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

Abstract.

The conventional view asserts that sharply falling transport costs practically closed the transatlantic price gap for grain by the end of the 19th century. This paper challenges that view on the basis of an analysis of a new data set of weekly wheat prices and freight costs from New York to UK markets. Although transport costs fell, the fall was neither sharp nor dramatic. The extent of the decline in real terms is very sensitive to the choice of deflator. It is argued that if you are assessing the trade inhibiting effect of transport costs, the 'freight factor' approach, using the price of the transported good as deflator, is the appropriate one. Port charges, insurance and marketing costs also fell by the same modest rate and since these costs were almost as large as transport costs, the price gap remained substantial. One implication is that we need to look elsewhere for the dramatic increase in New World grain exports.

1. Introduction: the traditional view.

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 or the last third of the nineteenth century and caused international commodity price gaps to close. Some of the best minds in the profession have made significant contributions to the literature. Douglass C. North (1958, 1965) documents a substantial fall in transatlantic freight rates in the 19th century from the inflated price level by the end of the Napoleonic wars. However the decline was not limited to these routes. J. E. Oribe Stemmer (Stemmer 1989) finds similar trends in the freight rates from Latin America to Europe, although the decline in outward freight rates from the UK to Latin America was muted. Y. Yasuba (1979) looks at rates for bulk commodities such as coal in Sino-Japanese trade, and he shows that they fell considerably in the 1880 to 1913 period. The routes involving the Black Sea were no different (G. Harlaftis and V. Kardasis, 2000).

The claims regarding sharply declining freight rates rely on two not entirely compatible sets of data: an analysis of international price-spreads (price gaps) and an analysis of observed transport costs. By and large the former conveys a more dramatic decline than the latter. It is perfectly legitimate to infer a transport cost decline from price convergence if all three of the following conditions are met:

1. Markets must be equally efficient over time, that is the price spread that is not accounted for by transport and transaction costs has been arbitraged away.
2. Transaction costs, such as insurance and port charges, are either insignificant or constant over time.
3. Quality differences between different varieties or grades of a commodity have been controlled for.

The analysis of price-spreads often infers an implausibly large decline in transport and transaction costs because one or several of the conditions listed above have been violated. 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 that indicate that the transatlantic price gap had been practically eliminated by the end of the 19th century (Harley 1980) or early 20th century (O'Rourke and Williamson 1999). It is suggested that a decline in wheat price spreads indicates not only a sharp but also an *actual* decline in transport costs according to O'Rourke and Williamson, and in transport and marketing costs according to Harley (1980).[1]

The dating of the decline in transport costs is a bit controversial. C. Knick Harley dates the decline in real transport costs to the second part of the 19th century but points out that large variations in freight rates make an exact timing of the decline difficult to determine. He takes issue with Douglass C. North who suggested two phases of decline in the 19th century, 1815 to 1851 and from the late 1870s to the first decade of the 20th century. It is noted by North (1958, 1965) that freight rates in 1815 were exceptionally high due to a long period of war and conflict in Europe, but the two indices North has published date the decline differently and differ in the assessment of the extent of the decline. That difference is substantial but has not, to my knowledge, been discussed by North and has been overlooked by those using North's data. As shown in Appendix 2, both series are indexed 1830 = 100 and are identical until 1840, but depart from then on. Much of the decline in North's 1965 assessment takes place in one single downward shift in the 1840s, but the extent of the decline also differs in that the index published in 1958 takes the value 63 in 1900, while the index published in 1965 ends at 36.7. 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 (Harley 1988). For the period after

1870 Harley relies on L. Isserlis' data (Harley 1988, Isserlis 1938). Isserlis' study is based on a large number of inward and outward routes and goods, each of which is represented by the average of the yearly maximum and minimum rate. Harley converts the Isserlis data to shillings per ton of coal and deflates the series by the UK GDP deflator constructed by C. Feinstein. The Isserlis data have been criticized by a number of authors and the use of an average of maximum and minimum prices rather than a conventional average was criticised in the discussion following the presentation of Isserlis' paper in 1937 (Isserlis 1938 pp.135-146). A potential upward bias in Isserlis is noted by Yashuba (1978) and S.I.S Mohammmed and J.G. Wiliamson (Mohammed and Williamson 2003) and J.T. Klovland (2004) have confirmed this bias.

The vast literature on freight rates in the 19th century is aptly summed up with a polemical emphasis 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' (O'Rourke and Williamson 1999, pp 33-36). They argue, furthermore, that the impact of trade liberalization starting in the mid-19th century was small compared to the 'enormous', 'amazing' and 'precipitous' fall in transport costs. 'In the nineteenth century', it is announced, 'international freight rates collapsed' as they estimate the fall in pre-1914 transport costs at 45 percentage points. (O'Rourke and Williamson 2002, pp. 35-37).

2. Challenging the conventional wisdom: New data, new results.

The motivation for this paper is the problem first posed by Douglass North and later by K. O'Rourke and J.G. Williamson regarding the role of transport cost reductions in the integration of the Atlantic economy in the second half of the 19th century. The consensus view holds that the sharp decline in transport costs dramatically changed the conditions for trade and market integration. This paper states that the combined effect of the limited fall in transport costs and other transaction costs meant that the price gap remained a significant barrier to trade and as a consequence we need to look elsewhere for an explanation of the rapid increase in New World grain exports.

There is no denying that nominal freight rates fell, especially in the last third of the 19th century. But this was also a period in which prices generally fell. The essential problem is therefore the one of assessing the fall in the *real* rates. The choice of deflator is, however, not a straightforward one, it depends on the problems to be solved. Much of the analytical effort in the previous research by Douglass C. North and Knick Harley was to estimate productivity gains in the maritime transport sector, which in the case of Harley motivated the use of a GDP deflator. However, the problem posed in this paper is to look at the trade barrier aspect of transport costs. A GDP deflator is therefore in appropriate since it includes non-tradables (Mohammed and Williamson, 2003). If you look at a basket of transported commodities, a commodity price index would do but it is of course desirable to have the basket of transported goods mimic the composition of the price index. The Harley and North indices are composed of a fairly small number of commodities and it is therefore doubtful that a wholesale commodity index is appropriate. Since we look at the trade barrier effect on a single good, wheat, the appropriate deflator is the price of that wheat. As a consequence the paper determines the extent of the transport cost decline in relative terms, i.e. transport costs are expressed as a proportion of the value of the transported commodity, for the following reason. If transport costs fall in relative terms, we believe that fall to stimulate trade and market integration, much as we believe that a decline in *ad valorem* tariffs does. In fact transport costs can be seen as an implicit *ad valorem* tariff. Douglass North invented the term 'freight factor' for this purpose.[2] You can either estimate the freight factor at the point of supply of wheat, say, New York, or the point of demand, say , London or Liverpool. The former gives an upper-bound estimate of the freight factor and the latter a lower-bound estimate. I will use both estimates.

I have chosen trans-Atlantic wheat transports in the 1850 to 1900 period because wheat, unlike cotton and tobacco, was widely produced on both sides of the Atlantic. Since cereal production was a major economic activity in Europe, changes in world market prices, tariffs and long-haul transport costs had immediate, albeit different, impacts on producers and consumers.

The data set on which this article rests documents, when available, weekly observations of prices of identical or close to identical grades of wheat in New York and London and transport costs from New York to UK ports for the period 1850-1900. The prices used are spot prices at major commodity exchanges as reported in contemporary newspaper sources. My data differ from the data traditionally used by higher frequency of observation and that great care has been taken to sort out and compare identical qualities at both ends of the trade route. Appendix 1 describes the conventions and exchange rate used to convert the data to shillings per imperial quarter. The data will be referred to as Persson's series and will be compared with other freight rate series, in particular those elaborated by North, Harley, Isserlis and Mohammed and Williamson. It is demonstrated that the new series do not differ significantly from other series as far as nominal freight rates are concerned. It will be argued, however, that the results in terms of real freight rates are extremely sensitive to the choice of deflator and the choice of period.

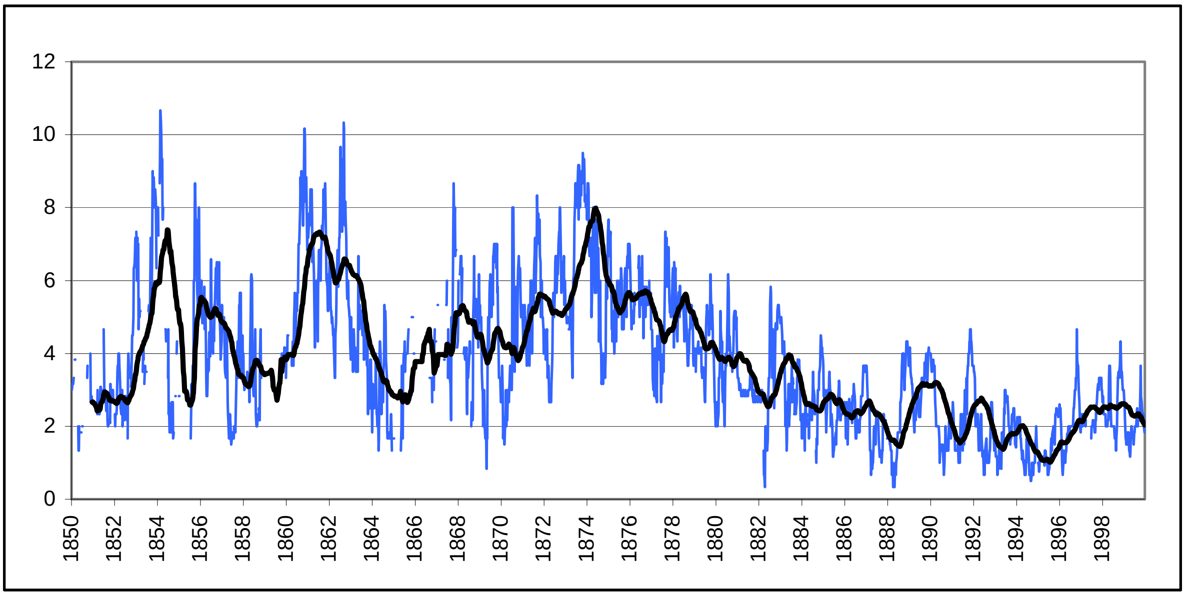
The rest of the paper is organized as follows. In section 3 the nominal freight rates are discussed and compared with other series. The question of whether wheat freight rates evolved differently than composite freight rate indices is then examined. Section 4 deals with real and relative freight rates and shows that the choice of deflator determines the extent of the real decline. Finally, it is demonstrated that the wheat 'freight factor', i.e. the relative freight costs of wheat, declined only modestly. Section 5 develops an accounting formula for the analysis of international price gaps.

Sections 6 and 7 document port charges and insurance premiums. In section 8 the size of the price gap is estimated and section 9 concludes the paper.

3. Nominal transatlantic wheat freight rates.

A suitable starting point for the discussion is a presentation of the transport costs data in nominal terms and for the entire period. Freight rates refer to New York to Liverpool in the first half of the period and to London after 1881, and there is a switch from sail to steam over the period. The underlying data for the figures and graphs are posted on my homepage (www.econ.ku.dk/kgp) and the sources as well as the conventions used to convert data originally expressed in different units to shillings per imperial quarter are discussed in Appendix 1.

Figure 1. Nominal wheat transport costs, New York to UK ports 1850-1900. Weekly observations and a 52 week moving average. Shillings per imperial quarter of wheat.



Note: 1850:1–1864:12 New York – Liverpool sail; 1865:1-1880:12 New York – Liverpool steam, and 1881:1-1900:12 New York – London steam.

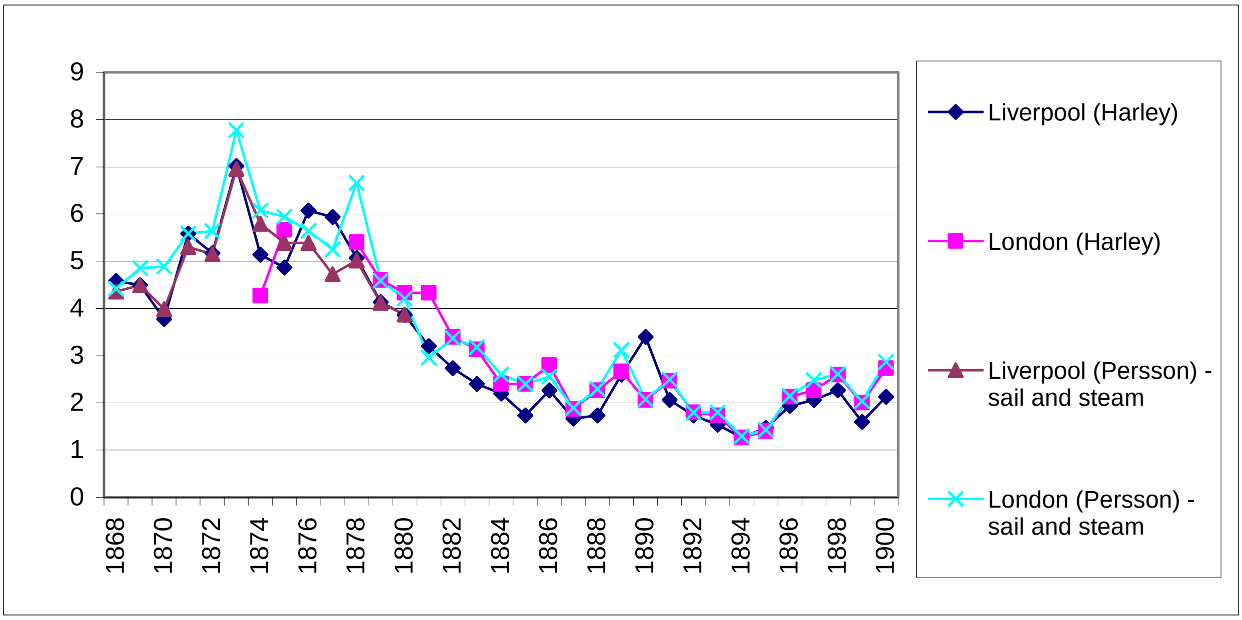
New York to Liverpool is used early in the period because it is most frequently quoted. Since Liverpool freight rates were practically identical to London freight rates from 1880 and onwards, the graph gives an accurate view of the New York to Liverpool rates. Rates to London were about 10 percent higher in the early years of the period.

Test statistics:	Intercept = 4.88725	sd = 0.05424	t = 90.10417	R^2 = 0.2428
	Trend = -0.00018246	sd = 0.00000665	t = -27.43759	

Sources: see Appendix 1.

Figure 1 displays the long term movement of freight rates. It is clear that there is a strong cyclical element with rates at peak level in the mid 1850s, during the US Civil War, and finally in the mid 1870s. It was possible, however, to fit a linear regression with a downward sloping trend to the data and the results are reported in the note under Figure 1. The peak in the 1870s is probably related to a rapid increase in demand for shipping: volumes of wheat shipped from the US to Europe increased almost tenfold over a short time-span after the US Civil War. It is worth noting that by 1874 freight rates had tripled in ten years and US wheat exports had reached their long run (1870 to 1900) average. The increase in freight rates stimulated shipbuilding, which drove prices down after the mid-1870s peak. More generally, the short run behaviour of freight rates is linked to the business cycle (Tinbergen 1959, Isserlis 1938, Meuldijk 1940, Klovland 2004). Jan Tinbergen noted that freight rate cycles are inversely correlated with lagged ship building cycles. The decline of freight rates during the first half of the 1890s triggered a decrease in shipbuilding, which led to an increase of freight rates in the second half of the 1890s. That increase stimulated shipbuilding in the first decade of the 20th century bringing freight rates down to an historic low, only to increase again (Tinbergen 1931). Given the strong cyclical element in freight rates, conclusions regarding trends are extremely sensitive to the period chosen for the study. However, it is safe to say that the declining *trend* from the mid 1870s to the mid 1890s is part of a general fall in prices on both sides of the Atlantic. The analyses confirms Harley's conclusion that a significant decline in freight rates in the 19th century only took place after the US Civil War and it is therefore worth looking at that period more closely. Do the data in this paper tell a different story than previous research? The answer is revealed in Figure 2.

Figure 2. Transport costs of wheat from New York to London and Liverpool, 1868-1900. Shillings per imperial quarter of wheat. Harley and Persson Compared.



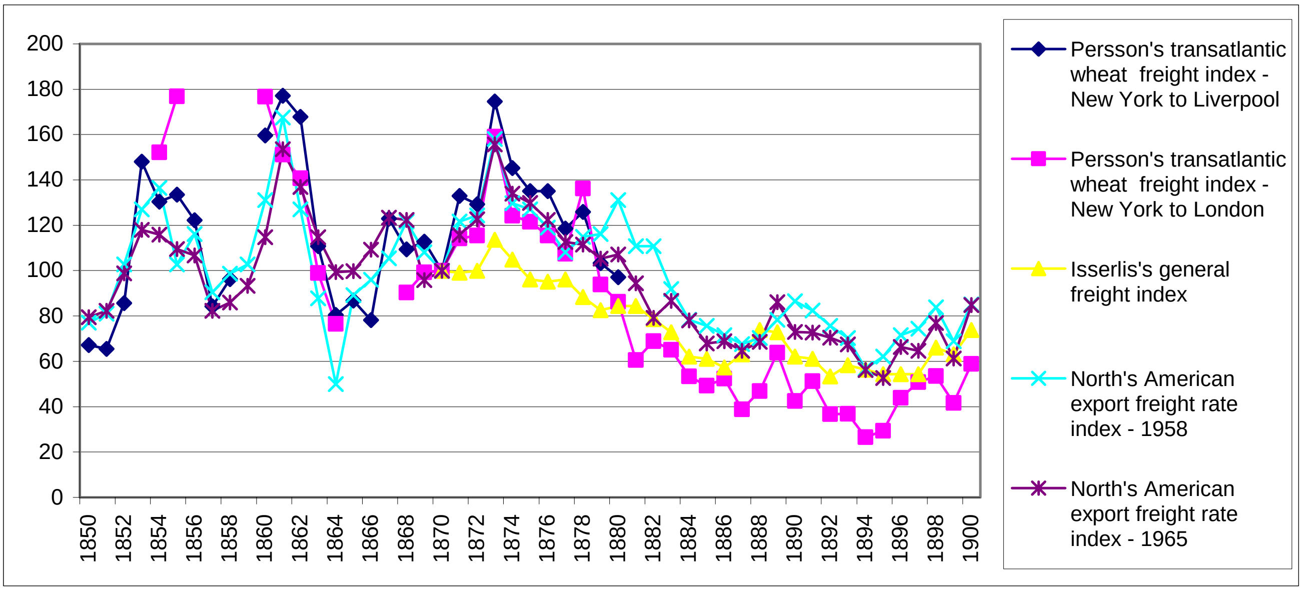
Sources: C.K. Harley, 'North Alantic Shipping in the Late Nineteenth Century. Freight Rates and the Interrelationship of Cargoes' in L.R. Fischer and H.W. Nordvik (eds), *Shipping and Trade,1750-1950:Essays in International Maritime Economic History*, Lofthouse Publications, Pontefract, 1990, pp. 147-171, Appendix table II; for Persson, see Appendix 1.

Harley has published an annual wheat/grain freight rate series starting in 1867. A comparison of that series with the data used in this paper, calculated as yearly averages, indicates a close correspondence. The relevant comparison is between the two destinations, London and Liverpool, separately. Except for a few cases, deviations are very small and many observations are identical.

There are only two observations in Persson's New York to London series that deviate significantly from Harley's series, but apart from these outliers, the movements are quite well synchronised. The London freights rates are of particular interest since they start out slightly higher than the Liverpool rates but then converge to the Liverpool rates by the end of the 19th century.

The argument in favour of sharply falling transport costs for the post 1870 period relies, however, not only on transatlantic grain freights rates but on a broader freight rate series, broader both in terms of commodities and trade routes. The first was constructed by Isserlis and later amended by Harley. North offered two series of US export freight rates discussed above and both of North's are used here. Are the grain freight series displayed in Figure 2 different from these more composite indices? We should not be surprised if they are because a series based on one commodity and one route necessarily displays more variance than an average of many routes, both outward and inward, and commodities. This expectation is also corroborated by Figure 3.

Figure 3. Isserlis's general freight rate index and North's American export freight rate index compared to Persson's transatlantic wheat freight index, 1850-1900. 1870 = 100.



Sources: North, Douglass 'Ocean Freight Rates and Economic Development 1750-1913', *The Journal of*

Economic History, Vol. 18, Issue 4 (Dec. 1958), pp. 537-555. North, Douglass 'The Role of Transportation in the Economic Development of North America' in *Les Grandes Voies Maritimes Dans Le Monde XV – XIX Siécles*, Paris: Ecole Pratique des Hautes Études, 1965, pp. 209-246; Isserlis, L. 'Tramp Shipping Cargoes, and freights', *Journal of the Royal Statistical Society*, Vol. 101, 1938, pp. 53-146; for Persson, see Appendix 1.

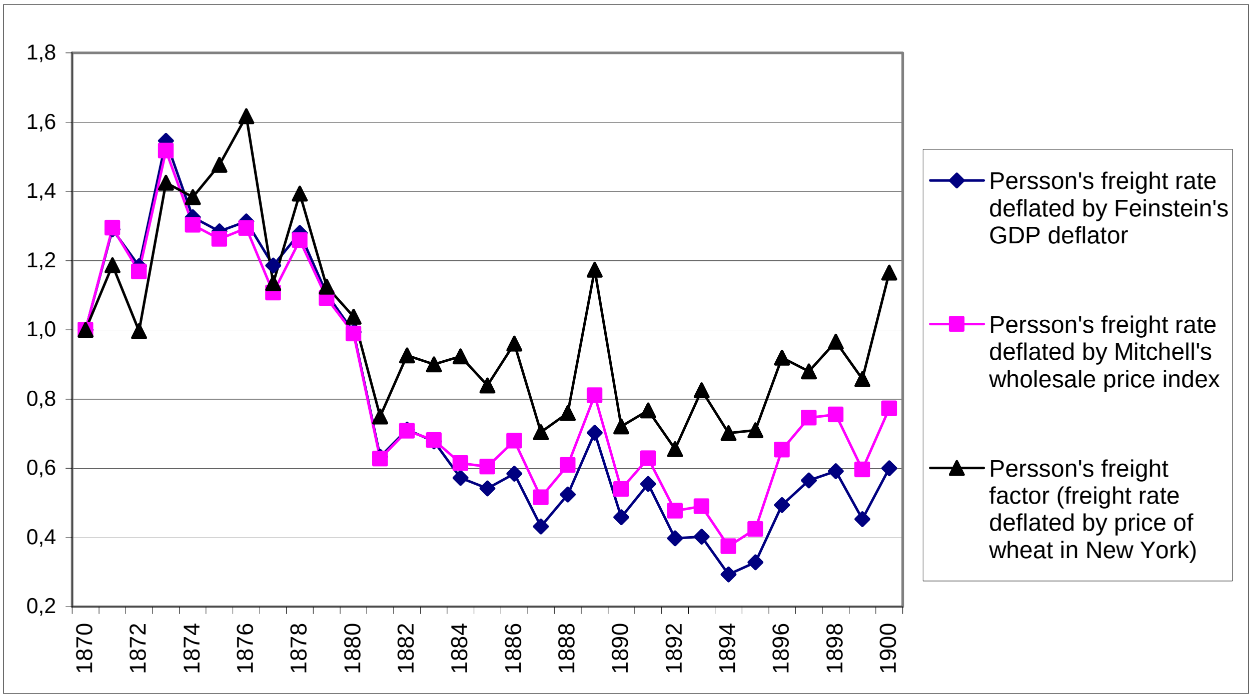
However, despite the differences in the series, it is worth stressing that the general drift in the series is similar after 1870 when the Isserlis series starts. The transatlantic freight rates (Persson and North) are quite inflated in the mid 1870s compared to Isserlis'. From then on both of North's series converge to Isserlis' index, while Persson's wheat freight series falls relative to the other series until the mid 1890s. It is important to stress that the results concerning real freight rates in section 4 below do not rely on the Persson's freight rates declining by less than other indices. On the contrary. It can be easily verified that the Persson series has the sharpest decline. The fact that freights are falling dramatically must be evaluated against the general fall in the international price level in the last quarter of the 19th century. From the mid 1870s prices fell for more than twenty years. The UK wholesale price index fell by 43 percent between 1873, when prices peaked, and 1896/7 when they hit the bottom; the US wholesale index fell by 49 percent while the UK GDP deflator fell by only 21 per cent. (Feinstein 1972, Table 61; B.R. Mitchell 1992, p. 840, B.R. Mitchell 1992, p. 690). While the New York price of No. 2 Winter fell by as much as the US wholesale price index, the Chicago price of Spring No 2 fell by a little less, 42 per cent. We need to keep these numbers in mind when we now turn to *real* freight rates.

4. The 'freight factor' and real freight rates.

The difference between the fall in the UK GDP deflator and the UK wholesale price indices highlights the fact that the choice of deflator matters a lot when we estimate the real fall in transport costs. There is, of course, no such thing as a correct deflator. The problem to be solved here is related to the evolution of the 'freight factor', that is, to what extent transport costs continued to constitute a substantial trade barrier for particular commodities. For a broader index of freight rates, a wholesale index would do nicely, and for a single commodity, the relevant deflator is the price of that commodity, either in the export or in the import market. Reiterating the arguments advanced above: what matters is the *proportional* weight of transport costs. The logic is in line with the argument that a fall in the *ad valorem* tariff would be expected to reduce barriers to trade. If, on the other hand, one is interested in the way the transport sector performs relative to the whole economy in terms of revealed efficiency, a GDP deflator seems relevant.

O'Rourke and Williamson are also interested in the freight factor, but their strong conclusions are based on price spread studies and Harley's data, which uses a British (Feinstein) GDP deflator. Their conclusion regarding the relative importance of the freight rate decline and the tariff reductions referred to in section 1 is therefore inappropriate, since they use different deflators for tariffs and transport, *ad valorem* deflated by 'own' commodity price and GDP deflator, respectively. Since the GDP deflator includes non-traded goods and services, it is particularly unfit for use in estimating 'freight factor' effects of traded goods. Does this difference between deflators matter? Yes it does, as demonstrated by Figure 4. In figure 4 the wheat freight rates from New York to UK ports have been deflated by Mitchell's British wholesale index and Feinstein's UK GDP-deflator for the UK and by the price of wheat in New York.

Figure 4. Real New York to UK wheat freight rates. 1870 = 1.00.



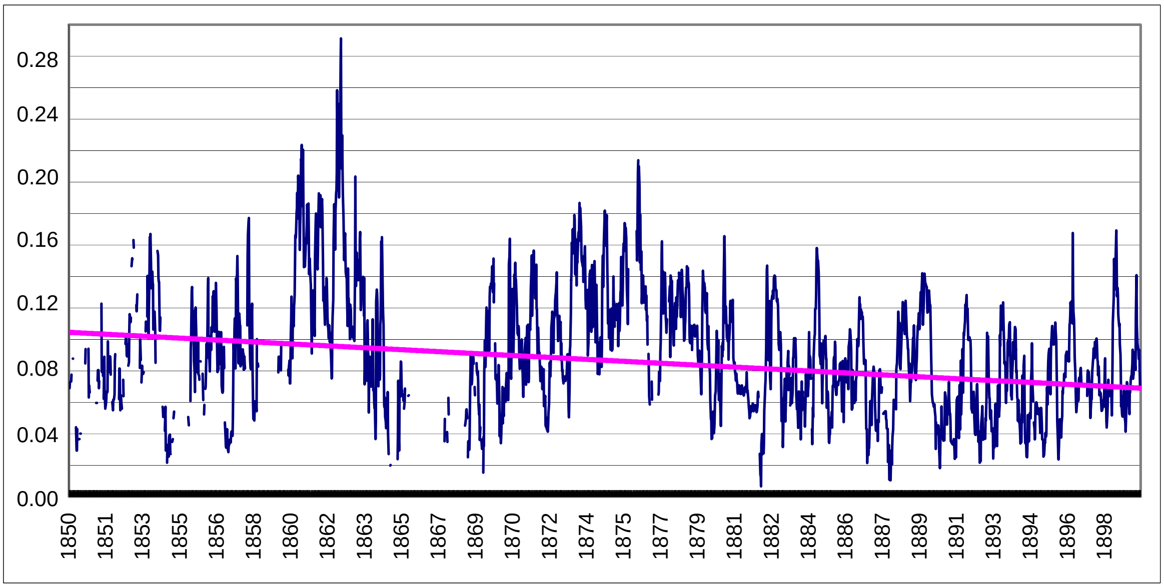
Note: Persson’s freight rate: New York to Liverpool 1870-1880; New York to London 1881-1900.

Sources: Appendix 1. C.H. Feinstein, *Statistical Tables of National Income, Expenditure and Output of the UK, 1855-1965*, Cambridge University Press, Cambridge, 1972, Table 61; B.R. Mitchell, *International Historical Statistics, Europe 1750-1988*, Stockton Press, New York, 1992, p. 840, Table H 1.

It turns out that the differential effect of the deflators on real freight rates is growing and persistent, ending at close to a 20 percentage point difference between the GDP deflator, generating the sharpest fall in real rates and the wholesale price index, and 40 percentage points when freights are deflated by the price of wheat. The reason for the surprisingly large difference in real freight rates between the wholesale price index and the GDP deflator is probably that the latter contains services and non-traded goods that are not affected by world market prices in a period of dramatic deflation. The small decline in the freight factor is explained by the fact that wheat prices fell much more than the composite commodity index. S.I.S. Mohammed and J.G. Williamson (Mohammed and Williamson, 2003, Table A3D) have decomposed freight rates on the basis of the original data used by Isserlis from the Angier Brothers annual reports. By applying a freight factor approach the freight rates for commodity specific routes were deflated by the price of the commodity. The East North American rates for grain exports should be comparable to my estimates and the data display the same u-pattern as the freight factor in Figure 3. However, the fall in rates after the mid 1870s is not as pronounced as in Persson's freight factor. By the end of the 1890s the freight factor in the Mohammed and Williamson estimate is back to the level in the mid 1870s: see Appendix 3.

If we extend the analysis of the evolution of the freight factor to the entire period, the conclusion that the second half of the 19th century experienced only a modest fall in the freight factor is inevitable. The series are presented in Figures 5 and 6 with transport costs divided by the price of wheat in New York (Fig. 5) and the price of US wheat in London (Fig. 6). At first sight they look like random walk processes. However, that hypothesis could be rejected. Both series are subject to a significant trend reverting mechanism indicating trend-stationarity and the trend was significantly negative. High autocorrelation means that the reversion to trend is slow. The left hand intercept (1850) in figure 5 was estimated to be 0.10447 and the right hand intercept (1900) was estimated to be 0.0689, implying that the 'freight factor' declined over fifty years by a little more than 3.6 percentage points, from 10.5 percent to 6.9 percent. Measuring the freight factor as a percentage of the London price of US wheat does not change the picture much; the intercepts in Figure 6 are 0.09356 and 0.06207, implying a slightly smaller decline of 3.1 percentage points. By any standards, these results cannot be called a 'dramatic', 'precipitous', 'amazing' or 'enormous' decline.

Figure 5. The freight factor, New York to UK ports 1852-1900. (Transport costs divided by the price of wheat in New York. Linear trend)

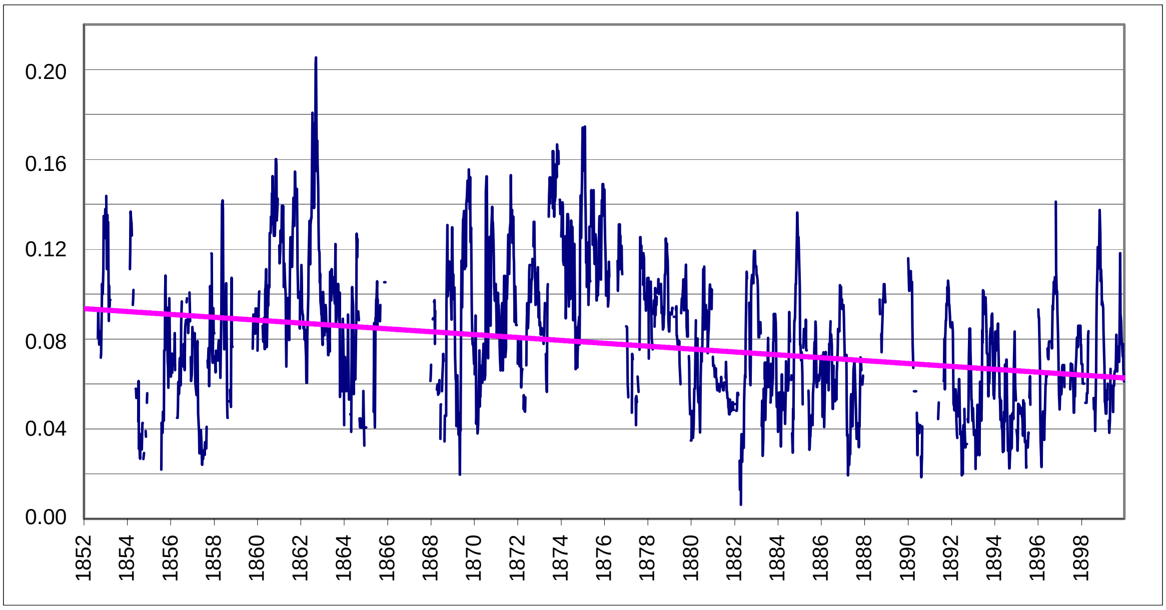


Note: 1850-1855:1 White Genesee, Liverpool sail; 1855:8-1864:12 Red Western, Liverpool sail; 1865:1-1870:7 Red Western, Liverpool steam; 1870:7-1873:3 Red and Amber, Liverpool steam; 1873:3-1877:12 Red Western, Liverpool steam; 1877:12-1880:12 Red Winter, Liverpool steam; 1881:1-1900:12 Red Winter, London steam.

Test statistics:	Intercept = 0.10447	sd = 0.0013	t = 80.36154	R^2 = 0.067
	Trend = -0.00000195	sd = 0,000000155	t = -12.58065	

Sources: See Appendix 1.

Figure 6. The freight factor, New York to UK ports 1852-1900. (Transport costs divided by the price of US wheat in London. Linear trend)



Note: 1852:8-1853:3 American, Liverpool sail; 1854:2-1864:12 US Red, Liverpool sail, 1865:1-1865:12 US Red, Liverpool steam; 1867:12-1869:6 American, Liverpool steam, 1869:7-1869:12 US Red, Liverpool steam; 1870:1-1874:12 American, Liverpool steam, 1875:1-1877:12 US Red, Liverpool steam, 1878:1-1880:12 Red Winter, Liverpool steam; 1881:1-1885:3 Red Winter, London steam; 1885:3-1895:8 No. 2 Red Winter, London steam; 1896:1-1900:12 No. 2 Red Winter (Glasgow), London steam.

Test statistics:	Intercept = 0.09356	sd = 0.0012	t = 77.96667	$R^2 = 0.078$
	Trend = -0.00000176	sd = 0.00000014	t = -12.57143	

Sources: See Appendix 1.

The impact of transport costs on commodity trade integration must be reconsidered accordingly. We observed previously that nominal freight rates were at a historic top when US grain exports landed at its long run average in the mid 1870s. Figures 5 and 6 indicate that the freight factor also was exceptionally high in the 1870s and above the trend value in this decisive decade of grain market integration. Another important implication is that price gaps must remain considerable with freight rates at close to 7 percent of the value of goods. Adding insurance, port charges and associated marketing costs means that a closing of the transatlantic price gap was far from realised. But how large was the transatlantic price gap and by how much did it fall? These issues are addressed next.

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

Let us consider a uni-directional trade pattern, with the US exporting wheat to the UK with prices in New York quoted exclusive of transport and insurance costs to the UK. In the price gap studies reported above, English wheat is usually the Gazette average, while the US price can be a specific, well-defined quality such as, say, Red Winter No.2. The price differential is given by the identity below:

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

where P is price, TRANS is transport costs, INS is the insurance premium, PC is port charges in the exporting and importing harbours and QUAL is the price premium reflecting the quality difference, or more generally consumers' preference or taste premium on the reference wheat quality 'English' relative to 'US' in identity (1) negotiated in London (English wheat) and New York (US wheat), respectively. TA is the tariff rate and although most of tariffs had been abolished by the start of the period under scrutiny, a small duty remained until the late 1860s. Finally, RES 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, unidentified (marketing) costs as well as estimation errors. QUAL is either negative, positive or zero depending on the qualities compared while TRANS, INS and PC are strictly positive. If all unidentified costs have been accounted for and if markets are perfect, RES should converge to 0 and the *transport and transaction cost adjusted law of one price* would rule (Ejrnæs and Persson 2000). There are historical records documenting P, TRANS, INS and PC, although only P and TRANS data are available on a frequent basis. QUAL is a non-trivial entity, price can differ by as much as 15 to 35 per cent for different qualities in a single market, and can therefore seriously bias estimates. In the framework of identity (1) above, it is clear that a (close to) zero price differential as reported by O'Rourke and Williamson and Harley must reflect a negative quality premium on 'English Gazette' wheat. As pointed out long ago by Thorstein Veblen (1893) the Gazette price is particularly tricky because it is an average of a changing number of markets and qualities.

QUAL can, however, be estimated by

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

Price differentials between different varieties of wheat in one single market must reflect quality differences as revealed by consumer preferences in that market.

There is a simple way of avoiding the quality problem in price spread accounting: simply substitute (2) for QUAL in (1), cancel terms, and (1) can be expressed as

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

That is, price gap studies should be based on price comparisons of strictly identical qualities in both 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 used in this paper.

6. 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 prices in New York were 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.[3] These charges differed according to whether the grain was in bulk or in bags, whether ships were unloaded on the 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 when grain prices decline in the last quarter of the 19th century.

Here are some vital details of the composition of porter age charges. Costs were divided by tasks such as landing on a quay and trimming (4.75d to 5d per ton of grain); filling into merchant's sacks and weighing (5.5d per ton); removed from scales and loading for re-stowing (2.5d per ton). These items come to a total of about 1s 1d per ton. The cost of 'receiving from ship, stowing on the quay or in barges and duly protecting and delivering to cart, railway truck or barge' varied according to time of delivery: 1s 2d 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 stored in warehouses there were of course additional costs of discharging and delivery. The storehouse rent was around 2d per ton 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 the typical cost of port handling from these data, we would arrive at a maximum of 8d (including storage) and a minimum of 3d per quarter. Assuming these charges were fairly rigid downwards, they will increase in proportional terms as the price of wheat declines. The charges are estimated here as one percent of the wheat price increasing to one and half per cent. For New York, charges are estimated to equal charges in London until 1878, after that date prices are quoted f.o.b and including a one per cent commission.

7. Marine insurance.

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 1. Insurance rates (cash premium as a percentage of the 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 1 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.

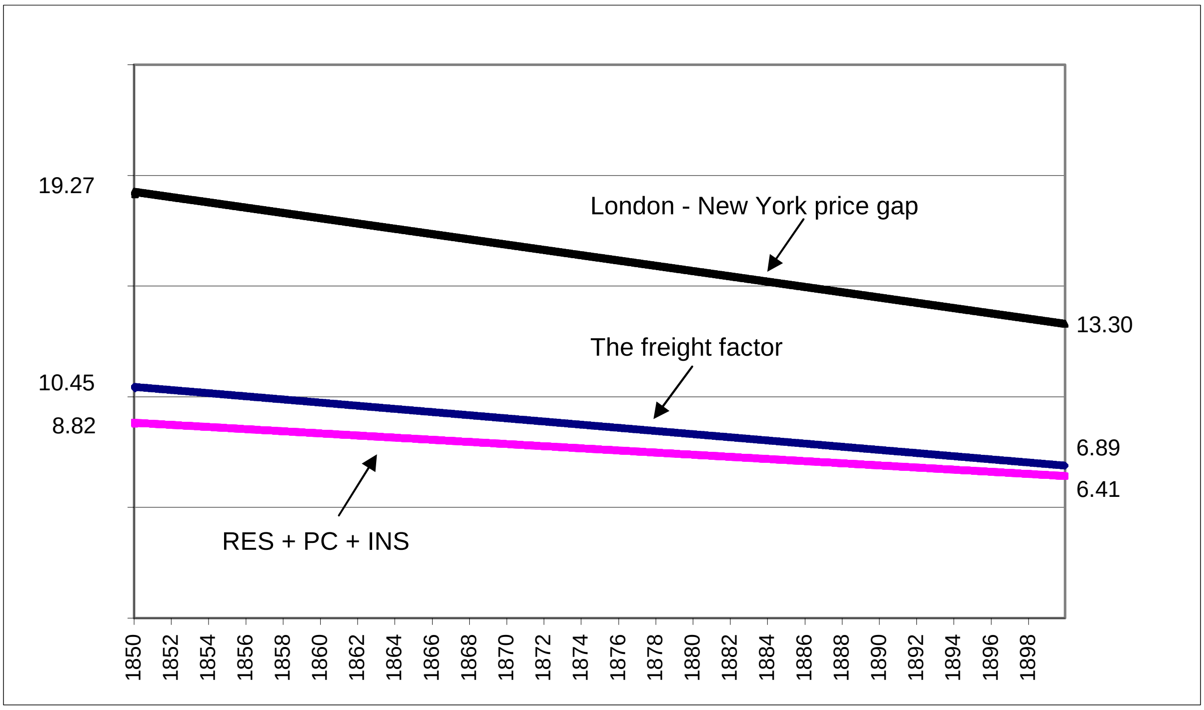
Individual rates differed reflecting the quality of ships and shippers. In the data on which Table 1 is based, the highest rate for grain was 7 per cent and the lowest was 0.7 per cent, but it is to be expected that as sail was replaced by steam and wooden vessels by iron, risks and rates declined. By 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 1.5 per cent seems plausible over the 1850-1900 period (Anonymous 1926, Martin 1876, p.399).

8. The price gap and its composition.

Let us now, finally, try to determine the extent of the London-New York price differential and its composition. Before discussing the results, it is worth noting that even if transatlantic grain markets were thin in the 1850s and specifically during the Civil War, the data are suitable for statistical analysis. Markets were fairly well integrated and pass standard co-integration tests. An error correction model was applied which yielded significant adjustment parameters with the right signs. As would be expected, adjustment parameters were smaller in the 1850s than at the end of the century.

The top line in Figure 7 is the linear regression of the price gap estimated as described in the note accompanying that figure. The price gap, defined as the percentage difference between the London and New York prices of US wheat, declined by exactly 6 percentage points from 19.3 to 13.3 per cent. Below that line the freight factor, that is the New York to UK transport cost as a percentage of the wheat price in New York is inserted. It declined from 10.5 to 6.9, implying that a little more than half of the decline in the price gap can be ascribed to the fall in transport costs. The regressions behind the two schedules discussed so far reveal trend stationary processes. Finally the bottom line linking the left and right hand intercepts of 8.8 and 6.4, respectively, has been estimated by subtracting transport costs from the price gap. This line measures the size of the sum of the residual, insurance and port charges, and tariffs, that is, RES+INS+PC+TA in equation (1'). That sum also falls significantly by 2.4 percentage points. It would be tempting to decompose the sum of insurance, port charges and the residual but the data are fragile. One question can be tentatively answered from the preceding narrative: is it plausible that the price gap not accounted for by transport costs, that is 8.8 per cent of the New York price of wheat by 1850 and 6.4 percent by 1900, can be explained by insurance and port charges only? The answer to that question is probably no. Port charges and insurance premiums accounted for about 3.75 percent in the first half of the period and 3 percent by the end of the period (see the last paragraphs of sections 6 and 7). However, there is a wide margin of error in the estimation of these costs. Furthermore, the remaining tariff of 1s per imperial quarter in the 1850s [4] would add as much as 2.13 percent to New York price, which implies that 33 percent, i.e 1 – [(3.75 + 2.13) /8.8], of the price gap that is not accounted for by transport costs can be explained by residual factors such as a risk premium and or inefficient arbitrage. By the end of the period tariffs had been phased out entirely and the estimate of port charges and insurance amounted to approximately three percent of the New York price, which means that, contrary to my initial expectation, the residual is as large as early in the period. Despite the uncertainties raised above, there is one robust and important conclusion from Figure 7: far from being eliminated, the transatlantic price gap remained substantial and equivalent to an ad valorem tariff of between 13 and 14 per cent.

Figure 7. The evolution of the transatlantic wheat price gap 1850-1900. Per cent of New York price of wheat.



Note: Due to the lack of strictly comparable qualities, the analysis of the price gap regression line, the top schedule, is based on data for the periods between 1855 to 1861 and 1878 to 1900. The data generate a trend stationary process with a declining trend. The qualities used in the analysis for the first period, 1855-61, are the average of Red Western and Red Southern in New York and American Red in London. In the latter period Red Winter is used for both New York and London, (Glasgow from 1895). The price gap is defined as the percentage difference between the London price and the New York price. Between these periods we cannot compare identical qualities, which, as noted above, is necessary in a precise comparison. Given the trend, the data are interpolated from 1850 to 1855 and from 1862 to 1877.

The freight factor regression is based on the data used to generate Figure 5. It gives an accurate description of the New York to Liverpool freight factor since it is based on the NY to Liverpool route up to 1880 and London from then on when London rates have converged to the Liverpool rates.

The bottom line is generated by subtracting the freight factor from the price gap, and it represents the sum of RES +PC + INS + TA.

Source: Appendix 1.

Test statistics:				
	Intercept = 0.1927	sd = 0.00485	t = 39.73196	$R^2 = 0.0289$
	Trend = -0.00000327	sd = 0.000000533	t = -6.135084	

Table 2. The London – New York price gap and its composition, per cent.

	1850	**1900**
Price Gap	19.27	13.30
Freight Factor		
Per cent of New York price	10.45	6.89
Per cent of London price	9.36	6.21
RES+PC+INS =		
Price Gap – Freight Factor (per cent of New York price)	8.82	6.41

Source: Figures 5-7. The ‘price gap’ is defined in the Note below Figure 7.

The data in Figure 7 have been summarized in Table 2 and it is clear that the annual decline in the price gap and in its components is so small that it could barely be noticed by contemporaries given the very strong fluctuations in the prices and freight rates.

In what way do the results reported here differ from previous results. Conventional price gap studies as discussed above (Figure 1 in Harley 1980, Figure 3.4 in O’Rourke&Williamson 1999) report a sharper rate of decline and an *elimination* of the price gap Even an approximate elimination of the price gap is however clearly implausible given positive freight rates and other transaction costs. The accounting identity in section 5 traces the origin of that implausible result in the use of heterogeneous qualities in the analysis of price gaps.

Although estimates of insurance, port charges and risk premium differ there is little differences in the estimates of transport costs which remained substantial. Harley (1980, Table 3) estimated the New York - Liverpool price gap for three benchmark periods by adding transport and transaction costs to the New York price. He implicitly assumed that markets were perfect so there were no risk premium involved, contrary to my results. He then found that the gap was 25.2 per cent in 1868/72, 17.1 in 1880/84 and 6.9 percent in 1910/1913. Compared to my results the Harley's gap was higher in 1868/72 and 1880/84 due mainly to the fact that Liverpool port charges were estimated at seven percent of price of wheat as opposed to my estimate of one per cent. Harley estimated these charges to only a half per cent in 1910/13 and that fact and lower transport costs explain the relatively low price gap compared to my 1900 estimate. However, I do find the Harley estimate of the initial level of Liverpool charges much too high and consequently the fall was exaggerated. The sum of Harley's estimate of New York and Liverpool charges are not compatible with my estimates in the sense that they alone exceed the sum of RES+INS+PC in my estimate.

9. Conclusion.

Previous research on price gaps and transport costs has grossly exaggerated the magnitude of the price convergence and the role of transport cost reductions therein. Transport costs fell but the fall only sets in during 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 13-14 per cent, down by at most 6 percentage points from the middle of the century.

These results point at new directions for future research. The traditional analysis of transatlantic and international grain market integration has looked at sharply falling transport costs as contributing to a fall in Old World prices generating an excess demand in the Old World. But the gains from transport cost reductions also benefited New World producers by increasing farm gate prices and stimulating an excess supply. In the end a new equilibrium emerged in which a larger share of Old World grain consumption was supplied by the New World producers.

Given the results of this paper and the historical fact that, the New World and the US, in particular emerged as a major grain supplier when freight rates were above trend, the principal new question is: Was the modest fall in transport costs really large enough to generate the dramatic increase in world grain trade in the last third of the 19th century? This question is linked to the distribution of the gains from the fall in transport costs. If the Old World captured most of the gains of falling transport costs as a decline in grain prices, little remained for the New World producers, and vice versa. One hypothesis worth looking into is, to what extent was the grain market integration driven by a downward shift in the New World supply schedule and/or a change in the supply schedule - its becoming more price elastic as nations with practically unlimited supplies of land were populated by immigrants. Allowing for these possibilities would give the modest fall in transport costs a modest role in transatlantic wheat market integration but perhaps the role it deserves.

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Appendix 1

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 such as *The Times* (London) and the *New York Times* and specialized commercial journals such as *Beerbohm's Evening Corn Trade List*. *The Times* (London) reported on a weekly basis from the Monday market at Mark Lane in London, while the *New York Times* and *Beerbohm's* reported 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 only contains US varieties, the London series has a large number of foreign and domestic wheat sorts. On that basis the data represent identical qualities traded on 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 it resumes at 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 the UK, Red Winter. Some caution should therefore be applied when interpreting the late 1860s and early 1870s data.

The data set is available at my homepage: www.econ.ku.dk/kgp

Sources

Wheat spot prices in New York, 1850-1900.

1850-53, from the *New York Journal of Commerce*. Prices refer to Prime White Genesee at Monday market. In 1850 the quoted price is the average of the maximum and minimum prices current. From 1851 it is the spot price. Prices in 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*. Prices refer 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 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 not available from 1895 to 1900. The Glasgow quotation has been used instead.

Conversion conventions

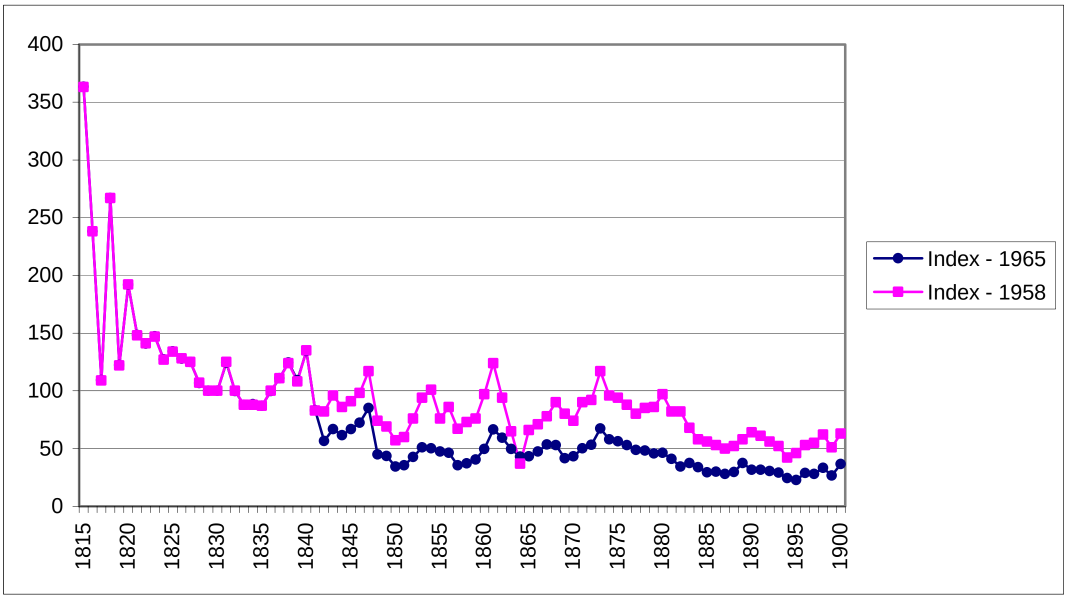
All prices have been expressed in monetary units and measures used in the UK, that is shillings per imperial quarter, with one imperial quarter being equal to eight imperial bushels of 0.03637 cubic metres. The bushel quoted in New York is assumed to be the US bushel, also called the Winchester bushel, 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. This assumption will have a level effect and if proved wrong the assumption underrates the actual freight rates.

In a few cases in the 1870s the price of transport is quoted in pence per a stated number of lbs. Prices are converted to pence per bushel assuming one imperial bushel equals 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 day 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 the exchange rate as the average of that month and the next. The source used is J Schneider *et al*.

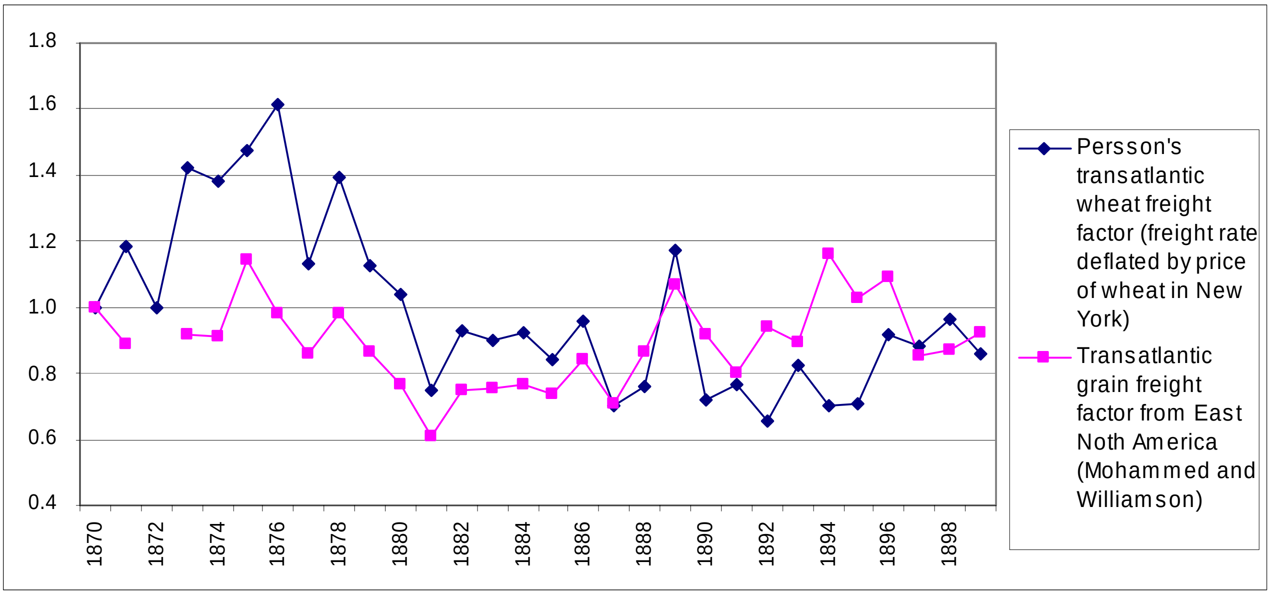
(eds), *Währungen der Welt I, Europäische and Nordamerikanische Devisenkurse 1777- 1914*, Vol 1, Stuttgart: Franz Steiner Verlag, 1991.

Appendix 2. D.C. North's American export freight rate indices, from the 1958 and the 1965 publication.



Sources: North, Douglass, 'Ocean Freight Rates and Economic Development 1750-1913', *The Journal of Economic History*, Vol. 18, Issue 4 (Dec. 1958), pp. 537-555. North, Douglass, 'The Role of Transportation in the Economic Development of North America' in *Les Grandes Voies Maritimes Dans Le Monde XV – XIX Siécles*, Paris: Ecole Pratique des Hautes Études, 1965, pp. 209-246.

Appendix 3. Transatlantic freight factors compared. Persson vs Mohammed and Williamson. 1870=1.00



Sources: See Figure 4 and S.I.S. Mohammed and J.G Williamson, Freight rates and productivity gains in British tramp shipping 1869-1950, NBER Working Paper 9351, 2003, Table A3D. The observation from 1872 in the East North America series has not been used because of suspected typo.

Footnotes

[1] C. Knick Harley (1980, pp.278-81)) says, in the context of the graph referred to in the main text, 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. He also makes more appropriate comparisons of identical qualities traded in Liverpool and New York and Chicago, which indicate a significant price gap in the 19th century. See Figure 1 and Table 3 in C. Knick Harley (1980), See also Figure 3.4 in K.H. O'Rourke and J.G. Williamson (1999). The problem with the widely used Gazette average, as noted by Thorstein Veblen, is that it is an average of a growing number of English markets and the composition of wheat qualities changes over time. T. Veblen dismisses the Gazette price saying, 'Gazette averages are useless for any exact comparison.' See T. Veblen (1893).

[2] Formally, freight factor = transport cost per unit of commodity x/value per unit of commodity x. See D.C. North (1958, p. 538).

[3] 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.

[4] There was a tariff of 1s per quarter from 1849 to 1864 when it was reduced, disappearing entirely in 1869. See J.H. Clapham (1926, Vol. 1, p. 496 and Vol. 2 p. 242).

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