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'Mind the Gap!': Transport Costs and Price Convergence in the 19th Century Atlantic Economy

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‘Mind the Gap!’
Transport costs and price convergence in the 19th century Atlantic economy.

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Abstract.
This paper challenges the widely held view that sharply falling real transport costs closed the transatlantic gap in grain prices in the second half of the 19th century. Several new results emerge from an analysis of a new data set of weekly wheat prices and freight costs from New York to UK markets. Firstly, there was a decline in the transatlantic price gap but it was not sharp and the gap remained substantial. Secondly, the fall in the transatlantic price differential had more to do with improved market and marketing efficiency than with falling transport costs. Thirdly, spurious price convergence (or divergence) can appear if quality differences associated with allegedly homogeneous commodities like wheat are not controlled for.

1.Introduction

There is almost universal agreement that not only nominal but also real transatlantic transport costs and long-haul freight rates in general declined sharply in the second half of the nineteenth century and caused international commodity price gaps to close. This line of research has engaged quite a few modern economic historians and is aptly summed up in a recent monograph by Kevin H. O’Rourke and Jeffrey G. Williamson, who conclude that they have ‘... documented an impressive increase in the extent of commodity market integration in the Atlantic economy as the late 19th century unfolded. Sharply declining transport costs

brought distant national markets much closer together than at any time before.[1] O'Rourke and Williamson inferred falling transport costs from their analysis of international price-spreads of a number of commodities and they also used freight rate data constructed and published by C. Knick Harley. The analysis of price-spreads usually suggests an implausible extent of the decline in transport and transaction costs. K. O'Rourke, for example, in his exciting analysis of the effects of the grain invasion on European late 19th century trade policy uses numbers on price spreads such as a negative price differential relative to US wheat by wheat importing Denmark and a zero differential for UK, which depended heavily on US wheat.[2] C.Knick Harley, as well as K. O'Rourke and J.G. Williamson, refer to persuasive graphical representations of price spreads of US and English wheat which indicate that the transatlantic price gap had been practically eliminated by the end of the 19th century (Harley) or early 20th century (O'Rourke and Williamson). It is suggested that a decline in price spreads indicates not only a sharp but approximately *actual* decline in transport costs (O'Rourke and Williamson) and transport and marketing costs (Harley).[3] This conclusion rests on an implicit assumption that the quality differential between, say, Chicago Spring No 2 and the English Gazette average, is stable over time. It also assumes that the *transport and transaction costs adjusted law of one price* operated throughout the period, that is that markets were fairly efficient. An important conclusion from the present article is that transatlantic markets were *not* but *became* increasingly efficient over time, which contributed to the decline in price spreads.

When we turn to actual freight cost data we are on safer ground. Harley dates the decline in real transport costs to around 1850 and takes issue with Douglass C. North who suggested an almost permanent fall from the mid-18th century. Harley's conclusion was based on a new freight series constructed from British coastal freight rates for coal as well as Baltic (timber and grain), Mediterranean (grain) and Atlantic (timber) freights up to 1870. Like O'Rourke

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[1] K.H.O'Rourke and J.G.Willliamson, *Globalization and History, The Evolution of the Nineteenth-Century Atlantic Economy*, Cambridge,Mass.: MIT Press, 1999, p.55

[2] K. H.O'Rourke,'The European Grain Invasion, 1870-1913', *Journal of Economic History*, 57, 1997, pp.775-801.

[3] C.Knick Harley says that 'the quite striking convergence of prices...resulted primarily from sharp declines in both ocean and overland transportation costs' on the basis of an analysis of Chicago (No.2 Spring) and British (Gazette) price convergence in the second half of the 19th century. Harley, however, explicitly introduces marketing costs and suggests that these costs also fell. See C.Knick Harley, 'Transportation, the World Wheat Trade, and the Kuznets Cycle, 1850-1913, *Explorations in Economic History*, 17, 1980, pp.218-250.

and Williamson, Harley relies on L. Isserlis' study[4] for the post-1870 period. This study is based on a large number of routes and goods, each of which is represented by the average of the yearly maximum and minimum rate. Harley converts the Isserlis data to s per ton of coal and deflate the series by the UK GNP deflator. K. O' Rourke and J.G. Williamson suggest on the basis of the North's, Isserlis and Harley's data that the decline in transatlantic transport costs amounts to between 41 to 70 per cent from the mid 19th century to WW1 decline, the interval in the assessment dependent on source and time period.[5]

This paper focuses on the role played by transport costs and other forces in the convergence of prices in the Atlantic economy during the second half of the 19th century. It challenges the presumptions that (a) changes in inter-market price spreads replicate changes in transport costs and that (b) a decline in price spreads is a good guide in analysing the extent of market integration, and finally it re-assesses (c) the extent of price-convergence and the impact of transport costs therein.

Price spreads are explained by transport costs, the extent of market efficiency and a rigorous analysis must control for quality differences in the goods compared, since quality price spreads are large and vary over time. The standard for judging market integration is the stability of the *transport and transaction cost adjusted* law of one price, rather than the law of one price in the literal sense of the word.[6] I will determine the impact of transport costs relative to improved market performance for the recorded price convergence. I do this by presenting a newly compiled data set of weekly observations of US and UK wheat prices as recorded in New York and London commodity markets and transport costs of wheat from New York to British ports in the period 1850-1900. Freight rates for wheat are deflated by the price of wheat in New York. The reason for using wheat prices rather than a GDP deflator or some other price index as a deflator is straightforward. Falling transport costs have been seen

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[4] C.Knick Harley, 'Ocean Freight Rates and Productivity, 1740-1913:The Primacy of Mechanical Invention Reaffirmed',*Journal of Economic History,*Vol.48,1988, pp. 851-875; Douglass C.North, 'Ocean Freight Rates and Economic Development 1750-1913', *Journal of Economic History,* Vol 18, 1958, pp.537-55; L.Isserlis, 'Tramp Shipping Cargoes, And Freights', *Journal of the Royal Statistical Society,*Vol 101,1938, pp.53-146.

[5] K.O'Rourke and J.G.Williamson, 'When did globalization begin?', *European Review of Economic History*, 6,1,2002,pp.23-50.

[6] M.Ejrnæs and K.G.Persson,'Market integration and Transport Costs in France 1825-1903:A Threshold Error Correction Approach to the Law of One Price,' *Explorations in Economic History*,37, 2000, pp.149-73.

as the prime factor closing the price gap, as measured by, say, the UK wheat price expressed as a ratio to the US price. This number converges to unity, so the argument goes, because the transport cost expressed as proportion of US price falls. There is an obvious parallel to tariffs here because high transport costs are a sort of effective – though implicit – tariff expressed as a percentage of the price of the imported good. The important question arises whether a proportional fall in transatlantic transport costs added to the impact of tariff reductions on European farmers, thus making transport costs partly responsible for the return to protectionism in Continental Europe. Williamson and O'Rourke argue that the late 19th and early 20th century transport costs reductions were far more important than the spectacular decline in trade barriers in the second half of the 20th century, which witnessed a decline in average tariffs form 40 to 7 percent of value of goods, a 33 percentage point decline, but it '…was smaller than the 45 percentage point fall in pre-1914 trade barriers due to transport improvements.' An astonishing claim, which is difficult to reconcile with known facts. [7]
If - as demonstrated in this article - transport costs did some, but not a great deal, to close the price gap, then what explains the convergence? The possibilities include port and dock charges in UK and marine insurance. These costs are too small a fraction of the price of wheat to have had a significant impact even if they were falling substantially. Therefore I focus on the decline of a residual price differential, which reveals increasing market efficiency as information density in markets improved with the telegraphic transmittance and printed press diffusion of information. The residual is that part of the price differential between, say, London and New York, that cannot be accounted for by transport costs, port charges, or marine insurance. The existence of that residual, it is suggested, was partly due to market imperfections. It reveals un-exploited profit opportunities or monopoly rents captured by traders, which could block the entry of competitors into the trade. A plausible conjecture is that risk-averse traders demanded a considerable margin due to the risks associated with the slow transmission of information and the associated volatility of prices. When traders became better informed with the advent of the telegraph and proliferation of the commercial press it was easier to assess risk and they no longer permitted profitable opportunities to remain unexploited, so the residual declined. Hidden costs, such as those associated with marketing and organisation of the grain trade might also turn up in the residual. Increased competition

[7] K.O'Rourke and J.G.Williamson, 'When did globalization begin?', *European Review of Economic History*, 6,1,2002,pp.23-50. The quote is from p.37.

linked to greater transparency might foster efficiency and will imply a fall in the residual. It will be demonstrated empirically that the decline in the residual is the major factor bringing about transatlantic price convergence in the last half of the 19th century.

The paper is organized as follows. In section 2 an accounting framework for the analysis of price spreads is developed and in sections 3 to 6 the elements of that accounting formula are documented. We will first look at transport costs in section 3, then move to port and dock charges in section 4 and marine insurance premiums in section 5. In section 6 we determine the relative strength of the forces behind the observed price convergence. Section 7 concludes. The data set is presented in the Appendix.

2.The determinants of international price gaps: an accounting framework

Let us consider a uni-directional trade pattern, with US exporting wheat to UK in a free trade regime and with prices in New York quoted exclusive of transport and insurance cost to UK. The price differential is given by the identity below:

$$(1)\ P^{\text{English wheat,London}} - P^{\text{US wheat,New York}} = TRANS + INS + PC + QUAL^{\text{English wheat - US wheat}} + RES$$

where P is price, TRANS are transport costs, INS is the insurance premium, PC are port charges in the exporting and importing harbours and QUAL is the price premium reflecting the quality difference between the reference wheat quality ('English' and 'US' in identity (1)) negotiated in London (English wheat) and New York (US wheat) respectively. RES, finally is a non-recorded residual indicating any arbitrage risk premium for traders working in poorly informed and uncertain environments, any profit captured by merchants exploiting exclusive information and, finally, un-identified (marketing) costs. QUAL is either negative, positive or zero depending on the qualities compared while TRANS, INS and PC are strictly positive. RES should be positive but converging to zero as market efficiency improves. If all unidentified costs have been accounted for and RES = 0 the *transport and transaction cost adjusted law of one price* rules. There are historical records documenting P, TRANS, INS and PC although only P and TRANS data are available on a frequent basis. Historical records help to solve (1) leaving the sum of RES + QUAL. However, I am particularly concerned with

getting an estimate of RES since the hypothesis is that RES has fallen considerably in the period when the density and speed of information had a positive impact on market efficiency. QUAL is a non-trivial entity - price differences can be as high as 15 to 35 per cent between qualities in a single market - and can therefore seriously bias estimates of price spreads. However a great many studies ignore these potential effects

In the framework of identity (1) above it is clear that a zero price differential as reported in both cases cited above must reflect a negative quality premium on 'English Gazette' wheat indicating its inferior quality. Quality premiums vary a lot over time due to harvest conditions and broad aggregates like 'Gazette' wheat are likely to change composition over time, making it unsuitable for long-term analysis of price spreads if the quality premium is not controlled. Thorstein Veblen pointed out long ago that well-defined grades also changed in relative price terms because milling technology innovations could make better use of previously underrated qualities. That is why hard spring wheat were catching up on winter wheat in US markets by the end of the 19th century.[8]
It is possible to estimate QUAL, however by solving (2)

(2) $QUAL^{\text{English wheat - US wheat}} = P^{\text{English wheat, London}} - P^{\text{US wheat, London}}$

Price differentials between different grades of wheat in one single market must reflect quality differences as revealed by consumer preferences. A priori we do not expect quality premia to be stable in the short run. Differences in weather conditions at different locations will affect quality in the short run, and for US wheat conditions in transit to Europe may be an additional hazard. However, it turns out that even if we look at well-defined qualities of wheat we do not find a stable long run relationship.

[8] T. Veblen distrusted the use of aggregates such as the English Gazette price: 'Gazette averages are useless for any exact comparison.' See his 'The Food Supply and the Price of Wheat', *Journal of Political Economy* ,1, 1893, pp.365-379.

Figure 1. The quality differential of English White and US Red Winter negotiated in London, 1878-1896 (English White relative to Red Winter 1878 - 23/02/1885 and US Red Winter No. 2 02/03/1885 - 1896) Sources: See Appendix

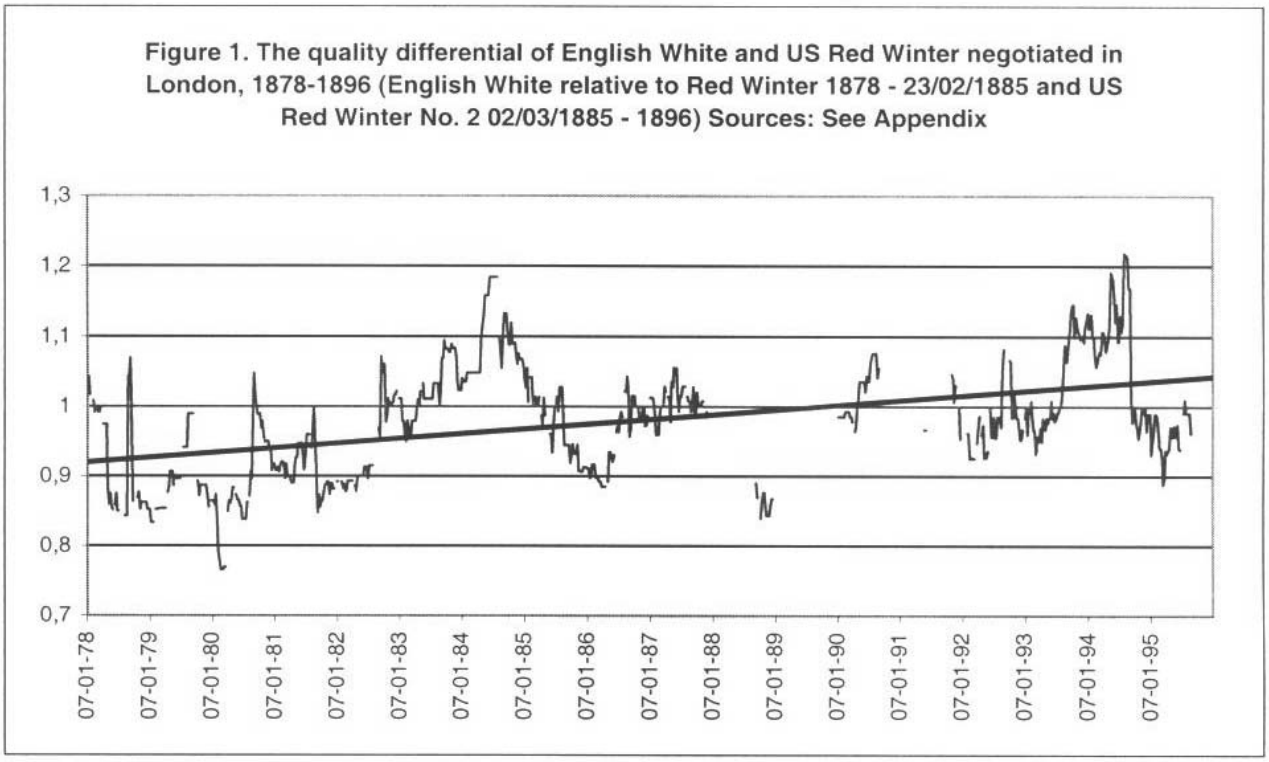


Figure 1 shows the price of English White relative to US grown American Red in 1878-1896, both negotiated at London's Mark Lane market. The data reveal a considerable variation in relative prices with fairly long transitory deviations with a length up to 50 weeks and as large as 25 to 30 percent from peak to trough, reflecting quality impact of harvest outcomes. There is also a drift in relative prices suggesting the possibility of quality reversals, or changing consumer preferences. The nature of the drift in relative prices differs by qualities but the magnitude of the variation is about the same and is present also for earlier periods. Suffice it to say that using different qualities can be seriously misleading and lead to spurious convergence or divergence results. However, there is a simple way of evading the quality problem in price spread accounting: simply substitute (2) for QUAL in (1), cancel terms, and (1) can be expressed as

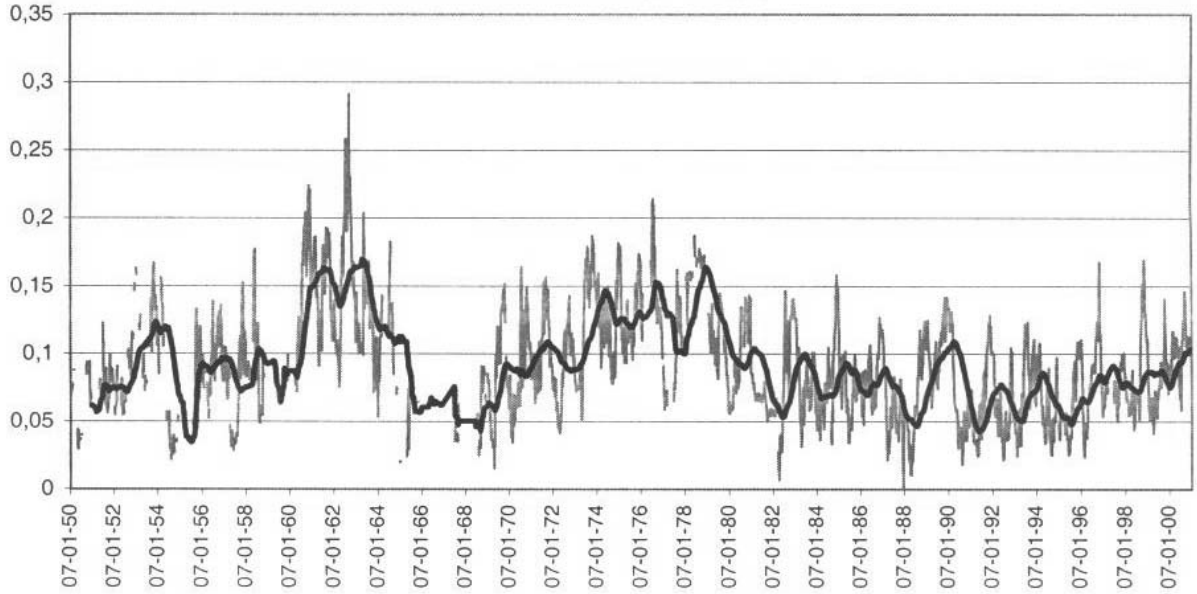
$$(1')\ P^{\text{US wheat,London}} - P^{\text{US wheat, New York}} = \text{TRANS} + \text{PC} + \text{INS} + \text{RES}$$

The solution is to use a strictly identical quality in both markets, rather than two qualities and two markets. P in equation (1') can be represented by, say, (US) Red Winter traded in London and US Red Winter traded in New York. That is the procedure chosen in this paper.

3. Relative transport costs

It is preferable to present the expressions in the accounting formula discussed above in relative terms, so henceforward they will be expressed as a proportion of the New York price. We look first at proportional transport costs, defined as the cost of freight from New York to Liverpool or London, and expressed in the US local price, represented by the New York price of Red Western, later Red Winter (no.2). These are depicted in Figure 2.

Figure 2. Relative transport costs, New York to UK ports 1852-1900 (Transport cost divided by price of wheat in New York. Weekly observations and a 52 weeks' moving average)



1850-1855:1 White Genesee, Liverpool sail; 1855:8-1864:2 Red Western, Liverpool sail; 1864:2-1870:7 Red Western, Liverpool steam; 1870:7-1873:3 Red & Amber, Liverpool steam; 1878:1-1880:9 Red Winter, London steam; 1880:9-1880:12 Red Winter, London sail; 1881:1-1900 Red Winter, London steam.

It is clear from Figure 2 that relative costs varied much but without displaying a strong downward trend. In fact the series does easily lend itself neither to linear trend analysis nor to meaningful statements in terms of a yearly percentage decline in real transport costs. There are two relatively short periods - 1861-64 and 1875-79 - with exceptionally high transport costs but for the rest of the period, that is for about 80 per cent of the years covered, relative costs were between five to ten per cent of New York wheat price. In the periods before, between and after the spells of high prices fluctuations are stationary around a constant level,

although there is a decline in the levels over time. The extent of that decline is documented in Table 1 with data on overlapping decadal freight rates and the table confirms the visual impression. That table presents two estimates of relative transport costs. The left hand column is based on New York to Liverpool freight rates between 1852 and 1877 and from then on for New York to London as in Figure 2. Since freight rates to London were slightly higher - on average by 12 per cent – the right hand column has been adjusted by a multiple of 1.12 for the period 1852-1877. The results relating to adjusted relative transport costs suggest a fall from the first and last period of Table 1 of 23 per cent. If you calculate the decline from the 1850s to the two last decades, that is 1881 to 1900 the decline is slightly higher at 31 per cent. It is worth pointing out that the decline in percentage points is within one standard deviation – between four and five percent – recorded in the early periods. By contrast nominal freight rates (see Appendix Figure 1) decline significantly from the mid 1870s but so do wheat prices, as shown in Appendix Figure 2. [9]

Table 1. Average relative transport cost in overlapping 10-year periods, 1852-1900

Year	Relative transport cost	S.D.	Adjusted relative transport cost
1852-1860	9.8	4.2	11.0
1856-1865	11.8	4.9	13.2
1861-1870	11.3	5.0	12.6
1866-1875	10.4	3.7	11.6
1871-1880	11.7	3.5	12.6
1876-1885	9.6	3.8	9.6
1881-1890	7.6	3.0	7.6
1886-1895	7.0	3.0	7.0
1891-1900	7.5	2.9	7.5
1896-1900	8.5	2.7	8.5

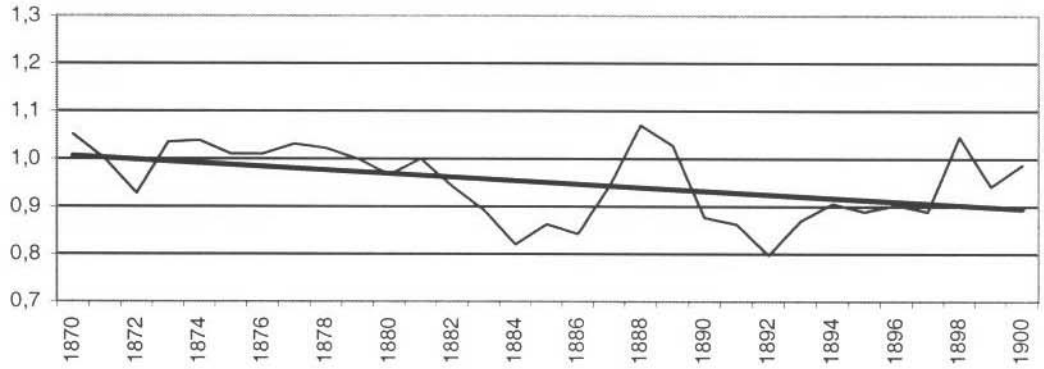
Sources: See Appendix. Transport cost represented by New York to Liverpool freights between 1852-1877 and from New York to London thereafter. To obtain *relative* transport costs, transport costs are divided by price of wheat in New York. The column for adjusted rates has been obtained by multiplying non-adjusted relative transport costs by 1.12 in 1852-1875. In 1871-1880 adjusted relative transport costs are the weighted sum of unadjusted and adjusted rates with a weight of 2/3 to adjusted and 1/3 to unadjusted. Wheat qualities used as in Figure 2.

[9] If I had expressed relative transport cost in terms of London price of wheat the recorded decline had been even lower since wheat price in London falls relative to price in New York. See Appendix Table 1.

As noted at the outset the results presented here challenge a conventional wisdom suggesting sharp rather than modest decline. It also disputes the view of sustained decline during the second half of the 19th century. My data rather suggest a decline only in the last quarter of the century. To the extent that claims of sharp decline are inferred from changes in price spreads of non-quality adjusted commodities they can easily be dismissed for reasons advanced above. But it is worth discussing other *explicit* estimates of freight rate decline. Of course there are major differences in number of routes and goods between my study and previous ones. What holds for a single good (wheat) on the New York-UK route might not hold for a basket of goods and a range of routes, coastal as well as long haul. Transatlantic wheat transport does not figure in North's and Harley's and only marginally in Isserlis' estimates. In principle the choice of deflator might matter. It might be that grain *and* transport costs were a couple falling relative to other prices in this period. However, I am inclined to take the view that the difference between my results and Isserlis' *original* data– which underlie much of modern transport cost research including Harley's results for the period after 1870 - are more apparent than real. As noted earlier Harley expresses Isserlis index in a new unit, transport costs in constant prices per ton of coal. A much reproduced Figure 1 from Harley's 1988 JEH article[10] conveys the impression of a sharp fall in real transport costs and has been interpreted by quite a few as indicating a transport revolution and by a few as representative for Atlantic transport costs.[11] My data suggest large variations in nominal and real freight rates. That fact implies that the choice of period can crucially affect results as any reader of Isserlis should know. On closer scrutiny, Isserlis' data do not support an interpretation of sharply falling real transport cost. Figures 3a-3c illustrate my point.

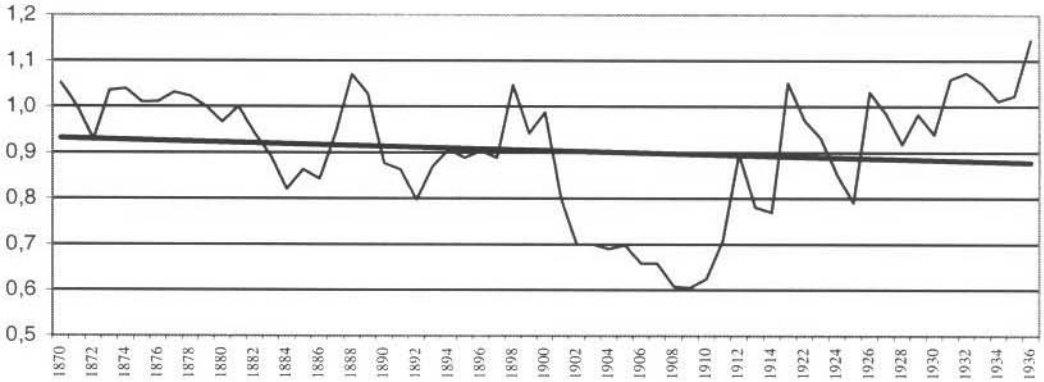
[10] C.Knick Harley, 'Ocean Freight Rates and Productivity, 1740-1913:The Primacy of Mechanical Invention Reaffirmed',*Journal of Economic History,*Vol.48,1988, pp. 851-875.
[11] To present Harley's results as indicative of Atlantic transport costs, as K.O'Rourke and J.G Williamson do, is quite misleading. Atlantic routes are a small proportion of Hartley's as well as Isserlis' samples of routes. See K.E.O'Rourke and J.G.Williamson, 'When did globalization begin?', *European Review of Economic History*, 6,1,2202,pp. 36-7.

Figure 3 a. The ratio of Isserlis' freight index to a wholesale price index, 1870-1900. Yearly observations and a linear trend. (1869=100)



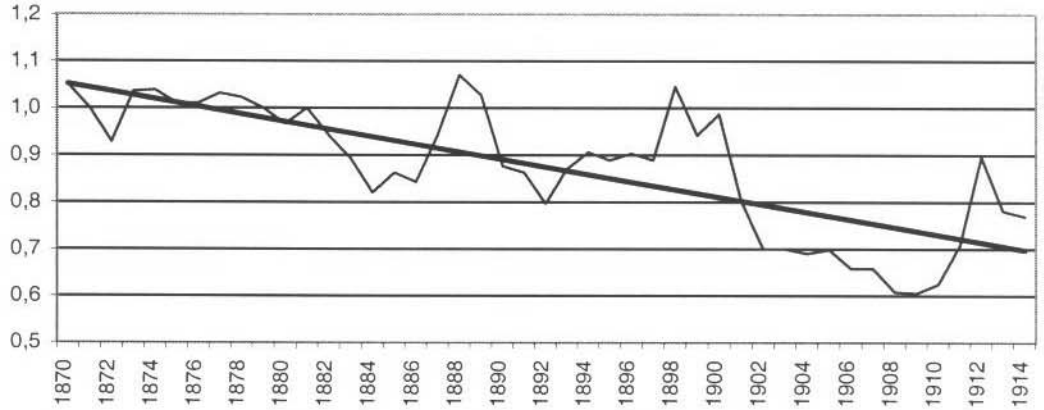
Source: Table VIII in L.Isserlis, 'Tramp Shipping and Cargoes', Journal of Royal Statstical Society, 101, 1, pp. 53-146, 1938

Figure 3 b. The ratio of Isserlis' freight index to a wholesale price index, 1870-1936. Yearly observations and a linear trend. (The observations for 1915-1920 have beeen excluded). (1869=100)



Source: Table VIII in L.Isserlis, 'Tramp Shipping and Cargoes', Journal of Royal Statstical Society, 101, 1, pp. 53-146, 1938

Figure 3c. The ratio of Isserlis' freight index to a wholesale price index, 1870-1914. Yearly obervations and a linear trend. (1869=100)



Source: Table VIII in L.Isserlis, 'Tramp Shipping and Cargoes', Journal of Royal Statstical Society, 101, 1, pp. 53-146, 1938

For those years when Isserlis' and my data intersect, that is 1870-1900, Isserlis results *reinforce* my argument that the decline is modest. Figure 3 a traces the ratio of his freight index to his wholesale price index and suggests a stationary process along a slowly – but as we will soon learn not significant - declining trend. The relative fall in transport costs is a mere 10 per cent. Extending the period to 1936, see Figure 3 b, which is the last year for which Isserlis provided data confirms the result of a small relative long-run decline in transport costs when we have excluded the outliers – freight rates rocketed during and immediately after WW1. It is only when the time series is cut off before WW1, see Figure 3 c, that you get a notable decline in freight costs relative to the wholesale price index, a 33 per cent decline. However it is lower than the numbers usually derived from Isserlis' data when combined with Harley's and North's series for the pre 1870 period implying a substantial pre-1870 decline in freight rates. My data, displayed in Figure 2 and Table 1, do not confirm a sustained decline in freight rates between the 1850s to the start of the Isserlis series in 1869/70. If anything there is an increase in real transport cost levels. How much confidence you have in the analysis of Isserlis data for the 1870 to 1914 period depends on the interpretation of the spell of extremely low freight rates between 1902 and 1910, in fact the historic trough of the series. Figure 3 b shows, however, that prices revert to a value around 0.9, which is the mean of the series, well before the outbreak of WW1. A sensible interpretation of the 1902-1910 experience is to see it as a transitory deviation – rather than permanent level change – and if so it should not be used for generalizations regarding the 19th century. That insight is supported by a formal analysis of the Isserlis price and freight indices. The falling trend – as noted above - in Figure 3 b is not significant. However econometric error correction tests indicate that the ratio of freight rates to prices is a strong mean reverting process with the mean of the series at 0.9. This is – in itself a remarkable result given the inflated claims of long run reductions in real transport costs. In the first simple error correction specification changes in the ratio was modelled as dependent on the deviation of observed ratio to its mean

$\Delta(F/P)_t = \alpha[(F/P)_{t-1} - \lambda] + \varepsilon_t$

where F is freight rates, P is the price level and λ the sample mean. It turned out that the adjustment parameter α was negative, as expected, and significant.

The other specification explicitly models both price and freight cost adjustments to deviations from the sample mean.

$$\Delta F_t = \alpha_1 [(F/P)_{t-1} - \lambda] + \varepsilon_t$$

$$\Delta P_t = \alpha_2 [(F/P)_{t-1} - \lambda] + \varepsilon_t$$

The Isserlis data refer to UK price level and inward and outward (mostly) UK freights. Consider the domestic UK price level P as linked proportionally to the international price level as we know it was during the Gold Standard. Then an increase in F/P signifies a rise in freight rates relative to the international price level. That means that UK c.i.f. export prices rise relative to the international price level and UK c.i.f. import prices rise relative to P. As a consequence demand for both outward and inward freights will fall and the expected sign on α_1 can be expected to be negative. The adjustment of the domestic price level P is ambiguous, however. Falling export demand will depress prices while the increase in import prices will divert demand from imports to domestic substitutes and stimulate the domestic price level. Two forces operate with opposing signs. It turns out that α_1 is significant (t-value –2.45) and negative (-0.25 when the estimation is done in logs) suggesting a half life of a shock of a little more than 2 years) as expected while α_2 is not significantly different from zero. The estimation is performed on the entire period with with WW1 (1915-1921) dummies. The results make sense in that it is plausible that real freight rates adjust to deviations from its long run ratio while it is less likely that the price level adjust to deviations in one of its constituent prices.

The claim that real transport costs declined dramatically, say, in the order of 40 -70 per cent during the second half of the 19th century and up to WW1 is seriously challenged both by my new data and a rigorous analysis of Isserlis' original data. Paradoxically most of the alleged late 19th century decline is inferred from a few years of outlier rates in the first decade of the 20th century. Since the analysis of segments of the Isserlis data yield widely different results my recommendation is to stick to the entire period which can meaningfully be represented as a mean reverting process.

4. Port charges.

It has not been possible - despite our best attempts - to produce a continuous time series either for marine insurance or port charges. We are interested in UK porterage charges throughout the period and for New York until 1878. After that date price in New York was quoted f.o.b.

There was no indication of dramatic changes in port charges over time in the data on Master Porter Rates in the archives of Merseyside Maritime Museum.[12] These charge differed according to whether the grain was in bulk or in bags, whether ships were unloaded on quay or not, and whether quality and weights of the received grain were checked or not. There seems to have been considerable nominal rigidity in what were basically labour costs which means that port handling costs might actually have increased relative to the price of grain as the decline in grain prices sets in the 1880s.(The nominal price of US Red wheat negotiated in New York is shown in Appendix Figure 2).

Here are some vital details of the composition of porterage charges. Costs were divided by tasks such as landing on quay and trimming (4.75 to 5d per ton of grain); filling into merchant's sacks and weighing (5.5d per ton); removing from scales and loading of or re-stowing (2.5d per ton). These items add to a total of about 1s 1d per ton. The cost of 'receiving from ship, stowing on quay or in barges and duly protected and delivery to cart, railway truck or barge' varied according to time of delivery: 1 s 2 d per ton if delivered within 7 days; 2s if delivered within 14 days; and 2s 4d if delivered within 21 days.

These charges included insurance and sack hire, but not the 'usual working out from ship', which apparently was the shipper's job. An extra ½d to 2d per ton is quoted as the Master Porter's rate if they had to do it.

Discharging in bags in London was slightly cheaper in 1872 (8d) than in 1879 at (10d).

If grain was in warehouses there were of course additional costs of discharging and delivery. The storehouse rent was around 2d per week but discharging and delivery rates were quite high at 2s 6d per ton. Such details could be magnified, but in the end if we try to work out a typical port handling cost from these data we would land at a maximum of 8d (including storage) and a minimum of 3d per quarter. Assuming these charges to be fairly rigid downwards they will increase in proportional terms as price of wheat declines. I will estimate the charges as one percent of wheat price increasing to one and half per cent. For New York charges are estimated to one per cent until 1878.

5. Marine insurance.

[12] See Revisions of Master Porter Rates, in Worked up papers, Merseyside Maritime Museum, vol. 66:1879 and *Dock and Port Charges of Great Britain and Ireland*, London 1881

Insurance premiums are very difficult to document since most records seem to have perished. It is impossible to establish anything like a time series. The Guildhall Library in London which houses the archives of many maritime insurance companies such as Lloyds, Royal Exchange Assurance, London Assurance, and Indemnity Marine Assurance holds hardly any documents on insurance rates, except for a few in the Commercial Union Assurance Company dossier. The few documents available give a detailed picture for a single year, 1863, as described in Table 1 below. However it can be safely assumed that although rates declined the decline was from a low level.

Table 2 Insurance rates (cash premium as a percentage of value of goods insured) for various transport routes 1863. Per cent.

UK ports to East Indies	1.4	East Indies to UK ports	2.6
UK ports to Australasia	1.52	Australasia to UK ports	1.19
UK ports to West Indies	2.0	West Indies to UK ports	2.53
UK ports to South America	0.61	South America to UK ports	1.65
UK ports to Mediterranean	0.44	Mediterranean to UK ports	0.73
UK ports to Spain & Portugal	0.2	Spain &Portugal to UK ports	0.37
UK ports to North Sea	0.24	North Sea to UK ports	0.45
UK ports to Holland&Belgium	0.18	Holland&Belgium to UK ports	0.23
UK ports to France and vice versa	0.14		
UK to Baltic	1.2	Baltic to UK ports	0.7
UK ports to British America	1.1	British America to UK	2.18
UK ports to US	0.96	US to UK ports	1.69
		New York to UK ports, grain	2.49
		excluding December -February	1.71

Sources: Commercial union assurance company, MS 23697 and MS 23698, Guildhall Library, London.

Table 2 shows, not surprisingly, a link between the length of passage and insurance rates - although the South American routes do not fit neatly into the picture- and in all but two cases outward rates are lower than inward rates. That fact probably reflects an additional agency cost faced by London-based insurance companies when insuring voyages from foreign ports since the assessment of risk was left to corresponding agents. However the incidence of waste and hence insurance risk are to some extent goods specific, and goods composition differed systematically between outward and inward transports. That might explain the two exceptions. Insurance rates also varied over the year, peaking in winter when the incidence of casualties was highest. On average the summer rates were about two-thirds of winter rates for Lloyds in 1853-72.[13]

Individual rates differed reflecting the quality of ships and shipper. In the data on which Table 1 is based the highest rate for grain was 7 per cent and the lowest 0.7 per cent but it is to be expected that as sail was replaced by steam and wooden vessels by iron risks and rates declined. By the early 1920s insurance rates for transatlantic grain were down to about 1 per cent of value, so all in all a decline from say around 1.75 per cent to 1.25 per cent seems plausible over the 1850-1900 period.[10]

6. Determining the relative impact of transport costs and market efficiency in the closing of the transatlantic price gap.

Let us now, finally, try to determine the extent of the London-New York price differential and its evolution. Due to the lack of strictly comparable qualities the analysis is restricted to a number of periods between 1855 and 1900 - rather than the entire period. The qualities used in the analysis are Red Western in New York and American Red in London for 1855-1864 and Red Winter in both markets for 1878-1900. The results are presented in Table 3.

In column 1 the difference between the London price and the New York price is shown as a percentage of the New York price. Column 2 documents the transport cost from New York to

[13] F.Martin, *The history of Lloyds and of marine insurance in Great Britain*, London: Macmillan, 1876, p 399.

[10] 'Price spreads and shipment costs in the wheat export trade of Canada' in *Wheat Studies*, Vol.2, No.5, 1926, pp.177-202.

UK ports as a percentage of New York wheat price. Column 3, finally, is the residual, which is column 1 minus column 2 minus marine insurance fees and port charges estimated to 3.75 per cent 1855-64 and 2.75 per cent thereafter, expressed in terms of New York price. As discussed in sections 5 and 6 porterage charges probably increased a little in proportional terms, while insurance decreased.

Table 3. London – New York wheat price differential, relative transport cost and residual differential. 1855 – 1900. Per cent.

Year	Price differential	S.D.	Relative transport cost	S.D.	Residual
1855-1858	22.0	10.5	9.9	3.1	8.4
1855-1864	26.5	13.7	13.4	4.7	9.3
1878-1900	15.2	6.2	8.1	3.3	4.4
1892-1900	13.9	5.5	7.6	2.8	3.5

Sources: See appendix. London - New York wheat price differential is American Red in London relative to Red Western in New York 1855-1858 and 1860-1864. In 1878-1888 and 1892-1900 the price differential is US Red Winter in London (Glasgow 1895-1900) and Red Winter in New York. Relative transport costs in 1855-64 have been adjusted as in Table 1. The residual is the price differential minus the relative transport cost minus 3.75 per cent insurance and port handling costs in 1855-64 and 2.75 per cent thereafter.

The table can be summarized as follows. The top and bottom rows show the first and last period under scrutiny and reveal a decline in the price differential of 8.1 percentage points of which 28 per cent can be accounted for by decline in freight rates. Both these periods constitute sub-periods in longer periods, 1855-1864 and 1878-1900, respectively, but both the longer periods have a couple of years of market inactivity around 1859 and 1890-1, respectively. A comparison of the two longer periods, 1855-64 and 1878-1900, does indicate a larger relative impact of the fall in transport costs, around 49 per cent. However the impact is probably not representative because the period 1855-64 contains a few years with exceptionally high transport cost. As pointed out in section 3 Isserlis' data also suggest a modest decline in real freight rates, in fact less than half of the decline I report for the years when we can compare results. The error correction analysis also strongly warns against using segments of the long series as a basis for strong conclusions.A balanced assessment of the decline would therefore lie between 20-30 per cent . Be as it may, it is clear that the residual is more than halved while the proportional decline in transport costs is much smaller.

To sum up: there is a role of transport cost reductions in price convergence but it is not the main factor. Improved market performance and marketing efficiency are more important. However, market inefficiencies were not entirely phased out with the residual remaining at 3.5 per cent. It is possible that the residual includes some un-identified costs, such as traders' commission, but these charges were probably not (much) higher than one per cent. Even had the residual been reduced to zero the sum of transport costs, marine insurance, and porterage charges would not have permitted price differences to be below ten per cent: down from mid-century but still big enough to matter.

7.Conclusion.

Previous research on price spreads and transport costs has exaggerated the scope of price convergence and the role of transport costs reduction therein. Transport costs fell but the fall sets in only in the last quarter of the 19th century. Transport costs and other transaction costs remained high and continued to give European peasants and landowners an implicit protection in the order of around 15 per cent , down by at most 10 percentage points. European farmers were affected by the general fall in producer's price, though. It is important to point out that Chicago prices fell, although the decline is less pronounced than the fall in New York. Appendix figure 3 indicates that Chicago Spring No 2 declined from a price of a little more than US$ 1 per bushel in the 1870s to a all time low low in the early 1890s of 60 cents. That decline is larger than the fall in transatlantic freight rates.

The main emphasis in this article is on market efficiency, as measured by a residual price differential, as a major contributor to price convergence. By neglecting improvements in market performance you risk neglecting a - in fact *the* –single most important factor in the process of market integration.

But how can we be so sure that the fall in the residual actually reveals increased market efficiency? Here is the answer. The residual is a measure of the price differential that cannot be accounted for by recorded costs. It therefore represents unexploited gains from trade, barriers to entry and inefficient marketing practices made possible by the lack of transparency. There are good reasons for risk-averse traders to ignore gains from trade in a market where information flowed at about the same speed as goods. That means that it took about a month for a London trader to know what the New York market made of the news from London. The telegraph transmitted information by the hour and the print media diffused it within 24 hours.

It should be obvious that gains from trade were more easily understood, known, and acted upon in the new information culture of the 1870s and onwards. This interpretation is supported by evidence on national markets: a recent study of grain markets in nineteenth century France found that almost the entire increase in the speed of adjustment to the transport cost adjusted law of one price took place between the 1825-35 and 1855-65. While the speed of transporting goods changed little, what differed between the periods was the information system. In 1855-65 all major French markets were linked telegraphically.[11] When inventory adjustments are possible what drives price adjustment will be new information rather than the arrival of new deliveries.

Traditional analysis of market integration has focused too much on price convergence, often identifying market integration with reduction in price gaps. However integrated markets need not - often cannot - obey to the law of one price in the literal sense of the word. The relevant standard for the extent of market integration is the *transport and transaction costs adjusted law of one price*. Markets can be well integrated leaving considerable price differentials reflecting transport and other trading costs. The real issue is the stability of the *transport and transaction cost adjusted law of one price* and the speed of adjustment back to that equilibrium after a shock. For example, in the last decades of the nineteenth century the half-life of a shock to the Paris and New York price differential equilibrium was only a fraction of the time it took goods to be transported from New York to Paris.

It is certainly not by accident that the entire dataset used for this study is collected from newspapers relying first on postal communication for news and later on telegraph-transmitted data. Whatever impact transport technology had in stimulating market integration it is now time to give the profound changes in 19th century information technology the role they deserve.

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[11] M.Ejrnæs and K.G.Persson,'Market integration and Transport Costs in France 1825-1903:A Threshold Error Correction Approach to the Law of One Price,' *Explorations in Economic History*,37, 2000, pp.149-73.

Sjuneson and James Walker. I have received useful comments from seminar participants at European University Institue in Florence, Institute of Economics in Copenhagen and Nuffield College, Oxford.
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Appendix

A new data set based on the reported transactions from commodity markets in New York, London, and Liverpool and a few other markets in Britain has been compiled. The main sources are general newspapers like *The* (London) *Times* and *New York Times* and specialized commercial journals like *Beerbohm's Evening Corn Trade List*. *The* (London) *Times* report on a weekly basis from Monday market at Mark Lane in London while *New York Times* and *Beerbohm's* report transactions from New York and a number of continental ports as well as London and a number of UK markets such as Glasgow and Liverpool. While the New York dataset just contains US varieties the London series have a large number of foreign and domestic wheat sorts. On that basis the data represent identical qualities traded the same day in New York, London, and Liverpool. Before 1855 and during a short spell in the mid 1860s, and early 1890s trading activities did not always permit us to find exactly matching days. However reported data represent at most a discrepancy of three to four market days. Grain trade becomes erratic in the mid 1860s and when in resumes in the end of that decade there are still difficulties finding comparable and identical qualities. It is not until 1878 that we have a continuous, frequent and perfectly matching pair of qualities in New York and UK, Red Winter. Some caution should therefore be applied when interpreting the late 1860s and early 1870s.

Sources

Wheat spot prices in New York, 1850-1900.

1850-53, from *New York Journal of Commerce.* Prices refer to Prime white Genesee at Monday market. In 1850 quoted price is the average of maximum and minimum price current. From 1851 it is the spot price. Prices in original are dollars per bushel. Prices read from microfilm made from an original in poor condition. New York Public Library and selected US research libraries.

1854-1877, from *New York Times* (widely available on microfilm). Prices refer to Monday market or a market day close to Monday market: for example, the Saturday market of the previous week or some other market day in the week of the Monday date. Several varieties (e.g. Red Southern, White Southern, Red Western, White Western, Red and Amber) ceased to be quoted from the early 1860s on. From then on only Red Western and White Western were quoted often enough to be useful. The price in the original source was quoted in dollars per bushel.
1878-1900, from *Beerbohm's Evening Corn Trade List*. Price refers to Red Winter in New York at Monday market. Dollars per bushel, transformed to shillings per quarter. *Beerbohm's* is available in hard copy at the British Library's newspaper branch at Colindale, North London.

Transport prices from New York to Liverpool, London and other ports 1852-1900.
Data from sources as for New York wheat, except that 1878 transport prices stem from the *New York Times*. Prices in original are in pence per bushel. In most cases prices refer to so called berth rates for transports to London and Liverpool. Berth rates were offered by liners loading grain as well as other goods. These were often slightly cheaper than chartered freights because loads had to be discharged immediately after arrival.

Wheat spot prices in London 1852-1900.
1852- 1877: *The Times*. Prices refer to Monday market at Mark Lane. For British wheat Essex and Kent White, Essex and Kent Red. For US wheat American Red and American white. From 1868 to 1877 only one 'American' quality is quoted.
1878-1900: *Beerbohm's Evening Corn Trade List*. British wheat: Mark Lane Monday market: English White and English Red. The New York quality quoted in London is Red winter The London price of US Red Winter is lacking from 1895 to 1900. The Glasg ow quotation has been used instead.

Conversion conventions
All prices have been expressed in monetary units and measures used in UK, that is shillings per imperial quarter with one imperial quarter being equal to eight imperial bushels of 0.03637 cubic metres. The bushel quoted in New York is assumed to be the US bushel, also called the Winchester bushel, at 0.03524 cubic metres. Transport costs are an exception: in the US and

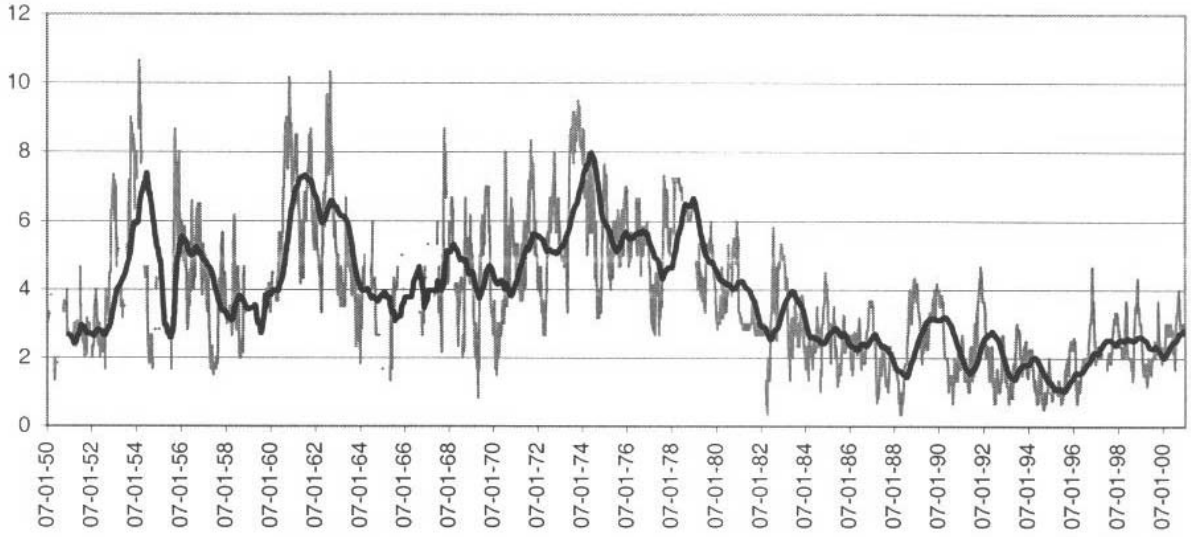
UK sources transports from New York are quoted in UK pence per bushel. That bushel has been assumed to be the imperial bushel.
In a few cases in the 1870s the price of transport is quoted in pence per a stated amount of lbs. Prices are converted to pence per bushel assuming one imperial bushel being 62 lbs.
Dollar prices in New York are converted to shillings by using the monthly exchange rates in New York for pound sterling at the 60 days bill of exchange rate. First week of a month quotes the exchange rate as the average of that month and the preceding month. Last week of the month quotes exchange rate as the average of that month and the next. The source used is J.Schneider *et al*. (eds), *Währungen der Welt I, Europäische and Nordamerikanische Devisenkurse 1777- 1914*, Vol 1, Stuttgart: Franz Steiner Verlag, 1991.

Appendix table 1. Average relative transport cost in overlapping 10-year periods, 1852-1900. Freight rates from New York to UK in per cent of price of US wheat in London.

Year	Relative transport cost	S.D.
1852-1860	8.0	3.1
1856-1865	9.0	3.2
1861-1870	9.3	3.3
1866-1875	10.2	3.2
1871-1880	10.5	2.8
1876-1885	8.1	2.9
1881-1890	6.7	2.3
1886-1895	6.1	2.3
1891-1900	6.7	2.4
1896-1900	7.6	2.2

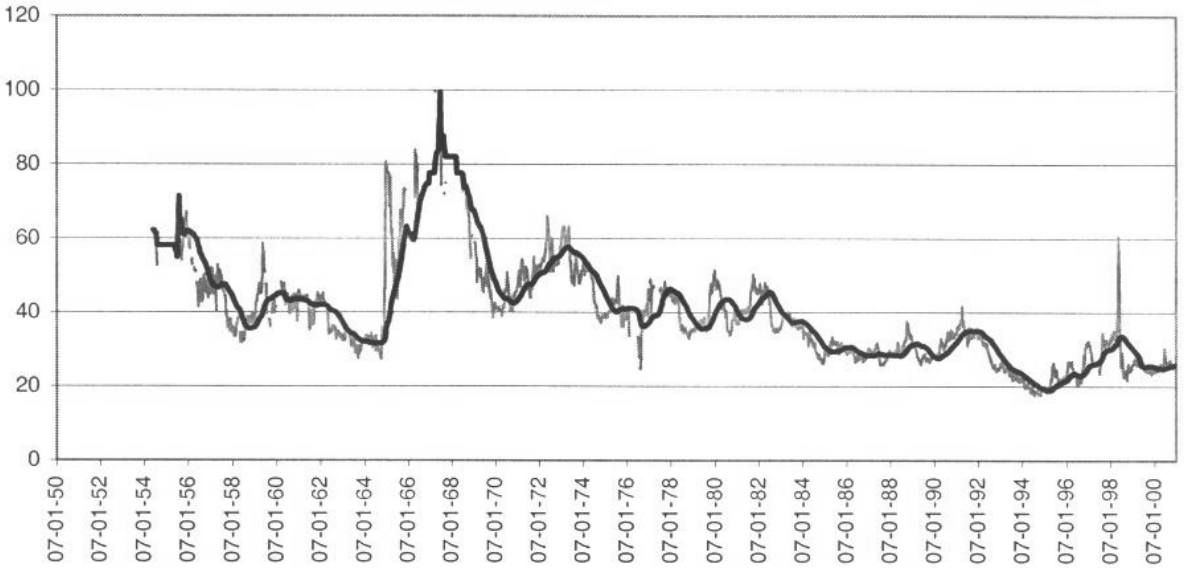
Sources: See Appendix. Relative transport cost estimated as in Figure 2, that is Liverpool freight rates have not been adjusted by a factor 1.12.

Appendix figure 1. Nominal transport costs New York to UK ports 1850-1900. Weekly observations and a 52 weeks' moving average, s per quarter. Sources: See Appendix



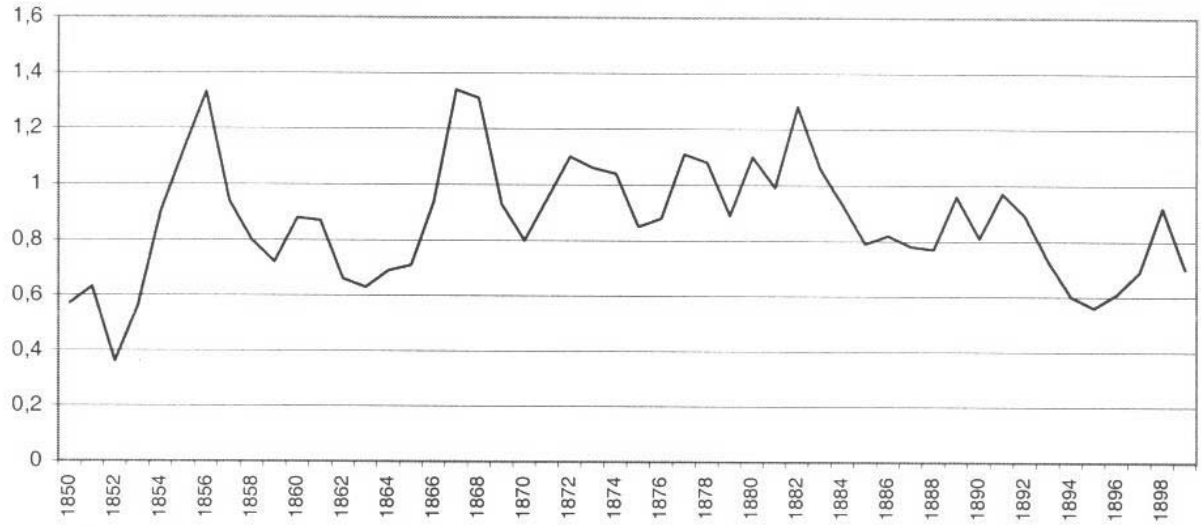
1850:1-1864:2 Liverpool sail; 1864:2-1877:12 Liverpool steam; 1878:1-1880:9 and 1881:1-1900:12 London steam; 1880:9-1880:12 London Sail.

Appendix figure 2. Nominal New York Red wheat prices 1854-1900. Weekly observations and a 52 weeks' moving average, s per quarter. Sources: See Appendix



1854-1870:7 and 1873:3-1877:12 Red Western; 1870:7-1873:3 Red and Amber; 1878-1900 Red Winter. US wheat prices in US bushel

Appendix figure 3. Chicago Spring No. 2 1850-1900



Wheat prices in gold dollars per bushel. Source: Appendix table in C. Knick Harley, "Transportation, the World Wheat Trade, and the Kuznets Cycle, 1850-1913, *Explorations in Economic History,* 17, 1980, pp. 218-250.