weekly market prices. Conversion to Grams Ag/kg: Körner,
Währungsbewertung.
Krakow, 1749-1914
Sources: Tomaszewski, Ceny w Krakowie; Gorkiewicz, Ceny w Krakowie. Grams Ag/litre, calendar
years. Available at http://www.nuff.ox.ac.uk/users/allen/studer/krakow.xls. Conversion into grams
Ag/kg using a conversion (for wheat) of 76kg/100litre proposed by Brugger, Statistisches Handbuch,
pp. 306.
Lausanne, 1700-1902
Source for 1700-1719: Radeff, „Le prix des céréales à Lausanne de 1550 à 1720”, pp. 15-19. Florin
Lausannois/quarteron, average institutional prices for harvest years. 1 quarteron = 13.7 l. Litre/kg
conversion for wheat as noted above.
market prices for calendar years.
Source for 1803-1902: Brugger, Statistisches Handbuch, pp. 320-1, 326-332. Swiss franc/100kg,
average market prices for calendar years, based on weekly market prices.
For the currency conversion to Grams Ag/kg: Körner, Währungsbewertung, and Körner et al.,
Währungen und Sortenkurse.
Lisbon, 1750-1855
Source: Coruche, A questão Monetaria. Reis/hl, calendar years. Available from David Jacks at
http://www.sfu.ca/~djacks/data/prices/Iberia/Lisbon,%20Wheat,%201728-1893,%20annual.xls
Litre/kg conversion as noted above. For the currency conversion: Grams Ag/Reis available at
http://gpih.ucdavis.edu/files/Portugal_1750-1855.xls
London, 1700-1914
Source: Rogers, A History of Agriculture. Prices in grams of silver per kg are available from the Allen-
Unger database at http://www.history.ubc.ca/unger/htm_files/new_grain.htm
Lucerne, 1700-1900
Spelt prices. Source: Haas-Zumbühl, „Die Kernenpreise“, pp. 370-372. Swiss francs/100kg, calendar
years. Based on different sources, most recording average market prices and some recording average
institutional prices. For the currency conversion to Grams Ag/kg: Körner, Währungsbewertung.
Milan, 1701-1860
Source: Maddelana, “Prezzi e mercendi”, pp. 379-82. Grams Ag/kg, calendar years.
Munich, 1700-1914
Source for 1700-1800: Seuffert, Statistik, p. 123. Kreuzer/Schäffel. Average market prices for calendar years, based on average monthly prices. 1 Schäffel = 362 l; Litre/kg conversion for wheat as noted above. 1 gulden = 60 kreuzer = 240 pfenning. The silver content of the pfennig is from David Jacks at http://www.sfu.ca/~djacks/data/prices/Metals/Silver%20content%20of%20currencies,%201258-1979%20annual.xls
Source for 1800-1914: Jacobs and Richter, „Die Grosshandelspreise“. Reichsmark/1000kg. Average wholesale prices for calendar years. For the currency conversions see Berlin.

Paris, 1700-1914
Prices in grams of silver per kg are available from the Allen-Unger database at http://www.history.ubc.ca/unger/htm_files/new_grain.htm

Schaffhausen, 1700-1880
Spelt prices. Source for 1700-1800: Göttmann, Getreidemarkt am Bodensee, pp. 480-84. Gulden/hl, average market prices for calendar years. Litre/kg conversion as noted above (using wheat). Silver content of the gulden from W. Tijms at http://odur.let.rug.nl/~nahi
Source for 1800-1880: Brugger, Statistisches Handbuch, pp. 349-50. Swiss francs/100kg. Calendar years, but no average price; prices based on “Martinischlag”. For currency conversions see Lucerne.

St Gall, 1814-1904
Source: Brugger, Statistisches Handbuch, pp. 313-14. Swiss francs/100kg. Calendar years. For currency conversions see Lucerne.

Toulouse, 1700-1803
Source for 1806-1913: Drame, Silvie, et al., Un siècle de commerce. Centimes/hl., biweekly market prices. I calculated average annual prices for calendar years from the monthly prices of this dataset provided by David Jacks in Dollars/100kg at http://www.sfu.ca/~djacks/data/prices/France/prices.html. The silver contents of the dollar are also his.

Überlingen, 1719-1907
Source for 1719-1810: Göttmann, Getreidemarkt am Bodensee. pp. 480-84. Spelt prices. Gulden/hl, average market prices for harvest years. Litre/kg conversion for spelt as noted above. Silver content of the gulden from W. Tijms at http://odur.let.rug.nl/~nahi

Vienna, 1700-1913

Zurich, 1700-1877
Spelt prices. Source: Müller, Joh. Heinrich Waser, pp. 50, 52. Francs/100kg. For the currency conversions see Lucerne.
Bibliography

Accompaniments nos. 1 to 9 to the letter from the Bombay Government to the Government of India. No. 1184, dated 8th July 1864.


Bombay Price Current (1828), various issues.


Brugger, Hans, Statistisches Handbuch der schweizerischen Landwirtschaft (Berne, 1968).


Chevallaz, Georges-André, Aspects de l’agriculture vaudoise (Lausanne, 1949).

Coruche, V. de, A questao Monetaria dos Cereaes (Lisbon, 1894).


De Vries, Jan and Ad van der Woude, The First Modern Economy. Success, Failure and Perseverance of the Dutch Economy, 1500-1815 (Cambridge, 1997).


———, Prices and Wages in Pune Region, 1805-1830 (Pune, 1989).


Everest, Robert, “On the famines that have devastated India, and on the probability of their being periodical”, *Journal of the Statistical Society of London*, 6, 3 (1843), p. 248.

*Financial and Economic Annual of Japan*, (Tokyo, various years).


Maddelana, Aldo, “Prezzi e mercendi a Milano dal 1701 al 1860”, *Studi e ricerche di storia economica Italiana nell’eta del Risorgimento*, XVI (Milano, 1974).


Prices and Wages in India, (Calcutta, 1873-1921), various issues.

Raju, A. Sarada, Economic conditions in the Madras Presidency, 1800-1850 (Madras, 1941).


Statistical Papers Relating to India (London, 1853).


Tomaszewski, E., Ceny w Krakowie w Latach, 1601-1795 (Lwow, 1934).


Wong, R. Bin, *China Transformed: Historical Change and the Limits of the European Experience* (Ithaca, 1997).