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**Market Integration and Convergence
in the World Wheat Market, 1800-2000**

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Abstract

This paper argues that the conventional view which sees international transport costs reductions as the major force in price convergence cannot be upheld when the period under scrutiny is extended to the last two centuries. Domestic transport costs fell for land-locked regions while real international transport costs fluctuated strongly without exhibiting a significant trend. Changes in trade policies were the single most important factor explaining convergence and divergence of prices in the long run.

Keywords: market integration, price convergence, protectionism.

JEL classification: N 70

1) Introduction: Jeffrey G. Williamson and market integration¹

Market integration has been one of the major issues in Williamson's research, since his pioneering book on *Late Nineteenth-century American Development* (Williamson 1974). His more recent work, most notably his book with Kevin O'Rourke (1999) has deeply shaped the conventional wisdom about globalization well beyond the charmed circle of economic historians (World Bank 2002). His overall research agenda can be summed up in four (sets of) questions:

- a) What happened? Did price converge or diverge? How fast was the process, if any?
- b) Why did it happen? What was the contribution of the fall in transportation costs, increased market efficiency and policy decisions?
- c) What consequences did market integration have on welfare, income distribution and long-term economic growth?
- d) How did these consequences shape the political agenda and foster the adoption of restrictive policies?

Apparently, scholars have been quite busy in tackling the first two questions. Indeed, integration of commodity markets is a hot topic in economic history: in the last year alone, the four major journals in the discipline have published six papers on this issue (Jacks 2005 a and b, Dobado-Marrera 2005, Trenkler-Wolf 2005, Shuie 2005 and Klovland 2005), and a lot of other work is in progress. Yet, Williamson's agenda is still largely unexplored O'Rourke (2002, 2003). In fact, most of the current research aims at testing with increasingly sophisticated econometrics, whether the markets violated the law of one price – i.e. whether they were efficient in the Fama (1970) definition. This is a different, although related issue. In fact, a degree of efficiency is a pre-condition for integration, but it is unlikely that inefficiency was so substantial as to prevent integration altogether. We believe that this latter is the really important story and that Williamson's research agenda deserves to be put back on the centre stage. To this aim, in this paper, we focus on the market for wheat and consider the process of integration (or lack of it) from the early 19th century to present. The next Section deals with price convergence between

¹ Revised version of paper presented at the New Comparative Economic History Conference in Honour of Jeffrey G. Williamson at Harvard University, November 2005.

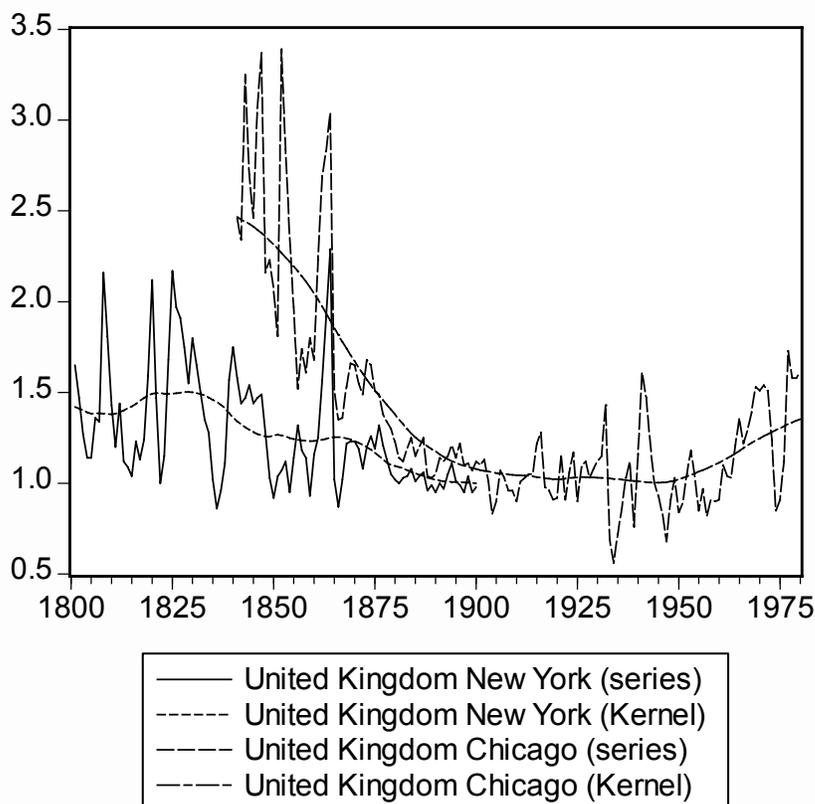
the United States and the United Kingdom, the archetypal producer and consumer countries. Section Three explores the patterns of integration in a wider range of countries, Williamson's "Atlantic" economy. Section Four assesses the importance of domestic versus international convergence. Section Five deals with the causes of integration, and section Six concludes.

2) What happened, I: price convergence across the Atlantic

As a starting point, Graph 1 compares ratios of wheat prices in the United Kingdom with prices in New York (1800-1900) and Chicago (1840 to present). Both series fluctuate widely in the short run – so the graph reports also the results of a Kernel fitting

²

Graph 1. Price convergence, United States to United Kingdom, 1800-2000



Source: See Appendix 2.

² Each point is obtained by fitting a polynomial, weighting the observations with a Epanechnikov kernel. All the rates of change quoted in this article are computed with linear interpolation, adding a AR(1) term when necessary.

The long-term trend of the UK-New York is unambiguously downward from the 1830s to the end of the century. However, the process was not particularly fast: price gap declined at a yearly rate of -0.57% p.a. from 1841 to 1900, i.e. by about a third over the whole period. The convergence was much faster between United Kingdom and Chicago: in the same years, the ratio fell by two thirds (rate of change -1.78%). The price differential remained roughly constant in the first half of the 20th century, but after 1950 they increased quite noticeably, at the yearly rate of 1.34%. This trend was insufficient to reverse the previous globalization: by 1985, the UK-Chicago price differential was only about half its level in the 1840s.

This simple comparison highlights the contribution of trends in the domestic American market to price convergence. Indeed the Chicago-New York price differential halved in the same period. Interestingly, the contribution of short-range integration seems quite small, if not negligible: the ratio of farm-gate prices in Wisconsin and Iowa and market prices in Chicago, or of farm-gate prices in up-state New York and market prices in New York are essentially trendless, with cumulated variation around or below 10%.³

The importance of domestic integration is somewhat neglected in the current debate, but these results tally fairly well with the conventional wisdom. However, they are subject to two important caveats:

a) First, both the United Kingdom price (the well known Gazette series) and the American series refer to a mix of different qualities of wheat, changing over time. This may be a problem because prices could differ substantially between qualities⁴ Therefore, the measured price gaps might be spurious and their movement might reflect quality changes instead of genuine integration. Market integration should be measured with

³ The rates of change are Chicago-Iowa (1870-1910) -0.18% p.a., corresponding to a cumulated 7% decrease, Chicago-Wisconsin 1844-1900 0.21% (cumulated change + 14%) and 0.04% 1845-1932 (+4%) and New York-Upstate-New York -0.11% 1842-1900 (-6.5%).

⁴ For instance, the allowed spread between the best and the worst deliverable quality at the Chicago future markets in the early 1920s was about 7.5% of the reference price (Prices 1934). This spread in all likelihood underestimates the true range, as low-quality wheat was not deliverable. If two qualities were perfectly substitutable, their price differentials would reflect only their intrinsic qualities (e.g. in the maximum milling ratio) and thus would be constant over time. However, it is unclear to what extent different qualities of wheat were perfect substitutes. For instance, it is well known, at least in Italy, that good pasta can be made only with hard wheat. In this case, movements in price gaps might reflect also changes in demand and supply of different varieties.

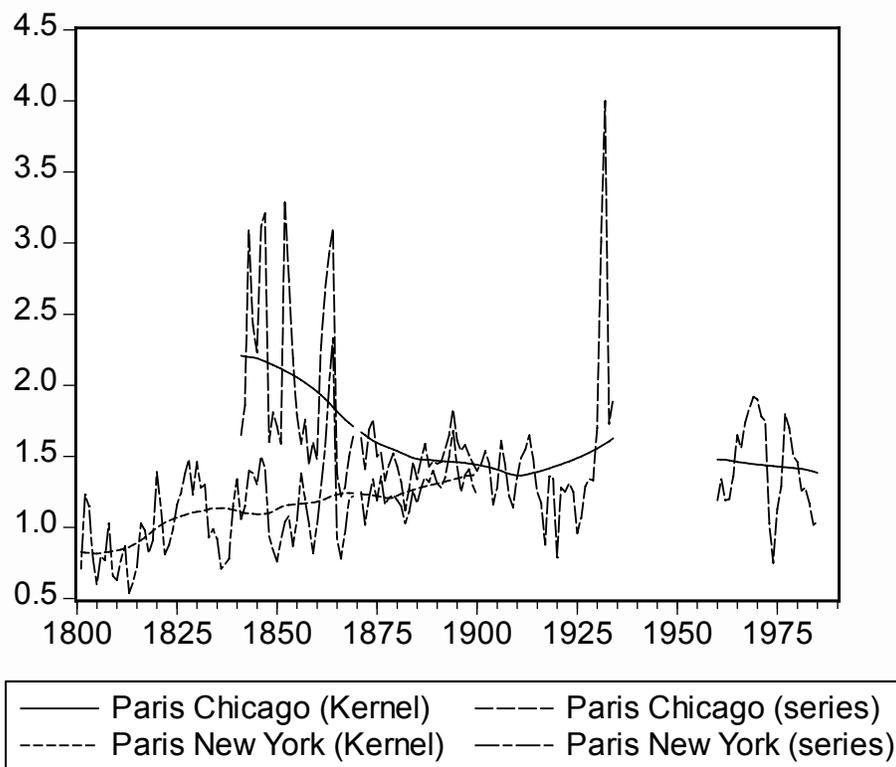
prices of the same quality in both markets. Unfortunately, these data are quite difficult to find, but the available information suggest that quality did matter. The adjustment for quality reduces the extent of convergence in the 19th century by about a fifth between New York and Chicago and by half between New York and London⁵. In fact, American US wheat improved relative to British domestic production (Ejrnæs, Persson and Rich 2004). Quality-adjusted price differentials remained constant in the years between the wars and increased very slowly in the 1980s and 1990s⁶. Unfortunately, these data are not directly comparable with the unadjusted differentials quoted above, as they refer to different pairs of markets (London-Winnipeg and Gulf port-Rotterdam versus London-Chicago) and, in the latter case, also to a different period (the adjusted series starts in 1985, exactly when the unadjusted one stops).

b) the United Kingdom and USA are not necessarily representative of the whole Atlantic economy. To illustrate this fairly obvious (but sometimes overlooked) point, one can consider the case of France. Graph 2 report data for (unadjusted) price differentials between Paris and the same two American cities, New York and Chicago.

⁵ The London-New York ratio do refer to the same quality (the US Red Western, later Red Winter n.2), while there are no data for the same quality in London and Chicago. It is nevertheless possible to estimate the implicit price of Red Western in Chicago as the price of Spring n.2 times the ratio between Red Winter and Spring No 2 in New York. The rate of change for quality-adjusted price ratio between Chicago and New York from 1859 to 1900 is -0.65% versus -0.80% for the unadjusted series in the same period. Adding a dummy for 1865, the rate drops to -0.51%. The rate of change for London-New York ratio is 0.54 and 0.40% with a dummy for 1864: neither coefficient is significant even at 10%. The first figure can be compared with the -0.99% decline in the unadjusted United Kingdom-New York series.

⁶ The interwar data refers to Canadian wheat (Manitoba Number 1 or 3) in Winnipeg and London. The rate of change 0.65% 1923-1939, but it drops to 0.38 by adding a 1931-32 dummy. The price gap for the No.2 Dark Northern Spring between Gulf ports and in Rotterdam increased by 0.3% p.a. from 1985 to 2005..

Graph 2. Price convergence, United States to France, 1800-2000



Source: See Appendix 2

The Paris-Chicago price differential declined from the 1840s to the 1920s. Price convergence was however slower than between United Kingdom and Chicago (the rate is only -0.94% from 1840 to 1900) and, above all, it was accounted for entirely by the integration of the domestic American market. In fact, the Paris-New York differential increased almost continuously throughout the whole 19th century. Until the 1840s, wheat prices were lower in Paris than in New York so that prices converged from below. This trend must reflect independent developments in the two countries, as France did not export wheat to New York. But the price ratio went on growing also later: for instance in 1870-1900 it increased by 20% while the United Kingdom-New York ratio in the same years decreased by about the same amount. The (straightforward) explanation of these trends can be postponed to Section Five: here it is sufficient to stress the difference with the British experience.

3) What happened, II: price convergence in the wide Atlantic economy

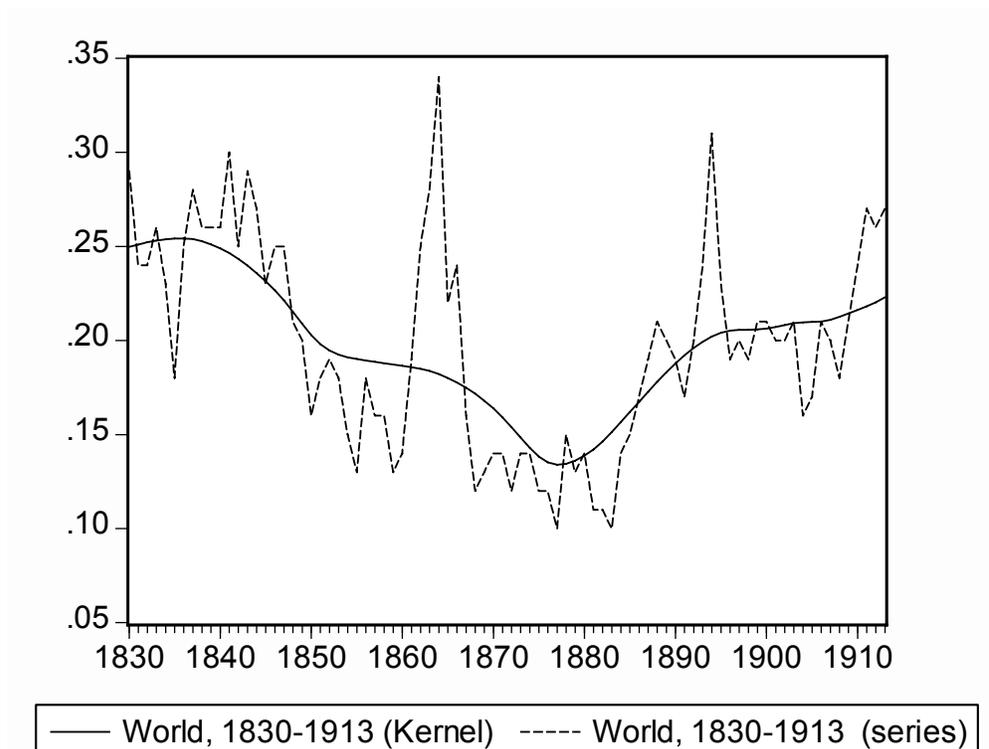
The graphical analysis of the previous section is too cumbersome to be replicated for a number of markets/countries large enough to be representative of the whole Atlantic economy. A much simpler measure of market integration is the coefficient of variation: a decrease corresponding to σ -convergence. One can resort to two sources, the impressive database collected by Jacks (2005a) for the period 1830-1913 and the journal *Wheat Studies* for the interwar years, from 1923 to 1939. The former consists of 107 series of prices in as many cities in ten countries (Austria-Hungary, Belgium, France, Germany, Norway, Italy, Spain, Russia, the United Kingdom and the United States), but gaps in series force to focus the analysis on a “core” group of about forty series in six countries from 1830 to 1907⁷. *Wheat Studies* reports data for 8 markets, one each for the four major exporting countries (USA, Canada, Australia and Argentina) and for the four major European importers (United Kingdom, France, Germany and Italy). Thus clearly it cannot consider domestic integration. Both samples cover about 70-80% of the Atlantic economy⁸. Thus they are fairly representative, provided that the selected (out of necessity) markets are representative. Unfortunately, these prices are not adjusted for quality and thus results are noisier than one would like.

Quite surprisingly, there is no evidence of a trend towards integration in the long 19th century (Graph 3).

⁷ This “core” group includes 4 markets in Austria-Hungary, 3 in Belgium, 12 in France, 2 or 3 (depending on the years) in Norway, 12 in the United Kingdom and 4 to 7 (depending on the year) in the USA. Further 8 markets can be added including Spain, but these series stop in 1907. The results are very similar. In two cases, Austria-Hungary and the United States, it is possible to extract different samples of cities (Austria-Hungary a and b, USA a, b and c). The data are available at www.sfu.ca/~djacks/

⁸ The Atlantic economy consists of the whole Europe, including Russia (until 1913), Serbia, Bulgaria and Romania, and its Western offshoots (North America, Oceania and Argentina). Population from Maddison (2003), wheat production from Mitchell (1998 a, b and c). The countries of the “core” sample accounted for only 44.5% of production and 44% of the population of the “Atlantic” economy before 1913. However, a χ^2 test fails to reject the hypothesis that the country distribution(s) of population and wheat production are equal in the sample and in the universe.

Graph 3. Coefficient of variation, “world” 1830-1913



Source: see text

Price converged until the late 1870s and diverged quite fast in the 1880s and early 1890s (the backlash), while dispersion remained roughly constant in the last fifteen years of the period. On the even of the War, the coefficient of variation of prices in “core” countries was slightly higher than in the early 1830s⁹

⁹ The long-term rate of change is 0.12 both in 1830-1907 (including Spain) and in 1830-1913 (omitting Spain) – but neither coefficient is significant.

Graph 4. Coefficient of variation, “world” 1923-1939



Source: see text

World War One brought about a dramatic change: in the early 1920s the coefficient of variation was less than a half its pre-war level (Graph 4). This difference is not accounted for by differences in the sample: the gap would be even greater if the co-efficient of variation is computed for the same (small) group of markets.¹⁰ This interlude of high integration was however very short-lived. From 1929 to 1931, the co-efficient of variation tripled, reaching an all-time peak - about double the previous ones

¹⁰ The sample includes five cities - London, Paris, St Louis, Berlin and Milan (the pre-war data are collected from “Il Sole”, the leading Italian trade newspaper) The coefficient of variation was 0.22 in 1911-1913 (against 0.21 in the “core” Jacks’ sample), 0.09 in 1923-1925 and 0.14 in 1929. The difference with the pre-war dispersion is not accounted for the omission of domestic variance either. In fact the coefficient of variation among country averages was 0.26 in 1905-07 (including Spain) and 0.20 in 1911-1913 (excluding Spain)

4) What happened, III: domestic versus international integration

Movements in the “world” coefficient of variation are the outcome of widely different trends within and across countries. Table 1 focuses on the process of domestic integration for eleven countries (adding Sweden to Jacks’ sample). For each of them, it reports the coefficient of variation of wheat prices at the starting date and in 1911-1913 and the rates of change over the whole period.

Table 1.

Domestic σ -convergence, 1800-1913

	Coefficient variation		Rates of σ -convergence			
	Initial Date \$	Final Date #	1800- 1870	1830- 1890	1870- 1913	Full period
Austria-Hungary a	0.264	0.046	-0.81***	-1.98***	-3.05***	-1.90***
Belgium	0.077	0.013	-0.45	-1.58*	-3.07***	-1.13***
France	0.226	0.072	-1.13***	-1.26***	-0.73***	-1.00***
Spain	0.229	0.064	-1.30***	-0.96***	-1.83	-1.21***
Sweden	0.09	0.057	0.51***	0.00	-0.82***	-0.06
UK	0.074	0.019	-1.09***	-0.50**	-1.55**	-0.73***
USA a	0.268	0.024	-1.01	-2.34***	-2.59***	-2.29***
Austria-Hungary b	0.085	0.053			-2.28***	-2.39***
Germany	0.091	0.076			-1.01*	-1.01*
Italy	0.219	0.072		-2.19***		-2.09***
Norway	0.017	0.053		2.67***	0.26	2.00***
Russia	0.125	0.076			-1.61*	-1.61*
USA b	0.208	0.045		-2.85***	-2.45***	-2.71***
USA c	0.076	0.053			-2.98**	-2.98**

* significant at 10%; ** significant at 5%; *** significant at 10%;

\$ Austria-Hungary a, Belgium, Sweden and UK 1800-1803, France 1806-1809, Spain 1814-1816, USA a 1816-1818, Italy 1826-1829, Norway 1830-1833, USA b 1841-1843, USA c and Germany 1899-1902; # all countries 1911-13, except Italy (1888-1890) and Spain (1905-1907)

Sources: Italy: Federico (2005a), Sweden: Jorberg (1972); all other data from Jacks (2005)

As expected, prices converged in all countries but two, Norway and Sweden. The integration was the faster the higher the initial level of dispersion was. It can be estimated that a 10% higher initial coefficient of variation augmented the absolute rate of change by 0.15 points. Unfortunately, about half of the series (lower part of Table 1) are useless for a long-term comparison, as they cover only a part of the period. The comparable series (upper part of Table 1) show that price convergence accelerated throughout the century. However, in four out of six cases (Austria-Hungary, France, United Kingdom and in the

United States), half or more of the total fall in price dispersion had been achieved by 1870. The importance of domestic integration in the first half of the century is confirmed by other research. Slaughter (1995) finds evidence a strong process of convergence in *ante-bellum* USA for a wide range of goods (omitting wheat but including flour). Ejrnaes and Persson (2000) argue that a French national market for wheat was already well developed by the mid-19th century. Federico (forthcoming) shows that wheat prices in Italy converged in two distinct phases, the 1840s and 1850s, and the 1870s and early 1880s. Metzler (1974) speculates, admittedly on the basis of very limited evidence, that integration in Tsarist Russia had started well before 1893.

If domestic integration went on throughout the century, the sharp increase in world-wide dispersion must have been caused by divergence among countries. This was indeed the case, but, as table 2 shows, only for some countries.

Table 2.

International σ -convergence, 1830-1913

	1830-1913	1830-1870	1870-1890	1890-1913
Free-market Europe	-1.80***	-3.17***	-2.04**	-2.82*
Protectionist Europe	-0.49**	-1.36**	2.14***	0.85*
Europe	0.27	-0.82	3.43***	0.14
Free world	-2.26***	-1.24	-4.11***	-3.77***
World	0.12	-0.83*	3.17***	0.90

* significant at 10%; ** significant at 5%; *** significant at 1%

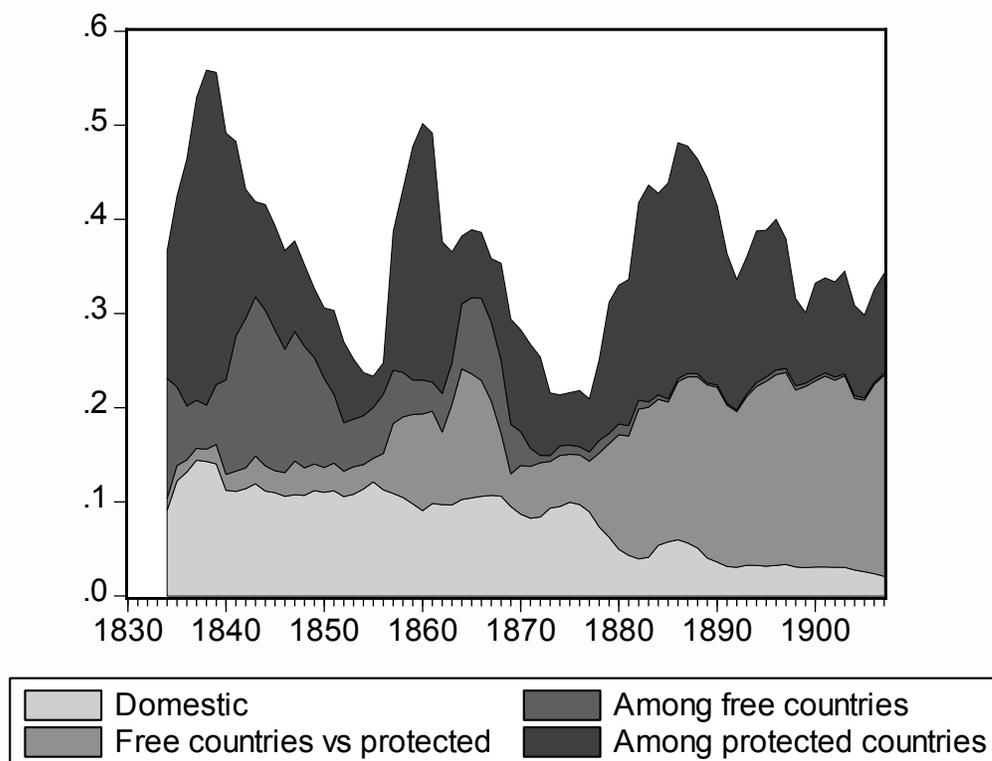
Source: Jacks (2005a)

Both the anti-integration backlash of the years 1870-1890 and the stagnation of the years to World War One can be attributed solely to the divergence among protectionist countries¹¹. Price convergence among “free-trade” countries went on and even accelerated relative to the pre-1870 years.

¹¹ “Protectionist” Europe includes Austria, France, Norway (belonging to Sweden until 1905) and Spain, while “free-market Europe” the United Kingdom (in spite of the Corn Laws) and Belgium. The row “free world” includes the United States and “free-market” European countries. All country is considered as a single market

So far, each component of total change has been considered in isolation. It is possible to estimate their contribution to integration (or dis-integration) of the “world” market with a simple variance analysis. Total variance is decomposed into i) domestic (within country) variance; ii) variance between protected countries and “free trade world” or “free” for short; iii) variance among “free” countries and iv) variance among protectionist countries¹².

Graph 5. Decomposition of “world” price variance, 1830 to 1913



Source: see text

Domestic integration was a fairly steady process: the within-countries variance decreased by three quarters in the whole period. Two thirds of this decrease is accounted for by

¹² The computation proceeds from the local to the general (see Appendix I). At each stage, all markets of the previous stage are treated as one, with a price equal the corresponding average. E.g. “protectionist” Europe consists of France, Spain, Austria and Norway and its variance is computed as if all markets in these countries had the same price. The variance is standardized by dividing by the world price times the number of markets in the relevant area. This method keeps symmetry in summations, but results are not strictly comparable with the coefficient of variations, which are standardized with national prices. Total within country variance is the sum of variance of individual countries. All series are computed as five-year moving averages

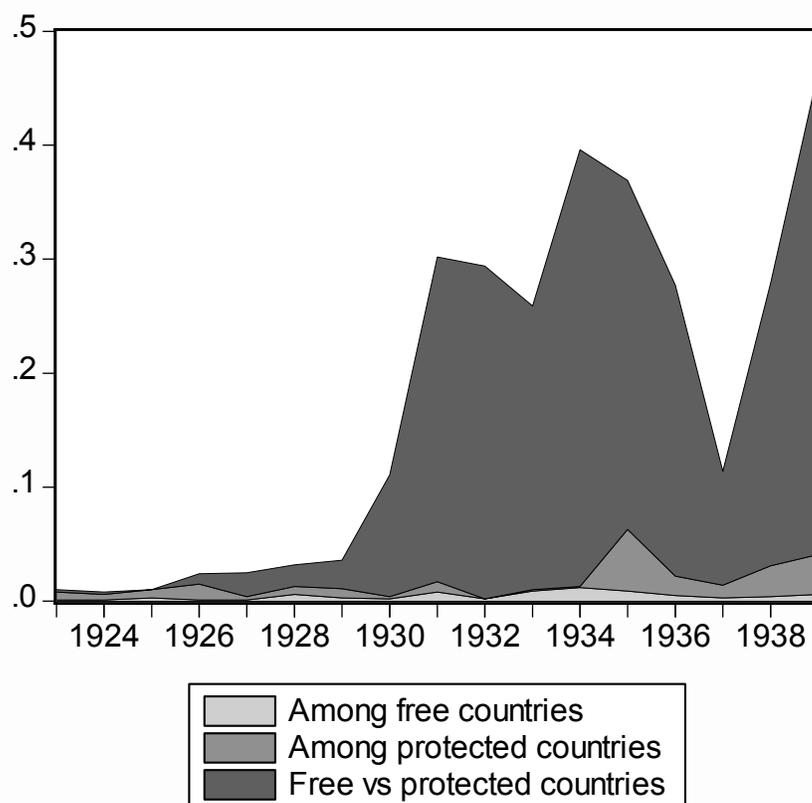
integration in Spain (especially in the 1870s and 1880s) and France. Other countries contributed much less, mainly because, by 1830, price dispersion was comparatively low.¹³ Without any contribution from international integration, domestic integration would have reduced world price dispersion by about a sixth. Although not negligible, this improvement is overshadowed by the convergence within free countries which accounted for most of the reduction in price dispersion in the first stage. From the 1830s to the 1870s, it would have reduced total variance by 15 points, more than 90% of the total decline in that period. Afterwards, price differentials among free countries remained negligible, accounting for no more than 2-3% of “world” variance. As implicit in Table 2, the backlash is to be attributed to the increase in the variance between free and protected world and that among protected countries. From the late 1870s to the mid 1890s, both increased by five times, accounting for about 40% each of the rise in total world variance. However, in the long run, trends in these two components differed substantially. The variance among protected countries decreased both before the 1870s and from the mid-1890s to the war, so that its effect in the long-run was fairly small (a 10% increase in total variance). In contrast, prices of the “free” and the “protected” world diverged in all the three periods. This component alone accounts for more than half the total increase in variance. Had this price gap remained constant throughout the whole period, total price dispersion on the eve of World War One would have been half its initial level.

Domestic integration cannot be considered in interwar years because, as said, *Wheat studies* cover only one market per country. This omission is less devastating that it seems. In fact, before the war, all countries in the sample had attained quite a high level of integration, and it seems highly unlikely that the war-time destructions had changed this situation. It is nevertheless possible that political changes, such as the dissolution of Austria-Hungary, disrupted integration. However the case of Poland shows how resilient market integration was: a national market for wheat flour was organised few years after the birth from of the new nation (Trenkler and Wolf 2005). Therefore, total variance in the interwar period is decomposed into i) variance between free-trade countries (United

¹³ Price dispersion was unusually low in the United States in 1831: the coefficient of variation in that year (0.09) was half the average of the other years of the decade.

Kingdom and overseas producers) and protected countries (France, Germany and Italy),
 ii) variance among protected countries, and iii) variance among free-trade countries.

Graph 6. Decomposition of “world” price variance, 1923 to 1939



Source: see text

The results of the decomposition (graph. 6) are quite clear. The increase in total dispersion in the 1930s reflects the divergence between prices in “free” and “protected” countries. It caused total variance to increase by forty times from 1923 to 1939. In comparison to this rise, the contribution from the two other sources disappears, although in absolute terms it is far from negligible (total variance would have tripled even if the price gap between “free” and “protected” countries had remained constant).

These results are not shockingly new. However, three points deserve some stress: i) domestic integration mattered, and its timing differ deeply from that of international integration; ii) most of the action, both within and across countries, pre-date 1870, the

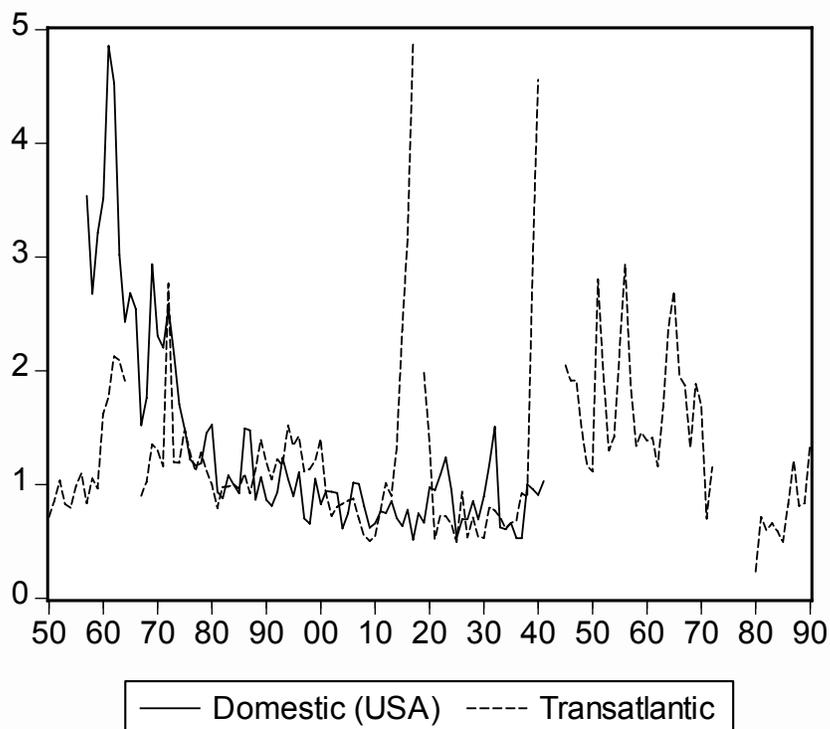
conventional starting point of the first globalization; iii) the integration of “world” wheat market peaked in the early 1920s, when, according to the conventional wisdom, anti-globalizing forces were already gaining the upper hand. These stylized facts suggest that the level of market integration depended more on policy-determined barriers to trade than on changes in transaction costs.

6) Why did it happen? The causes of convergence

In theory, in a perfectly efficient market, the (quality-adjusted) price gap between two markets is equivalent to total transaction costs, which include transportation costs, barriers to trade (if any) and other costs, such as insurance charges, commissions and minor costs (short-term storage, porter charges and so on). The difference between these costs and the actual price gap measures the risk premium and inefficiency – i.e. the violations of the law of one price. In theory, were complete and accurate data on all costs available, one could measure the contribution to changes in transaction costs to price convergence (or divergence). The residual, if any, would measure changes in risk premium and/or efficiency of the market. Let us consider, for instance, the quality adjusted price gap between Chicago and London. From 1857-1865 to 1890-1900, it fell from 75% to 26% of the Chicago price, while transport costs declined only from 46% to 15% of the price. In other words, the measured residual decreased from 30% of the Chicago price to only 11% in the 1890s. These figures seem too high to be accounted for by other costs, even taking into account the small duty levied on import to the United Kingdom until 1869. In fact, transaction costs were unlikely to exceed 5-8%, possibly 10% of wheat price, and the two main items, commissions and insurance fees, were proportional to price. Therefore, the fall in the residual must reflect an improvement in pure market efficiency and/or a sharp decrease in the risk premium (itself evidence of improvement in the market), plus measurement errors, which should, however, be unbiased. It is impossible to be more precise or, a fortiori, to replicate this analysis for all the pairs of market for all the period. However, some insights can be obtained by considering separately the changes in two main items of costs – transportation and barriers to trade.

The best measure of long-term change of transportation costs is the so-called freight factor – *i.e.*, the ratio of nominal freight to the price of wheat from the place of origin. This method of deflation corresponds to the “iceberg” approach to transaction costs in trade models.

Graph 7. Freight factors, 1850-1990 (1884=1)



Source: see Appendix 2

Graph 7 reports separate indexes for “freight factor” for transportation of American wheat from Chicago to New York and from New York to London. The difference is striking, especially in the first period. The domestic factor declined from about 25% in the late 1850s to slightly less than 10% in the late 1870s, drifted gently downwards until War World One and then remained stable¹⁴ In contrast, international freight factor

¹⁴ The yearly rates of changes are -4.90% from 1858 to 1880, -1.20% from 1880 to 1913, +0.41% (not significant) from 1913 and 1941 and -1.41% for the whole period.

remained constant in the very long run, although with huge fluctuations¹⁵. It declined fast in the twenty years before World War One and also from 1950 to 1990, while it increased in the years between the wars and above all between the late 1930s and the 1950s (it almost tripled from 1936-1938 to the all-time peak of 1957-1959). Actually, one would not expect a big fall because by the late 1850s transatlantic transportation was fairly cheap: the nominal freights accounted for about 7% of the New York price. The cost of transportation by sea must have declined earlier, in the first half of the century. Indeed, the Odessa-London freight, in nominal terms, halved from the early 1820s to the late 1860s (Harley 1989 Tab. 9). Unfortunately, it is impossible to compute the freight factor, as prices in Odessa are not available before 1893. One has to use other price series, and the choice matters. From 1820-22 to 1849-51, the “freight factor” declined by 44.4% if computed with New York prices, by 28% if computed with Paris prices and only by 18% if computed with London ones. Although the exact measure of decline is uncertain, thus, freights did decrease substantially in the first half of the 19th century.

One would be tempted to attribute the difference between domestic and transatlantic freight factor to the direct competition of railways. One must resist to this temptation. In fact, transportation from Chicago to New York remained cheaper by water (“lake and canal”) than by rail until World War One and afterwards.¹⁶ But the cost of domestic transportation fell much more than transatlantic freight: in 1857-1859, it cost 6.71 cents to ship a bushel of grain from Chicago to New York and 3.57 to forward it to the United Kingdom. In 1881-1883, the transatlantic freight had declined by 12% at 3.17 cents, while the cost of internal transport had plunged to 2.87 cents – i.e. by 60%. It seems implausible that such a big difference was caused only by differential technological change in shipping between the Great Lakes and the Atlantic. It might reflect change in market organization, such as a growing competition among domestic shippers (while transatlantic shipping was more competitive since the start). Or it might reflect the

¹⁵ The yearly rates of change for the whole period 1851-1990 is 0.12, and it reduces to 0.08 if one adds dummies for the Civil War years. The rate is -0.37 for the period 1850-1890, but it comes out positive (0.38) by adding the Civil War dummies. None of these rates is significant. The rates of change are -2.84 1890-1913, 2.18 for 1920-1938 (not significant) and -2.32 for 1950-1990.

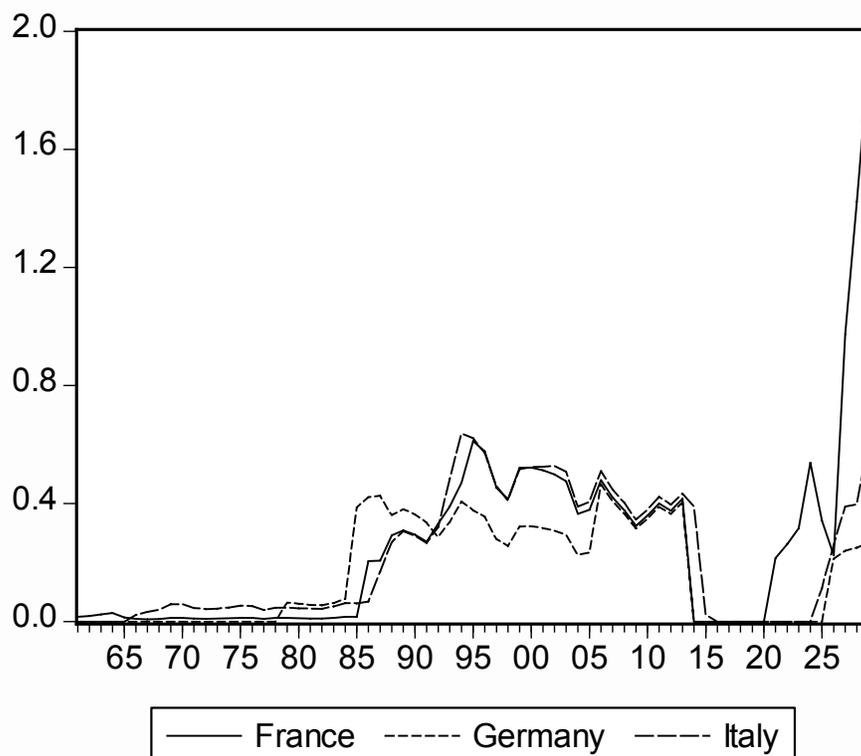
¹⁶ By 1912, the lake and canal route cost 5.37 cents/bushel, versus 6.54 for the lake and rail and 9.73 for the all rail route (Chicago Board of trade, 1912). By 1929, the lake and rail route for exported grain cost 10.42 and the all rail 12.37 cents/bushel.

indirect effect of the building of railways: their rates set the upper bound of water-borne transportation costs, which were slower and less reliable. As Williamson pointed out long ago (1974), one should compute the gains from railways by comparing rail rates not with the actual (post-railways) cost of water transportation, but with the counterfactual cost in the absence of railways. Metzler (1974) attributes railways a major role in fostering integration in Russia, but his inference is based mainly on the coincidence in time between their construction and the process of integration. In contrast, the construction of railways did not contribute much to market integration in 19th century Italy (Federico forthcoming). Prices did converge, but mainly because the fall in maritime freight rates fostered Italy's integration with the "world" (*i.e.*, pan-European) market.

. The barriers to trade were not so important in the first half of the 19th century: many European countries, including France and Prussia, were net exporters of wheat and thus their duties were irrelevant in practice. The only exception were the British Corn Laws, which however accounted for a minor proportion of "world" variance before the repeal¹⁷ After the abolition of the Corn Laws, wheat trade was practically free all over the Continent until the protectionist backlash of the 1880s (O'Rourke 1997). The extent of this latter can be appraised from Graph 8¹⁸.

¹⁷ The variance between United Kingdom and Belgium accounted for about 10% of the total in 1839-1841 and it fell to about 2% in 1843-1845. Had it remained constant at its 1841 level, by 1843-1845 "world" variance would have decreased by 9% instead of by 16%.

¹⁸ When duties changed within a year, the duty is computed by averaging the rates before and after the change, weighted with the proportion of months under each regime. This method yields unbiased figures if imports are evenly distributed across the year.

Graph 8. Duties on wheat in Europe, 1860-1929

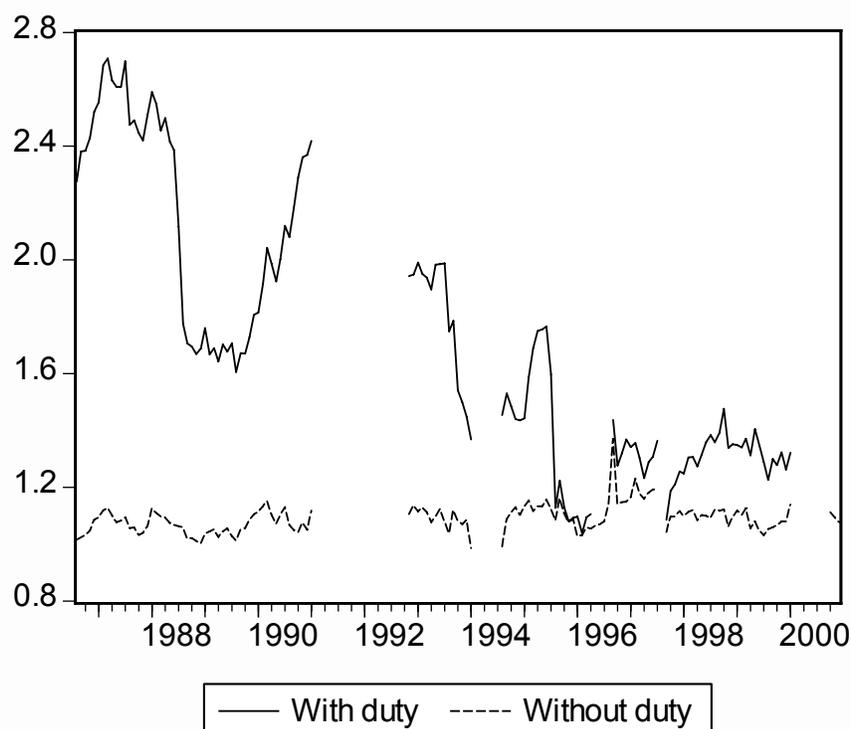
Source: duties Bacon and Schloemer 1940, wheat prices in Chicago Appendix 2

The duties of the three main Continental countries in the mid-1890s exceeded 60% of the Chicago price, while all other transaction costs did not amount to 20-25%. The paramount importance of trade policy in determining integration is confirmed by the results of a recent paper by Jacks (2005b).

All European countries abolished their duties with outbreak of World War One and freedom to import accounts for the very high level of integration in the early 1920s. As the graph shows, duties were imposed again since the mid-1920s, but the real watershed was the Great Depression. Importing countries dramatically increased their duties, and resorted to new instruments, such as forcing millers to process a minimum share of national wheat (usually in excess of 95%), setting quotas and managing the whole wheat trade (Tracy 1989, Federico 2005c). Also the traditionally free-trade United Kingdom followed this path for a couple of years, before letting imports from Commonwealth countries free after the Ottawa agreement of 1932 and subsidizing directly farmers

(Rooth 1992 pp. 89-94 and 212-231). In the United States, the Agricultural Adjustment Act, one of the first measures of the New Deal, set a minimum price for agricultural products after 1933 (Libecap 1998 pp. 186-196)¹⁹. Many of these policies were maintained well after the end of the emergency, until the 1990s. Indeed, price differential between Gulf States and Rotterdam, inclusive of duty, quite different from the series without duty (graph 9).

Graph 9. The impact of the Common Agricultural Policy



Source: see Appendix 2

As said, this latter remained constant around 1.2, while the former started around 2.5 in the mid 1980s and fell very quickly to about 1.30 after 1992, after the McSharry reform of the Common Agricultural Policy. Just for comparison, the London/New York price ratio exceeded 2 only three times before the repeal of Corn Laws, in 1808, 1820 and 1825. The world market for wheat was less integrated in the 1980s than at the beginning of the 19th century.

¹⁹ The ratio of the US price to the average of the three other “free-trade” countries jumped from 1.12 in March 1932-February 1933 to 1.57 from April 1933.

7) Conclusion

This paper makes four points:

- a) Although unadjusted prices are better than no price, one should be careful when drawing inferences from them. Quality mattered, even for a relatively homogeneous commodity such as wheat. Integration of markets created incentives for standardisation and quality improvement in exporting markets so that unadjusted data could bias the extent of integration upwards.
- b) The story of market integration is long and complex and focusing only on one specific period, such as the years 1870-1913, might yield a biased picture. Arguably, prices converged even faster before 1870, and the 1920s stand out as a short interlude of high integration.
- c) Price convergence (and divergence) has been a far-reaching process, involving both domestic and international markets and, to a different degree, all the countries in the Atlantic economy. But trends differed, and thus focusing only on transatlantic integration between the United Kingdom and United States is not enough, and might even be misleading.
- d) The emphasis on transatlantic freight as a cause of convergence might be misplaced. Domestic transportation costs also mattered a lot, and, above all, prices were largely determined by trade policies.

These statements refer to wheat and possibly to other cereals. Do they hold true for other commodities? The answer is not easy, because few studies deal with them (Froot, Kim and Rogoff 1995, O'Rourke and Williamson 1994, Slaughter 1995, Klovland 2005, Buyenka and Labys 2005, Federico forthcoming). It is impossible to draw any inference from their results, but it is possible to make some educated guesses on the basis of information about commodity-specific transaction costs. Freight rates for all primary commodities moved in parallel from the 1860s to World War One (Mohammed and Williamson 2004) ²⁰ It is also likely that all commodities benefited from improvements in

²⁰ The rates of change in nominal freights from 1869 to 1913 are -2.12% for wheat from Black Sea, -2.98% for coal to Genua and -2.68% for cotton from Alexandria (all significant at 1%). The

the circulation of information and in overall efficiency. However, one cannot rule out that the effect differed across commodities. For instance, the grading system was much less developed for other primary commodities than for wheat, and the quality problem was, if any, greater.²¹ But trade policy differed quite markedly. Raw materials remained largely exempt from duties, and thus, *ceteris paribus*, integration must have been easier in the market for cotton or coal than in the market for grain. This inference is not necessarily true for manufactured goods, which were hit by protection. Given these contrasting influences, the least bad guess suggests that wheat may be fairly, although not fully, representative. However, this hypothesis, and all the conclusions of this paper, should be buttressed by further research. Williamson's research agenda still remains exciting and full of promise for our understanding of modern economic growth.

cumulated decrease amounts to 60% for wheat, 69% coal and 73% for cotton (Mohammed-Williamson 2004).

²¹ For instance there were 15 basic qualities of silk according to provenance and method of production – and the price range double (Federico 1997). Many of them were further subdivided: the best qualities, such as the Italian, Japanese and Shanghai filatures, were classified according to the title and to the quality

Appendix 1

The variance decomposition

a) 1830-1913

The total world variance is decomposed as:

World=Free vs Protected + USA vs. Free Europe + Within Free Europe + Within Protected Europe + Within Austria-Hungary + Within France + Within Norway + Within Spain + Within United Kingdom + Within United States

Defining P the price in a market, μ the average price and n the number of markets in each area with the subscripts W World, FC free-trade countries (USA, Belgium and the United Kingdom), P protectionist countries (Austria-Hungary, France, Norway and Spain), FE free-trade European countries, PE protectionist European countries, AH Austria-Hungary, B Belgium, F France, N Norway, S Spain, UK United Kingdom, USA United States.

$$\text{World} = \sum (P_i - \mu_W)^2$$

$$\text{Free vs Protected} = (\mu_{FC} - \mu_W)^2 * n_{FC} + (\mu_{PC} - \mu_W)^2 * n_{PC}$$

$$\text{USA vs. Free Europe} = (\mu_{USA} - \mu_{FC})^2 * n_{USA} + (\mu_{FE} - \mu_{FC})^2 * n_{FC}$$

$$\text{Within Free Europe} = (\mu_B - \mu_{FE})^2 * n_B + (\mu_{UK} - \mu_{FE})^2 * n_{UK}$$

$$\text{Within Protected Europe} = (\mu_{AH} - \mu_{PE})^2 * n_{AH} + (\mu_F - \mu_{PE})^2 * n_F + (\mu_N - \mu_{PE})^2 * n_N + (\mu_S - \mu_{PE})^2 * n_S$$

$$\text{Within Austria-Hungary} = \sum (P_{AH} - \mu_{AH})^2$$

$$\text{Within France} = \sum (P_F - \mu_F)^2$$

$$\text{Within Norway} = \sum (P_N - \mu_N)^2$$

$$\text{Within Spain} = \sum (P_S - \mu_S)^2$$

$$\text{Within United Kingdom} = \sum (P_{UK} - \mu_{UK})^2$$

$$\text{Within United States} = \sum (P_{USA} - \mu_{USA})^2$$

$$\begin{aligned} \sum (P_i - \mu_W)^2 / [(\mu_W * n_W)] = & [(\mu_{FC} - \mu_W)^2 * n_{FC} + (\mu_{PC} - \mu_W)^2 * n_{PC}] / [(\mu_W * n_W)] + [(\mu_{USA} - \mu_{FC})^2 * n_{USA} + (\mu_{FE} - \mu_{FC})^2 * n_{FC}] / [(\mu_W * n_W)] + [(\mu_B - \mu_{FE})^2 * n_B + (\mu_{UK} - \mu_{FE})^2 * n_{UK}] / [(\mu_W * n_W)] + [(\mu_{AH} - \mu_{PE})^2 * n_{AH} + (\mu_F - \mu_{PE})^2 * n_F + (\mu_N - \mu_{PE})^2 * n_N + (\mu_S - \mu_{PE})^2 * n_S] / [(\mu_W * n_W)] + [\sum (P_{AH} - \mu_{AH})^2 + \sum (P_F - \mu_F)^2 + \sum (P_N - \mu_N)^2 + \sum (P_S - \mu_S)^2 + \sum (P_{UK} - \mu_{UK})^2 + \sum (P_{USA} - \mu_{USA})^2] / [(\mu_W * n_W)] \end{aligned}$$

b) 1923-1939

Total variance is decomposed as

World=Free vs Protected + Within Free countries + Within Protected Europe

In this case the free trade countries are USA (USA) Canada (C) Australia (AU) Argentina (AR), United Kingdom (UK) and the protected ones France (F), Germany (G) and Italy

(I)

Therefore, the formula is

$$\begin{aligned} \sum (P_i - \mu_W)^2 / [(\mu_W * n_W)] = & [(\mu_{FC} - \mu_W)^2 * n_{FC} + (\mu_{PC} - \mu_W)^2 * n_{PC}] / [(\mu_W * n_W)] + [(\mu_{USA} - \mu_{FE})^2 * n_{USA} + (\mu_{UK} - \mu_{FE})^2 * n_{UK} + (\mu_{AU} - \mu_{FE})^2 * n_{AU} + (\mu_C - \mu_{FE})^2 * n_C + (\mu_{AR} - \mu_{FE})^2 * n_{AR}] / [(\mu_W * n_W)] + [(\mu_G - \mu_{PE})^2 * n_G + (\mu_F - \mu_{PE})^2 * n_F + (\mu_I - \mu_{PE})^2 * n_I] / [(\mu_W * n_W)] \end{aligned}$$

It is possible to compute two alternative counterfactual measures of variance at time t – under the assumptions that

i) one single component had remained constant at the initial level – e.g. for “domestic” integration

$$\begin{aligned} \sum (P_i^t - \mu^t_W)^2 / [(\mu^t_W * n_W)] = & [(\mu^t_{FC} - \mu^t_W)^2 * n_{FC} + (\mu^t_{PC} - \mu^t_W)^2 * n_{PC}] / [(\mu^t_W * n_W)] + [(\mu^t_{USA} - \mu^t_{FC})^2 * n_{USA} + (\mu^t_{FE} - \mu^t_{FC})^2 * n_{FC}] / [(\mu^t_W * n_W)] + [(\mu^t_B - \mu^t_{FE})^2 * n_B + (\mu^t_{UK} - \mu^t_{FE})^2 * n_{UK}] / [(\mu^t_W * n_W)] + [(\mu^t_{AH} - \mu^t_{PE})^2 * n_{AH} + (\mu^t_F - \mu^t_{PE})^2 * n_F + (\mu^t_N - \mu^t_{PE})^2 * n_N + (\mu^t_S - \mu^t_{PE})^2 * n_S] / [(\mu^t_W * n_W)] + [\sum (P^0_{AH} - \mu^0_{AH})^2 + \sum (P^0_F - \mu^0_F)^2 + \sum (P^0_N - \mu^0_N)^2 + \sum (P^0_S - \mu^0_S)^2 + \sum (P^0_{UK} - \mu^0_{UK})^2 + \sum (P^0_{USA} - \mu^0_{USA})^2] / [(\mu^0_W * n_W)] \end{aligned}$$

ii) all but one single component had remained constant at the initial level –e.g. for “free vs protected countries”

$$\begin{aligned} \sum (P^t - \mu^t_w)^2 / [(\mu^t_w * n_w)] = & [(\mu^t_{FC} - \mu^t_w)^2 * n_{FC} + (\mu^t_{PC} - \mu^t_w)^2 * n_{PC}] / [(\mu^t_w * n_w)] + [(\mu^0_{USA} - \mu^0_{FC}) \\ & ^2 * n_{USA} + (\mu^0_{FE} - \mu^0_{FC})^2 * n_{FC}] / [(\mu^0_w * n_w)] + [(\mu^0_B - \mu^0_{FE})^2 * n_B + (\mu^0_{uk} - \mu^0_{FE})^2 * n_{UK}] \\ & / [(\mu^0_w * n_w)] + [(\mu^0_{AH} - \mu^0_{PE})^2 * n_{AH} + (\mu^0_F - \mu^0_{PE})^2 * n_F + (\mu^0_N - \mu^0_{PE})^2 * n_N + (\mu^0_S - \mu^0_{PE}) \\ & ^2 * n_S] / [(\mu^0_w * n_w)] + [\sum (P^0_{AH} - \mu^0_{AH})^2 + \sum (P^0_F - \mu^0_F)^2 + \sum (P^0_N - \mu^0_N)^2 + \sum (P^0_S - \mu^0_S)^2 + \sum \\ & (P^0_{UK} - \mu^0_{UK})^2 + \sum (P^0_{USA} - \mu^0_{USA})^2] / [(\mu^0_w * n_w)] \end{aligned}$$

This formula has been used to estimate the contribution of each component for graphs 5 and 6.

Appendix 2

Sources for prices

United Kingdom and France (Paris) until 1903:

British Parliamentary Papers, Second series of memoranda, statistical tables and charts: prepared in the Board of Trade with reference to various matters bearing on British and foreign trade and industrial conditions. London 1904. Gazette average for UK, quality not specified for France.

1904-1934 National Bureau of Economic Research Historical Database (1904-1934), <http://www.nber.org/databases/macroeconomichistory/contents/chapter04.html>. Grades not specified

1960-1985 Economic Research Service, US Department of Agriculture.

United States²²:

(New York) 1800-49 Arthur Harrison Cole (1938), 1850-1900 Karl Gunnar Persson (2004). Main sources were New York Times and J.E. Beerbohm's Evening Corn Trade News.

(Chicago) 1840-1995 National Bureau of Economic Research Data base.

<http://www.nber.org/databases/macroeconomichistory/contents/chapter04.html> , C. Knick Harley (1980)

Grades: New York: 1800-1836, North River; 1837, Genesee; 1838-1840, North River; 1841-1845, Genesee; 1846-1848, North River; 1849, Genesee; 1850-1854, White Genesee; 1855-1877, Red Western/Red and Amber; 1878-1900, Red Winter No. 2. Cole 1938 between 1800-49, Persson 2004 from 1850-1900.

Chicago: 1841-1849, Spring Wheat (NBER); 1850-1859, Spring No 2 (Harley); 1860-1863, Spring No. 2, (NBER); 1864-65 Spring No. 1 (NBER) 1866-78 Spring No. 2 (NYT) , 1879-97 No. 2. Spring (NBER); 1898-1904, "Regular Wheat"; 1905-1918, No. 2 Red Winter; 1919-1920, No.2. Northern; 1921-1922, No.2. Red Northern.

Iowa Williamson 1974 tab. A.6, Wisconsin Wisconsin 1934 Upstate New York prices New York 1936.

²² A British bushel is assumed to be 1.0321 times an American one.

Sources for transatlantic freight factor:

1850-1868 Persson 2004, 1869-1950 Mohammed and J.G. Williamson 2003 Table A3D

1950-1974 *FAO Production Yearbook*, vol. 21, 1967 and vol.24,1975

Source for Common Agriculture Policy:

1980-2004 *World Grain Statistics* published yearly by International Grains Council,
London.

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