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Giovanni Federico

EUROPEAN UNIVERSITY INSTITUTE

DEPARTMENT OF HISTORY AND CIVILIZATION

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Abstract

This paper argues that market integration should be measured as σ-convergence over the largest possible sample of markets. It test this claim with an empirical analysis of the European market for wheat, rye and candles from the middle of the 18^{th} century to the eve of the first globalization with a new data-base of more than 450 price series. Price dispersion remained constant until the outbreak of French wars, then it increased abruptly. It started to decline after the end of the war, and the process continued steadily until an all-time low in the 1860s. Domestic and international integration contributed in roughly the same proportion to integration in the long-run, but the latter were much more important to account for medium-term changes. The fall in cost of maritime transportation accounted for a substantial share of the price convergence in the second quarter of the 19^{th} century. These results suggest that the level of integration was determined for most of the period by war and political events.

1) Introduction

Market integration is nowadays one of the hottest topics in economic history. The interest in the issue was initially rekindled by the (re)-discovery of the so-called first globalization of the late 19th century and the bulk of the literature still deals with the Atlantic economy in those years. However, in recent years the scholars have greatly widened the scope of their researches. They have explored the historical antecedents of 19th century globalization, have tried to measure integration in Europe in the pre-industrial age, and have compared it with Asia, to test Pomeranz (2000) statement about the causes of the "great divergence". Rather surprisingly, the interwar years and the period after WWII have been rather neglected.

It seems fair to sum up the conventional wisdom in three stylized facts

a) the early modern period, from the 14th to the late 18th century, shows no world-wide convergence in prices (O'Rourke and Williamson 2004) and a mixed record in Europe (Froot et al. 1995, Jacks 2004, Őzmucur and Pamuk 2007, Bateman 2007). Trends within countries differed a lot while the overall integration of the European market waxed and waned. On the eve of the Industrial revolution, the market in Europe no more integrated than in China (Shiue 2002, Shiue and Keller 2007), while India still lagged behind (Studer 2008). The consensus view suggests that improvements in transport technology, if any, were too small to foster price convergence. By default, changes in integration reflected political events (wars, changes in boundaries etc.) and changes in regulation (Epstein 2006).

b) after the shock of Napoleonic wars (O'Rourke 2006), the "long" 19th century featured a far-reaching process of integration within and across countries, in Europe and overseas. The process started in the first half of the century (Slaughter 1995, Shiue 2005, Jacks 2005, Federico 2007, Federico and Persson 2007), fostered by improvements in transportation, first at sea and later overland, and by liberalization of trade. In the second half of the century, domestic integration continued in industrializing countries, and started also in backward ones, such as Mexico (Dobado and Marrero 2005) and India (Studer 2008). In contrast, international integration was slowed down or in some cases reversed by the return to protection of the 1880s (O'Rourke and Williamson 1994, Federico and Persson 2007)

c) World War One did not affect much the level of integration. It remained high in the domestic markets of the old (survived) states, and increased fast in new ones, such as Poland (Trenkler-Wolf 2005). According to Federico and Persson (2007), in the early 1920s, the international market was even more integrated than before the war. However, this situation did not last for long: the protectionist backlash after the Great Crisis had devastating effects. It is widely believed that international commodity markets have been re-integrating since World War Two up to a level of integration comparable to the (alleged) historical peak before

World War One [1]. Actually, the empirical literature, although not abundant, does not fully confirm this conventional wisdom, at least for the 20th century (Rogoff 1996, Knetter and Slaughter 2001, O'Rourke 2002, Bukenya and Labys 2005)

In spite of such a massive research efforts, much remains to be done. Our knowledge of what happened remains still patchy. Large areas are poorly covered and trends in local and rural markets, where most transaction were conducted, are almost totally unknown for lack of data. Furthermore, most research focuses on the market for wheat (or rice in Asia), assuming it to be representative of the whole range of traded commodity. This assumption is questionable. Transport costs differed between products and cereals enjoyed a special attention from policy-makers for their key role as food. Only few studies deal with goods other than cereals (O'Rourke-Williamson 1994, Klovland 2005, Federico 2007), but they do highlight substantial differences in pattern and timing of integration. Even if cereals were perfectly representative, the literature would be less useful than it could have been. As argued at length in Section Two, the authors have used a bewildering array of measures, with a strong preference for the latest state-of-the-art techniques from time-series analysis, in the econometric equivalent of the Cold War arms race. As a consequence, their results are often difficult to compare. Furthermore, all advanced techniques embody stringent assumptions about the process of price adjustment which may not correspond to the historical conditions. Arguably, most of them are much more suitable to test market efficiency as defined by Fama (1970) than integration.

This paper uses a less glamorous but, in the author's opinion, sounder approach. It measures integration as σ-convergence in prices over the largest possible sample of markets. As argued ib Section Two, this approach has three appealing features: i) it needs no a priori assumptions about the adjustment, ii) it is more robust than others to errors in data, and, last but not least, iii) it is highly flexible. Markets can be grouped in various ways to tackle different historical issues and their contribution to changes in total dispersion can be measured with a straightforward variance analysis. Apart from its methodological ambitions, this paper makes three contributions to the historical debate. First, it straddles the ancien regime and the 19th century, making it possible to tackle issues so far not addressed in the literature. Had integration already started in the 18th century? How big was the shock caused by Napoleonic wars and how long did it last? To what extent was the integration in the early 19th century a return to the pre-war situation or something new? Second, the paper deals not only with wheat and rye but also with wax and tallow candles. A priori they seem a good candidate for an analysis of integration in markets for manufactures. Before the diffusion of domestic gas lighting in the second half of the 19th century, candles were almost as indispensable to civilized life in Western Europe as cereals and they were

[1] This assumption underlies the huge economic literature on the so-called pass through of exchange rates (e.g. O'Connolly and Wei 2001, Crucini and Shintani 2004, Imbs et al 2005 Gopinath-Rigobon 2008 Nakamura 2008, Goldberg-Hellerstein 2008). It attributes the incomplete adjustment to a wide range of possible causes, such as the taxation and/or the existence non-tradable components of prices (marketing and so on), without quoting the possibility of less than perfect integration in wholesale markets.

much a more homogeneous good than cloths, the next best alternative. Third, the paper provides a back-of-the-envelope estimate of welfare gains (losses) from integration (dis-integration), an issue which has so far been almost totally neglected in the literature

Section Two reviews the methods for testing integration. Section Three provides the essential information about the data-base and its shortcomings. Section Four reports the main results for wheat, while Section Five tests their robustness to the shortcomings of the data-base. Section Six deals with the markets for rye and candles. Section Seven returns to the case of wheat, estimating the main sources of changes in variance and interpreting them with the available evidence. Section Eight estimates the welfare gains from integration and Section Nine concludes.

2) Testing market integration: a survey

2.1 The statement about the methodological shortcomings of the literature may seem unduly harsh. This Section substantiates it with a wide-ranging survey of the historical works, with selected references to the (agricultural) economic literature, which often pioneers techniques later employed by historians[2]. The discussion focuses on the economic interpretation of the different measures more than on details of implementation in any specific work or on historical results.

The empirical literature uses a very simple theoretical framework to test market efficiency. It assumes the existence of two "markets" (I and J), which are in practice identified with cities. Moving one unit of good between them cost τ_{ji}, as the sum of transport costs, duties and other taxes on trade, pure transaction costs (brokerage fees), information costs and so on. Prices are subject to shocks, from production side (e.g. news about the harvest) or consumption side (e.g. a sudden increase in income). Some shocks, such as harvest failures, are purely local. Others, although common to both markets, affect them to a different extent (e.g. a sudden boom in demand for wheat in London is more likely to affect prices in Reading than in Buenos Ayres). Therefore, a substantial proportion of shocks causes price differentials to change, and some (or most) of these change cause the differential to exceed τ_{ji}. This case offers an opportunity for arbitrage, which rational traders are bound to exploit. Therefore, equilibrium price differentials cannot permanently exceed the total transaction costs (also known as the "commodity points")

$|Pi-Pj| \leq \tau_{ij}$ 1 a)

Price differentials could be smaller than "commodity points" only if the two markets do not trade. Otherwise, traders would lose money when shipping their wares. Thus, the condition for trading markets narrows down to equality

$|Pi-Pj| = \tau_{ij}$ 1 b)

The extension to a multi-market case is straightforward. In an integrated market, condition(s) 1) must hold also for a third market k

$(P_i-P_k) \leq \tau_{ik}$ and $(P_j-P_k) \leq \tau_{jk}$ 2)

[2] Cf. for an extensive survey of the economic literature of the 1990s Fackler and Goodwin 2001

so that the price differential must satisfy also the indirect arbitrage condition
$(P_i-P_j)\leq(\tau_{ik}-\tau_{jk})$ 3)

Thus, prices differentials between two locations could not exceed the minimum difference in transaction costs between any other pair of locations. In other words, indirect arbitrage could force price gaps to be smaller than the "commodity points" for direct arbitrage. This additional condition is essential, but difficult to test, as it implies to take into account an unknown and potentially very large number of markets.

2.2 The pioneer of the modern analysis of market integration was Oskar Morgenstern (1959). He found that deviations of the dollar-pound exchange rates from gold parity often exceeded the "gold points" – i.e. the cost of shipping gold from New York to London (or vice-versa). He concluded that the market was not integrated. His results caused some surprise, as the currency market among the two leading economic powers of the Atlantic economy at the heyday of the first globalization was generally deemed a paragon of integration. Morgestern's results were confirmed by Clark (1984) but not by Officer (1996 pp.117-176). He re-estimated "gold points" with extreme care in sixty thick pages, finding only three violations in the whole period 1890-1906 and a few more (but all very small) in the years 1925-1931.

Authors working on commodity markets have almost unanimously refrained from following Morgestern's example. The computation of "commodity points" is a painstakingly labour-intensive task and the results are likely to be downward biased, because the computation is bound to omit unobservable costs for information and/or for arbitrage risk. These costs did not exist in the currency market under the gold standard as the mint prices for dollar and sterling were constant and perfectly known to all traders. Thus, scholars have resorted to the statistical analysis of price movements, with three different sets of statistical tools, correlation measures, cointegration tests or volatility indexes.

a) The coefficient of correlation between series of prices has been used as a measure of integration since the 1960s (Sereni 1960, Granger and Elliot 1967, Latham and Neal 1983, Chartres 1985, Allen and Unger 1990). It is still used, sometimes as the main measure of integration (Barquin Gil 1997, Shiue 2002), sometimes as an introduction to more sophisticated methods (Shiue and Keller 2007, Studer 2008). Other authors (Brandt 1985) have used a regression, such as

$P_{it}=\alpha+\beta P_{jt}+\varepsilon_t$ 4)

The closer β is to unity, the more the market is integrated. Unlike the simple coefficient of correlation, the regression implies a causal relationship between prices. Ravaillon (1987) elaborates this idea by testing explicitly the hypothesis of market leadership, reflecting asymmetries in information flows about prices among markets. Traders in the "central" market know prices in all "local" ones (P_i), while traders in "local" markets know only prices in the "central" market (P_c). Ravaillon estimates this model in a dynamic framework, with current prices depending on past prices and on other factors (**X**). Thus, he runs a regression
$P_{C,t}=\Sigma\alpha P_{C,t-1}+\Sigma\Sigma\beta P_{i,t-j}+\gamma \mathbf{X}_{C,t}$ 5a)
for the central market and

$P_{i,t}=\Sigma\alpha P_{i,t-1}+\Sigma\beta P_{C\ t-j}+\gamma\mathbf{X}_{i,t}$ 5b)

for local ones. This dynamic approach yields valuable information about the speed of transmission of information and thus about the operational efficiency of the market, but it is not strictly necessary. Keller and Shiue (2007a) simply relate local (provincial) prices in 18th century China to average prices for the whole country at the same time, which they argue embodied all necessary information about supply and demand outside the area.

Correlation measures are open to two critiques. First, the results can be spurious, if series are not stationary. Second, as pointed out some years ago by McCloskey and Zecher (1984), the historical interpretation needs a standard for integration. The first objection can be easily tackled with de-trending or differentiation, while the second seems much more difficult to handle. How big is big? It is possible to define integrated a market if the coefficient of correlation exceeds 0.95, or 0.90 – but what about 0.8 or 0.7? Any threshold cannot be but arbitrary.

b) The cointegration tests seem the solution to McCloskey and Zecher (1984) puzzle. By definition, if price series are cointegrated, price differentials must return to their equilibrium level after a shock. Thus, cointegration is a necessary and sufficient condition for Cournot's condition ii) to hold. Some authors simply test the null of cointegration – either with an ADF tests of residuals of a regression of prices (Shiue and Keller 2007) or with an Johansen-Juselius test of cointegration between two (Baten and Wallusch 2005) or several markets (Őzmucur and Pamuk (2007). However, most authors (Persson 1999 pp.96-105, Kopsidis 2002, Klovland 2005, Bateman 2007, Studer 2008) add an ECM specification such as

$\Delta(P_{it}-P_{jt}) = \rho(P_{it-1}-P_{jt-1})+ \delta X_t+\varepsilon_t$ 6)

where X is an (optional) set of proxies for shocks [3]. This method makes it possible to compute the speed of adjustment as (1+ ρ), and thus to compare integration across time or space. In a very recent paper, Ejrnæs et al. (forthcoming) add a third market, in the first explicit attempt to model the indirect arbitrage, although the choice of markets is still determined by available price series.

This ECM specification is open to a different objection. It assumes that price differentials continue to adjust towards equilibrium even within the "commodity points", a region where arbitrage is not profitable. The estimates of the speed of adjustment are correspondingly biased downward and the error is the greater the wider the band is (Taylor 2001). This problem can be fixed by using the so called Band-TAR (Threshold Auto-Regressive) model (Obstfeld and Taylor 1997, Lo and Zivot 2001, Balcombe et al 2007) [4]. It assumes that price differential

[3] Thompson et al (2003) suggest to add the lagged values of changes in price differentials, in order to increase the power of the test

[4] In contrast, the Eq-TAR assume that price differentials will converge towards an equilibrium level within the band, possibly at different speed of adjustment. Trenkler-Wolf (2005) compare results of AR and TAR models, which do not come out so much superior.

converges only to the “commodity points”, while they follow a random walk inside the band – i.e.

$$\Delta(P_{it}-P_{jt}) \begin{cases} =\Phi[(Pi-Pj)_{t-1} - \tau_{ij}] + \varepsilon_t & \text{if } (Pi-Pj)> \tau_{ij} & 7a) \\ =\varepsilon_t & \text{if } |Pi-Pj|< \tau_{ij} & 7b) \\ =\Phi[(Pi-Pj)_{t-1} + \tau_{jt}] + \varepsilon_t & \text{if } (Pi-Pj)<-\tau_{ij} & 7c) \end{cases}$$

The algorithm orders all pairs of price differentials by size and uses a grid-search procedure to find the one which maximizes the discontinuity. This pair is assumed to be the best estimates of transaction costs τ_{jt} and τ_{ij} (the two need not be equal). The possibility to estimate transaction costs, on top of the speed of adjustment makes these models particularly appealing for historians, who have little information on these costs. Indeed, Band-TAR models have been used to study integration of wheat markets in Russia (Goodwin and Grennes 1998), France (Ejrnæs and Persson 2000), interwar Poland (Trenkler and Wolf 2005) and in the whole Atlantic economy in the “long” century (Jacks 2005), of butter market in 19th century United States (Goodwin et al. 2002), and even of financial markets in the Middle Ages (Volckart and Wolf 2006).

Agricultural economists have employed another method, the parity bound model (Spiller and Wood 1988, Baulch 1997, Park et al 2002, Negassa and Myers 2007), which however is not popular at all among economic historians (Spiller and Huang 1986 being a solitary exception). By definition, price differentials can be equal, lower or higher than transaction costs –i.e.

i) $P_{it}-P_{jt} = \tau_{ij} + \varepsilon_t$ 8a)

ii) $P_{it}-P_{jt} = \tau_{ij} + v_t + \varepsilon_t$ 8b)

iii) $P_{it}-P_{jt} = \tau_{ij} - v_t + \varepsilon_t$ 8c)

The parity bound model attributes probability $1-\lambda_1-\lambda_2$, λ_1 and λ_2 respectively to these three regimes, and estimates them under the assumption that v_t is normally distributed but only positive (i.e. that its distribution is truncated at zero). This is tantamount to assume that large deviations from parity are less likely than small ones – i.e., in economic terms that arbitrage is more likely far away from the commodity points.

c) The use of volatility-based measures was pioneered by Weir, in a rather neglected paper on famines in 18th century France (1989). He argued that arbitrage dampened the effect of local shocks (mostly from harvests) and thus that the more integrated the market was, the less volatile prices had to be. Weir used a rather user-unfriendly measure of variance of raw prices, which since then has been almost entirely neglected (Jacks 2004 being the only exception). Other authors have followed his idea, with more standard measures of volatility, such as deviations from a moving average of prices (Reher 2001, Bateman 2007), or residuals around a regression of prices over time (Persson 1999, Shiue and Keller 2007). But the idea itself is questionable, as it implies that the size and number of shocks remained constant over the period. This might not be the case. From one hand, the size of local harvest-related shocks can decline thanks to technological progress, and from the other integration itself could expose the market to shocks originating in far-away areas.

An alternative is to measure volatility of relative prices. It is bound to be negatively related to the width of "commodity points". The wider the "commodity points" are, the more likely that a given shock does not trigger arbitrage, and therefore that price fluctuations in different markets are independent. Pursuing this idea, in a famous paper on the effect of Canada-USA border, Engel and Roger (1996) measure integration as

$$V=(1/t[\Sigma_{t=1}^{t}(\log (P_{it}/ P_{jt}) - \log (P_{it-1}/ P_{jt-1}))^{2}]^{0.5}) \quad 9)$$

i.e. with the standard deviation of differences in logs of relative prices between two markets. Later, Engel and Rogers (2001) and Parsley and Wei (2001) have suggested slightly different versions of this measure. The former considers variability across goods in the same market as well as across markets, the latter compute variability from residuals of a regression of changes in price differentials between cities. In spite of its popularity among economists, the Engel-Rogers index has failed to raise much enthusiasm among historians. At most, it has been used for comparative purposes (Shiue 2005, Trenkler and Wolf 2005 and Federico 2007).

2.3 All the measures discussed so far assume that i) the frequency of observations fits well the timing of the adjustment process and ii) transaction costs over the estimation period are constant or, if estimated in log form, change proportionally to prices, as implicit in the iceberg approach to modeling trade costs[5]. The violation of either assumption can bias the results.

i) The consequences of a misfit between data frequency and adjustment lag have been thoroughly analyzed by Taylor (2001). He compares the results of estimating the same AR model with actual data and averages over a period of time (e.g. with a weekly average of daily prices). He shows that averaging biases upwards the half-life of shocks (downwards the speed of adjustment) and that the error is potentially boundless if the number of periods exceeds the half life of the shock (e.g. if the model is run with monthly data, while shock adjust in one week). He also shows that running the model with actual prices, even if observations are staggered over time, yields unbiased – even if not so accurate- results.

ii) The consequences of neglecting changes in transaction costs are fairly evident. The Engel-Roger measure would mix different levels of volatility, weighted according to the duration of each regime. The Band-TAR model would return anyway a single pair of thresholds, even if the correct number should equal to n+1, where n is the number of changes. As a rule, ceteris paribus, if changes in transaction costs are evenly distributed in time, the bias is the less likely the more frequent the data are and the fewer observations are necessary to use a given technique. One hundred observations correspond to 15-20 weeks with daily data, but to more than eight years with monthly ones. The

[5] This hypothesis holds true in some cases (e.g. the ad valorem duties), but not in general. Some costs might be vaguely related to prices (e.g. transport costs depend on wages, and these latter are affected by prices of wage goods), while others, such as railway fares or specific duties, are surely independent from prices at least in the short to medium run.

cointegration-based measures need more observations than the correlation-based or the volatility ones, and thus are more sensitive to this bias.

Both these problems can be tackled empirically, at least in principle, with the right data. For instance, were both actual price at a specific date and monthly averages available, an admittedly unlikely case, it would be possible to run first the model with actual prices in order to estimate the unbiased adjustment lag and then, if by chance adjustment takes exactly one month, re-run the model with monthly averages to increase the precision of the estimate. If the number of observations is large enough relative to the minimum requirements, authors can explore changes in transaction costs. They can investigate the effect of some specific event by imposing a priori a break in series at the relevant date. For instance, Goodwin et al. (2002), in their work on the market for butter, choose 1895, the year of the introduction of refrigerated cars on American railways. If there is no a priori information about the timing of changes in transaction costs, authors can let data speak for themselves, by using rolling windows. Their length, and thus ultimately the accuracy of estimates, depends on the frequency of the data. Jacks (2005), with monthly prices of wheat in Europe, is forced to cover ten years at a time, while Canjels et al (2004), with their daily data on exchange rates, can afford to run rolling window of 1500 observations, equivalent to five years. Recently Von Campenhout (2007) has proposed a modified TAR measure, with time-varying transaction costs [6]. The formula assumes the change to be linear over the period of estimation. This assumption may be realistic in some instances, but not in other: some of the changes can be discrete in time, as determined by events such as a change in trade policy or the opening of a new railway line.

2.4 The real weakness of the standard approach to market integration lies however not in the empirical details of estimation but in its theoretical foundations (Machlup 1977, Fackler-Goodwin 2001). Its roots can be traced back to the work by the French economist and mathematician Cournot. In his 1838 book, *Recherches sur les principles mathematiques de la theorie des richesesses*, he defined an integrated market as "an entire territory of which the parts are so united by the relations of unrestricted commerce that prices take the <u>same</u> level throughout with <u>ease and rapidity</u>" (quoted by Spiller and Huang 1986 p.131 [emphasis added]). In other words in an integrated market i) the equilibrium level of prices must be equal (the famous law of one price or LOP for short) and ii) prices must return quickly to their equilibrium level after any shock. Both conditions are necessary but not sufficient. A market should not be called integrated if equilibrium prices differ and/or if deviation from equilibrium last for long.

The standard approach to "integration" deals only with one of these conditions, the second one. Indeed, condition 1) would hold with any level of price differential, no matter how large it is and thus it cannot test the law of one price.

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[6] The equivalent of condition 7a) in his model is

$\Delta(P_{it}\text{-}P_{jt}) = \Phi[(Pi\text{-}Pj)_{t-1} - \theta_{ij}] + \Phi'{*}t{*}[(Pi\text{-}Pj)_{t-1} - \theta_{ij}] + \varepsilon_t \quad \text{if } (Pi\text{-}Pj) > \theta_{ij}$

Where $\theta_t = \theta_0 + [(\theta_T - \theta_0)/T]{*}t$. Thus transaction costs are assumed to increase linearly from θ_0 to θ_T.

The meaning of Cournot's second condition can be better appraised by framing it in the theory of market efficiency, which was developed by financial economists in the 1960s. In Eugene Fama's words "a market in which prices always "fully reflect" available information is called "efficient"" (1970 p.383). Rational traders would exploit any type of information, provided that gains from trading exceed marginal costs of the transaction. Fama distinguished three forms, or levels, of efficiency, according to the nature of information available to traders

a) "weak form", where the set of available information consists only in prices in other markets

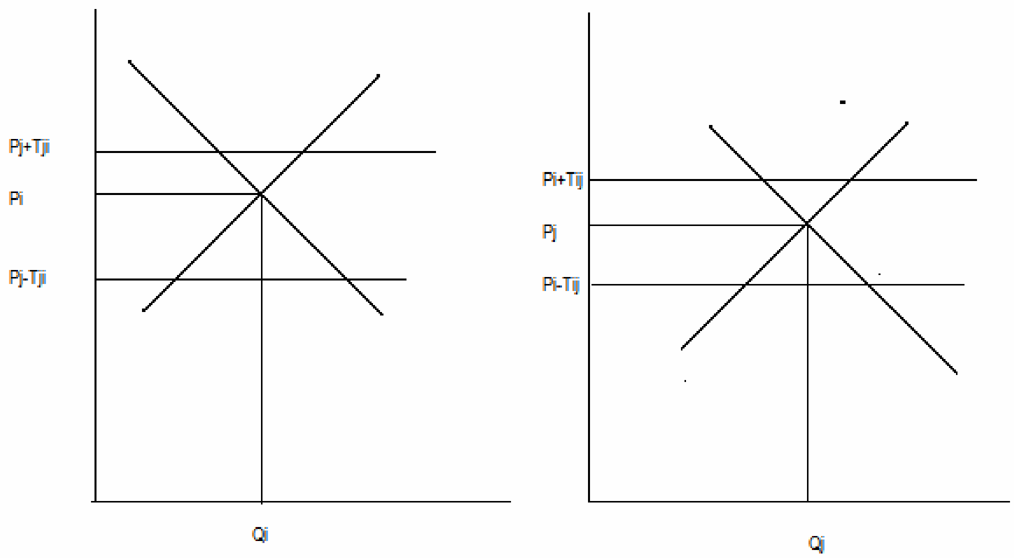
b) "semi-strong", where the set includes also other publicly available information

c) "strong", where it includes <u>all</u> relevant information – including the reserved ones

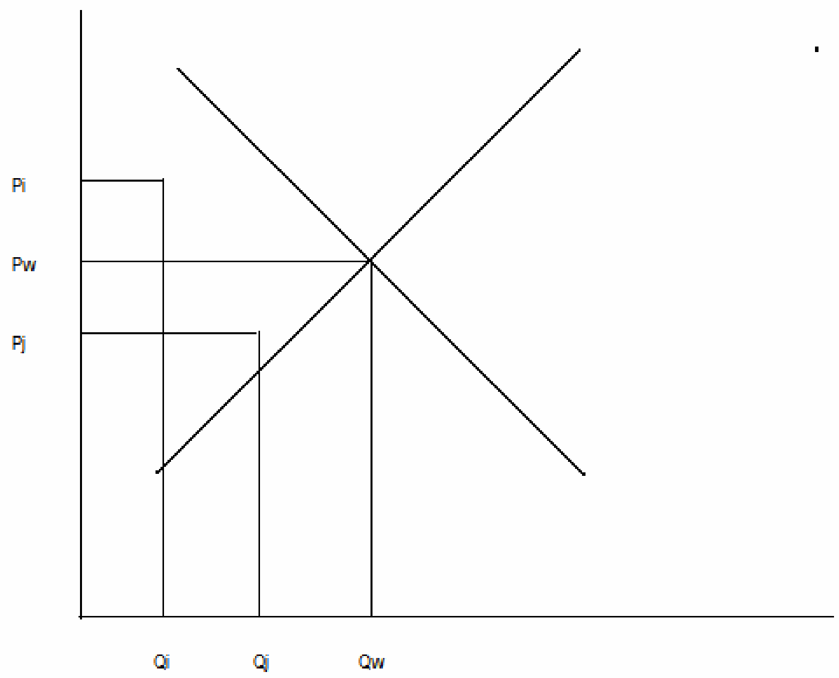
This definition of efficiency refers exclusively to the use of information, and thus it should be kept distinct from "operational" efficiency, which depend on fees, liquidity, supply of credit and any other feature of the market which determine the transaction costs (Houthakker and Williamson 1996 p.130)

The concept of "efficiency" has spawned a huge empirical literature about financial markets with mixed results (Malkiel 2003, Shiller 2003). Scholars have tested whether prices of assets behave as random walk (i.e. future prices are not predictable from past ones), whether differences between spot and future prices are not systematic (intertemporal efficiency), whether share prices are consistent with expected dividends and so on. The standard reference works on the efficient markets hypothesis totally neglect commodity markets (Dybvig and Ross 1987, Blake 2000, Lo 2006), but the concept of efficiency can be easily extended to them. Indeed, Hamilton (1992) and Mc Kenzie and Holt (2002) have tested the intertemporal efficiency of commodity markets, during the Great Depression and in 1960-2000. This specific test is meaningful only in presence of future markets, but clearly any violation of "commodity points" entails a "weak" inefficiency, in Fama's taxonomy. As long as price differentials exceed the commodity points, traders would not be exploiting fully information about prices and costs of transaction and would be foregoing opportunities for arbitrage. In other words, the standard approach to market integration tests whether the market was "weakly" efficient. By definition, it overlooks the possibility of "semi-strong" efficiency. The nature of the process of adjustment in the two cases can be illustrated by two simple graphs

Graph 1
Price adjustment under the “weak efficiency” hypothesis



Graph 2
Price adjustment under the "semi-strong efficiency" hypothesis



Graph 1 considers the case of a “weakly efficient” market. Prices in each market are determined by local supply and demand and constrained by arbitrage not to exceed “commodity points”. In contrast, in a “semi-strongly” efficient market (Graph 2) the “world” price Pw is determined by world supply and demand. By definition the “world” supply must be equal to the sum of quantity traded in all markets (Qi+Qj=Qw). There is not a corresponding condition for prices. The “world” price (P_W) does not correspond to price in any specific location, while prices in each location are determined by the flow of information. However, the difference between market prices in different locations, Pi and Pj, is still constrained by market-specific “commodity points”. The difference between P_W and actual market prices depends on transaction costs among all pairs of markets and on the flow of information. If (rational) traders in both markets have the same information about shocks, prices might adjust before reaching the “commodity points”. This information need not be accurate or abundant: a rumor about a crop failure can spread faster and more widely than the news about a price rise in any specific market.

The difference between “weakly” and “semi-strongly” efficient markets can be illustrated by tracing the response to an exogenous shock which hits the i-th market at time t_0. Let’s define

t_{ai} and t_{aj} as the minimum time for adjustment of prices in the two markets (I and J)

t_i^s as the minimum time for transmitting the information about the shocks from I to J

t_i^p as the minimum time for transmitting the information about prices from I to J

t_g as the minimum time for physical transportation of goods,

The price differential would return to the equilibrium

a) in a “semi-strongly” efficient market, when the information about the shock reaches J – i.e. at time $T=t_0+ t_i^s+ t_{aj}$.
b) in “weakly” efficient market when the information about the price change in I reaches J – i.e. at time $T=t_0+ t_{ai} + t_{aj}+ t_i^p$
c) in an (partially) inefficient market, when arbitrage is completed - i.e. when goods physically reach J– i.e. at time $T=t_0+ t_{ai}+ t_{aj} + t_i^S+ t_g$
d) in a totally inefficient market prices would never adjust or adjust after an arbitrarily long period ε – i.e. $T= t_0+ t_{ai}+ t_{aj} + t_i^S+ t_g+ \varepsilon$

One should note two implications. First P_J might adjust earlier than P_I, if $t_0+ t_i^s + t_{aj} > t_0+t_{ai}$. – i.e. if market J is more operationally efficient than I and the difference in speed of reaction is greater than the time of transmission of information. Second, all shocks, even those too small to push P_I beyond the “commodity points”, would affect P_J, via their effect on the “world” price. In this framework, the speed of adjustment can decrease as a consequence of an improvement in the operational efficiency of each market (i.e. a decline in t_{ai} and/or t_{aj}) or across markets (a decline in t_{is} or t_g), but also of a change in the informational efficiency – i.e. a move from “weak” to “semi-strong” efficiency. The standard framework for testing information assumes a constant level of informational (“weak”) efficiency and thus attributes the whole change in speed to the improvement of operational efficiency. But it could be possible to start from the alternative assumption of a constant level of operational efficiency and attribute the same movement entirely to changes in informational efficiency.

2.5 Consistently with the theoretical framework, most measures of "integration" simply ignore absolute prices and the law of one price. Two price series can be perfectly correlated or cointegrated even if their absolute level differs widely. One can argue that the Band-TAR model is different, as it yields estimates of "commodity points". Indeed, Jacks (2006) in a widely admired paper, has used his own estimates of thresholds and speed of adjustment as dependent variables to explore the causes of integration. Yet, the estimated thresholds can measure actual transaction costs only under very stringent conditions, even if they are constant. In fact, the grid search procedure for Band-TAR assumes that some observations are inside and some outside the "commodity points". Therefore, in general, the estimated thresholds would measure of transaction costs if i) the market is "weakly" efficient, ii) shocks are big enough to push prices, at least sometimes, beyond the commodity points and iii) indirect arbitrage with a third market does not prevent prices to reach the true "commodity points" for that specific pair of markets[7]. If the market is inefficient, price differentials would remain permanently outside the "commodity points" and the optimally selected thresholds would overestimate the true transaction costs. Symmetrically, the estimated thresholds would underestimate the costs if prices differentials remain within the "commodity points", because the shocks are very small or the market is "semi-strongly" efficient or indirect arbitrage constraints the movements of price differentials[8]. A case in point seems to be the "gold points" in late 19th century. The econometric estimates by Canjels et al (2004) come out to be significantly lower than direct compilation by Officer (1996). The divergence might reflect either rational behavior by traders, who expected the rate to return towards parity, as suggested by Officer himself (1985) or indirect arbitrage via Paris, as recently hypothesized by Coleman (2007). In short, as argued by Anderson and von Wincoop (2004), it is impossible to infer the level of transaction costs from information about prices only.

2.6 The focus on efficiency instead of on LOP is somewhat unfortunate. The issue is surely of the highest interest in financial economics as the discovery of any regularity in the behaviour of shares could open prospects for huge gains. Discovering that 19th century wheat traders overlooked potential gains from arbitrage is surely interesting but it would change our interpretation of long-run growth only if inefficiency was so serious as to prevent adjustment to major shocks. It seems much more interesting to know whether the equilibrium level of prices differed among areas, as prices determines the decisions of millions of producers and consumers.

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[7] In the case of trading markets, these conditions are replaced by a more general one – i.e. that the market is efficient. In this case, as said, traders are bound to lose both if price differentials are not exactly equal to transaction costs. In principle, one could test efficiency simply by comparing differentials with transaction costs. However, this exercise would be meaningful only if trade is surely going on at those prices, and this condition is very difficult to ascertain.

[8] See von Campenhout (2007) for a similar criticism of the parity bound models.

The relevance of price level must not have escaped historians. Why have they, by and large, neglected the issue? They might be concerned by the poor quality of the data. For instance, Baten and Wallusch (2005) candidly admit that they have opted for a cointegration approach because they find it difficult to convert of prices in a common currency. But this cannot be the only problem: as the next Section will show, the conversion is surely time-consuming and fraught with potential pitfalls but not impossible. In all likelihood, the comparison of prices is hampered also by the McCloskey-Zecher (1984) problem – the difficulty to specify a realistic standard for integration. Taken literally, the law of one price is almost never met: prices could be perfectly equal only if transaction costs are nil – and this case is not terribly plausible, to say the least. Some authors (Stigler and Sherwin 1985, Barrett and Li 2002, Ejrnæs and Persson 2000) suggest to define "perfectly integrated" any market where price differentials equal transaction cost – i.e. to return to equation 1). But, as said, the condition would hold even if price differentials were very large, and thus the key insight of the law of one price would be lost. The best way forward is to adopt a dynamic setting, following the advice by O'Rourke and Williamson: "the best way to gauge that historical process of market integration is to measure the extent to which prices of the same commodities converge worldwide" (2004 p.109).

Quite a few authors have followed this advice, often to provide a first map of integration before moving to (allegedly) more sophisticated techniques. Indeed, price convergence between pair of markets can be detected by looking at trends in price differentials (Metzler 1974) or in price ratios (O'Rourke and Williamson 1994, Froot et al 1995, Klovland 2005, Federico and Persson 2007, Federico 2007). In an interesting variant to this approach, Dobado and Marrero (2005) computes convergence towards a nationwide average, which might be construed as the "world" price in a "semi-strongly" efficient market. Furthermore, price differentials have been widely used as dependent variable in recent works on the causes of integration (Federico 2007, Keller and Shiue 2008).

Pairwise comparisons, although sound from a theoretical point of view, become difficult to interpret for large data-bases, as the number of pairs increases exponentially with the number of series. Thus, instead of computing separate trends for each pair, Bateman (2007) estimates fixed-effect panel regression for all pairs of markets, which yields a single rate of convergence. The same result can be obtained also by measuring changes in dispersion over the whole data-base. The simplest measure of dispersion is the coefficient of variation at time t

$$CV^t=DS/\mu=(1/n[\Sigma(p_i^t - \mu^t)^2]^{0.5}) / \mu^t \quad (9)$$

Price converge if the coefficient σ in a log-linear regression with a time trend T

$$\text{Log } CV^t = \alpha+\sigma T+ \varepsilon_t \quad 10)$$

is negative and significant [9]. It is possible to detect major changes in levels or trends in dispersion, with standard statistical tests for breaks in time series and then interpret the results with additional evidence.
An alternative to the coefficient of variation is Geary's index of spatial autocorrelation. First, markets are grouped according to distance (or some other criteria) [10]. Then, for each group the index is computed as

$$C_k = \frac{(N-1)\Sigma_{i=1}\Sigma_{j=1} w_{ij}^{(k)} (p_i-p_j)^2}{4J_k\Sigma_{i=1} (p_i-\mu)^2} \quad 11)$$

where N is the total number of markets, J is the number of markets in the group and μ the average price over all markets and w is a dummy (one for markets within the group and zero otherwise). In a nutshell, the index is the ratio of the covariance within the group to the variance for all markets, suitably adjusted to take into account the number of markets in the group. The lower the ratio, down to zero, is the more integrated the group is relative to markets outside the group. The Geary index has been used in historical research only by Shiue (Shuie 2005, Keller and Shiue 2007b), while the coefficient of variation has a long tradition since the 1960s (Friemdling and Hohorst 1969, Jorberg 1972) and its use is still fairly widespread (Knetter and Slaughter 1999, Toniolo et al 2003, Jacks 2004, Dobado and Marrero 2005, Őzmucur and Pamuk 2007, Federico and Persson 2007 Studer 2008).
2.7 Arguably, the coefficient of variation is the best measure of price dispersion, and thus of convergence. It is simple, intuitive and, as a single dimensionless figure, easy to compare across time and space. Unlike the Geary index, it does not need a preliminary allocation of markets to groups, while it can be computed with any subset of market which seems historically relevant. On the other hand, the coefficient of variation is sensitive to movements in absolute prices. If transaction costs remained constant, a price rise would narrow the "commodity points" and thus, in an efficient market, cause dispersion to fall. It would be rash to interpret this fall as a true process of "integration", if this latter is strictly defined as a consequence of falling transaction costs. Such a combination of growing prices and constant transaction costs is not terribly plausible for wage goods such as cereals. Anyway, from the point of view of agents, the effects are similar: for an Italian farmer, it did not matter whether prices of Russian wheat was falling thanks to technical progress in shipping or not growing enough because constant transportation costs accounted for a lower proportion of the increasing sale price. What mattered was whether he could match the prices of imported grain on his local market.
The coefficient of variation has two additional advantages.

[9] Őzmucur and Pamuk (2007) reject integration if the series of the coefficient of variation is not stationary. This method does not discriminate between convergence, divergence or pure random walk.
[10] For instance Keller and Shiue (2007b) divide markets in 18th century China in eight distance bands (from 0-200 to 1400-1600 km.) and then in three main regions.

a) it is fairly robust to errors in data, much more than pairwise comparisons (Persson 2004). Let's hypothesise that the registered price p_i for the i-th market in year t differs, for any reason, from the "true" one p_i^Q, which should refer to the same quality for all markets (hence the subscript). The coefficient of variation would be biased upwards if the quality of the traded quality is higher than the reference one in high-price markets (whose price is consistently higher than the quality-adjusted world price μ_W) <u>or</u> if it is lower in low-price markets – i.e. if

$(p_i - p_i^Q)>0$ and $(p_i^Q - \mu_W^Q)>0$ <u>or</u> $(p_i - p_i^Q)<0$ and $(p_i^Q - \mu_W^Q)<0$ 12 a)

but it would be biased downwards in the opposite case –i.e. if

$(p_i - p_i^Q)>0$ and $(p_i^Q - \mu_W^Q)<0$ <u>or</u> $(p_i - p_i^Q)<0$ and $(p_i^Q - \mu_W^Q)>0$ 12 b).

Thus, if errors are randomly distributed, upwards and downwards biases should offset each other. Of course, the coefficient of variation might still be biased by large errors in some series, but the impact of any given error is the smaller the larger the data-base is. Furthermore, any error would affect only that year – so that the bias would affect the residual ε of regression 10), but not the estimated rate of convergence σ.

b) the approach makes it possible to compute, with a variance analysis, the contribution of different groups of markets to changes in total dispersion. For instance, if markets are grouped according to political boundaries into two countries, 1 and 2, one can decompose total variance at time t as

$$Var^t = \sum (p^t_i - \mu^t_W)^2 = [(\mu^t_1 - \mu^t_W)^2 * n_1 + (\mu^t_2 - \mu^t_W)^2 * n_2] + [\sum (p^t_{1i} - \mu^t_i)^2] + [\sum (p^t_{2j} - \mu^t_j)^2] \quad (13)$$

where n is the number of markets and W (for "world") refers to all available series. The first term measures the change in dispersion between countries, the two others dispersion within each country. Comparison across time or space is easier if data are normalized by dividing variance by the number of markets times the average price:

$$Var^t = \sum (p^t_i - \mu^t_W)^2/[(\mu^t_W * n^t_W)] = [(\mu^t_1 - \mu^t_W)^2 * n_1 + (\mu^t_2 - \mu^t_W)^2 * n_2]/[(\mu^t_W * n^t_W)] + [\sum (p^t_{1i} - \mu^t_i)^2]/[(\mu^t_W * n^t_W)] +$$

$$+ [\sum (P^t_{2j} - \mu^t_F)^2]/[(\mu^t_W * n^t_W)] \quad (14)$$

The contribution of each component to total change can be measured by letting its variance to change and keeping the variance of all other components at their initial level. For instance, the contribution of domestic integration in country 1 (or Con(1)) can be measured by computing first the counterfactual total variance CVar (1) as

$CVar\,(1)^t = [(\mu^0_1 - \mu^0_W)^2 * n_1 + (\mu^0_2 - \mu^0_W)^2 * n_2] / [(\mu^0_W * {}^0_W)] + [\sum (p^t_{1i} - \mu^t_1)^2] / [(\mu^t_W * n^t_W)]$ +

$+ [\sum (p^0_{2j} - \mu_2^0)^2] / [(\mu^0_W * n^0_W)]$ (15)

and then the ratio

$Con(1) = [CVar(1)^t - CVar(1)^0] / [Var^t - Var^0]$ (16)

This method is highly flexible, as one can choose different dates and split the sample of markets in different groups according to the issue at hand. For instance, to study the impact of trade policy, one can add a further distinction between free-trade (FC) and protectionist countries (PC). In the case of four countries, the formula becomes, omitting time superscripts for simplicity

$Var^t = \sum (p_i - \mu_W)^2 / [(\mu_W * n_W)] = [(\mu_{FC} - \mu_W)^2 * n_{FC} + (\mu_{PC} - \mu_W)^2 * n_{PC}] / [(\mu_W * n_W)]$

$+ [(\mu_3 - \mu_{FC})^2 * n_3 + (\mu_4 - \mu_{FC})^2 * n_4] / [(\mu_W * n_W)]$ +

$+ [(\mu_1 - \mu_{PC})^2 * n_1 + (\mu_2 - \mu_{PC})^2 * n_2] / [(\mu_W * n_W)]$ +

$+ [\sum (p_{1i} - \mu_1)^2] / [(\mu_W * n_W)] + [\sum (p_{2j} - \mu^t_2)^2] / [(\mu_W * n_W)] + [\sum (p_{3i} - \mu_3)^2] / [(\mu^t_W * n^t_W)]$ +

$+ [\sum (p_{4j} - \mu_4)^2] / [(\mu_W * n_W)]$ (17)

In (17), the first term measures the convergence (or divergence) between free-trade and protectionist countries, the second the convergence between the two protectionist countries (1 and 2) the third the similar convergence between the two free trade countries (3 and 4) and the remaining terms (last two lines) the “domestic” convergence within each country. Of course, the greater the number of series, the more detailed and thus historically insightful the grouping can be. This confirms that the larger the data-base is, the better.

3) Sources and methods

According to the rule stated at the end of the previous section, the research has aimed at collecting as many series of wholesale prices for wheat, rye or candle as possible, provided they do not refer to a specific date in the year (e.g. November 1). This collection has yielded 480 “basic” series for wheat, 243 for rye, 54 for tallow and 42 for wax candles (see the Data Appendix for a full list of sources and methods of processing). Most of them are taken from official sources (mercuriales and other enquiries), with a substantial contribution from private ones (mostly records of purchases by large institutions such as hospitals). Many authors convert the original data in silver for hectoliter, but quite a few report data local currency and weights. Thus, the first task is to convert all prices into a common currency (pound sterling) and unit of measure (quintals for cereals, kilograms for candles). Unfortunately, very few series span the whole period 1750-1870. On the other hand data for the same market are often available from different sources, and so it is possible to piece together longer series. Sometimes data from different sources overlap in time and in a handful of cases the level of prices in the same year differs enough to cause a discontinuity if the series were pieced together. To avoid such discontinuities, the final series is obtained by interpolating or extrapolating one of them.

This work yields a data-base of 300 "market" series for wheat and some 150 for rye. Each of them refers to a specific location - a city or, in the case of France after 1797, a department (Table 1).

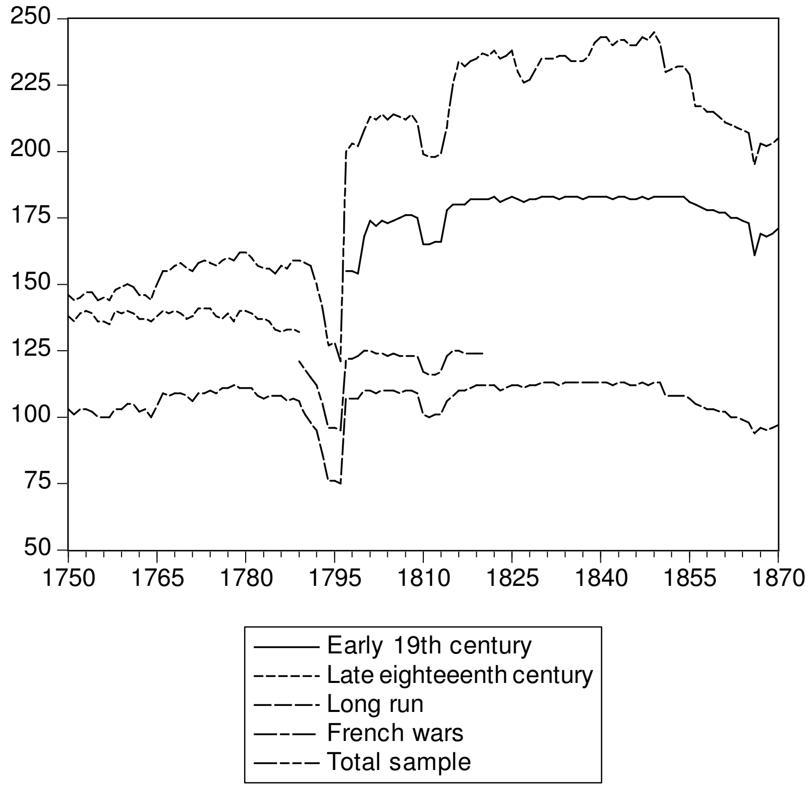
Table 1
Number of observations

	Period	Number Series	Number observations Years	Potential	actual	%
Wheat						
Data-base		304	121	36784	21372	0.58
Samples						
Long run	1750-1870	113	121	13673	12850	0.94
Late eighteenth century	1750-1793	140	43	6020	5720	0.95
French wars	1789-1820	125	32	4000	3797	0.95
Early nineteenth century	1797-1870	183	74	13542	13119	0.97
Rye						
Data-base	1750-1870	149	121	18029	11578	0.64
Long-run sample	1750-1870	67	121	8107	7664	0.95
Wax candles	1750-1870	42	121	5082	2529	0.50
Tallow candles	1750-1870	54	121	6534	3011	0.46

Unfortunately, only a minority of these "market" series, 24 for wheat, 28 for rye and none for candles, cover the whole period 1750-1870 without a single missing observation. About two fifths of the observations are missing (Table 1) and the number of available series varies widely from one year to another (Graph 3).

Graph 3

Number of available observations, wheat



In theory, the sample of markets should be consistent over time in order to ensure the comparability of results, but dropping all series with a single gap would yield a hardly meaningful sample. Therefore, a series is retained in the main ("long-run") sample if it features at least three quarters of observations over the whole period – i.e. 91 out of 121. Only one third of market series pass this threshold, but in this sample the number of missing observations is reduced to about 6% (Table 1). The size of the sample can be increased by shortening the reference period, while keeping the same threshold. It is thus possible to extract three additional samples on top of the main ("long-run") one, henceforth labeled "late eighteenth century", the "French wars" and the "early nineteenth century". The more extensive market coverage increases the precision of results on period-specific issues, such as the effect of British Corn Laws

Another major problem of data-base is its geographical coverage. Some countries, blessed by an efficient centralized civil service, are much better covered than others. Labrousse et al (1970) publish series for every French department since 1797 and Jorberg (1972) data for up to 24 Swedish provinces. In contrast there are only four series of wheat prices for the whole Russia, and only one of them, for Warsaw, meets the minimum requirements to feature in the "long run" sample. In theory, a representative sample of markets should reproduce the distribution of transactions. Although there is no evidence on this latter, it seems plausible to assume it depended on the location of production and/or consumption. Unfortunately, data on production are not available for most countries until the second half of the 19th century. Consumption can be proxied by population, in spite of the substantial differences in income and dietary habits across Europe. Wheat was not the staple bread cereal in many areas of North and Central Europe (substituted by rye) and also of the Mediterranean (substituted by maize). Thus the distribution of markets by country (at their 1871 boundaries) is compared with the share on the total European population in 1800 and 1870 [11]. The null hypothesis of equal distribution is soundly rejected in both years[12]. The difference is so wide as to rule out the possibility that more precise data on the distribution of transaction change the result. The "long-run" sample (or any other sample) is not technically representative.

4) Long-term trends

There is no doubt that in the long run the European market for wheat has become much more integrated. In 1750-1754, the average price in the five most expensive markets of the Continent was three times higher than in the five least expensive ones. Wheat in Luzern was 4.6 times more expensive than in Acquaviva delle Fonti, in Southern Italy. More than one century later, in 1866-1870, the ratio between the five top and bottom markets was down to 1.6, and that between Luzern and Acquaviva to 2.6 times. The coefficient of variation halved, falling from 0.259 (0.296 according to the larger "late 18th century sample") to 0.134 (0.123 according to the "early 19th century sample"). Table 2 shows how widespread the process was: all rates of σ-convergence are negative and all but three are highly significant

Table 2
Rates of σ-convergence, "long-run" sample

	1750-1788	1793-1815	1816-1870	1750-1870	Cumulated Change
Europe	-0.40	-0.82	-1.90***	-0.62**	-52.4
Among "countries"	-0.14	-1.22	-2.28***	-0.40*	-38.1
Within countries					
Austria-Hungary	-0.78**	-0.59	-1.87***	-0.71***	-57.1
Belgium	-1.38	-0.74	-0.68	-0.06	-7.1

[11] Population data are taken from McEvedy and Jones (1978) for 1800 and Mitchell (1998) for 1870. Alsace is considered to belong to France The choice of 1871 a base year aims at enhancing the comparability with the results for the following period (Federico-Persson 2007). Anyway, no date could have been really representative for such a politically turbulent period.

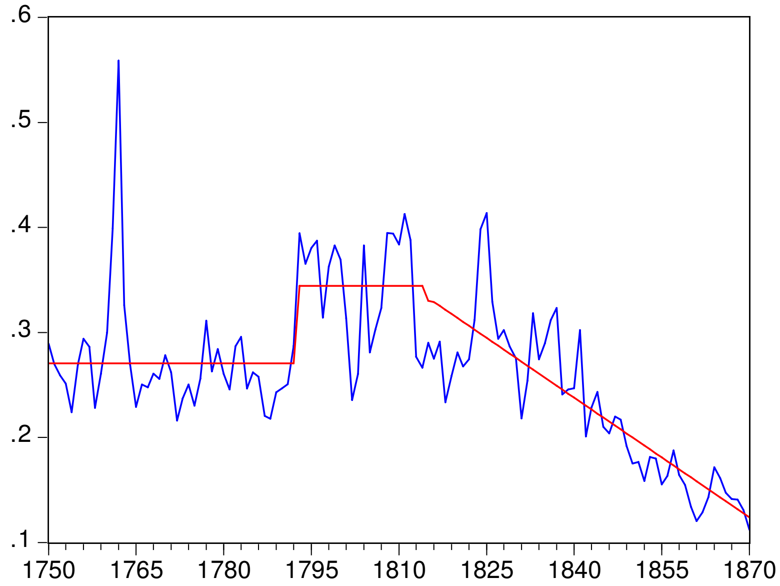
[12] The value of the X^2 is 150.5 in 1800 and 137.4 in 1870, against a test statistic at 5% of 21.3. Omitting Russia, the value drops to 73.3 and 70.6 respectively, still well above the test statistics (19.7).

France	-0.34	-3.12***	-1.65***	-1.11***	-73.7
Germany	-2.02	-1.11	-1.88***	-0.85***	-63.8
Italy	-0.04	0.25	-0.70***	-0.24**	-24.8
Netherlands	0.04	-1.70	-0.98***	-0.20	-21.2
Spain	-0.59	-1.51	-2.28***	-0.52***	-46.5
Sweden	-0.97*	-0.48	-0.32	-0.32**	-31.8
Switzerland	0.22	1.46	-0.53*	-0.12	-13.8
United Kingdom	-1.04	1.17	-1.96***	-0.44***	-41.0

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

However, a look at the yearly series of coefficients, aided by some lines (Graph 4), highlights at least four major stages

Graph 4
Trends in coefficient of variation, wheat, “long-run” sample 1750-1870



There is little evidence of the development of an integrated “European” wheat market in the second half of the 18th century. The σ coefficient is negative and fairly high, as it corresponds to a 15% decline in dispersion. But it is not significant and anyway this result is heavily influenced by a spike in 1761-1762, which reflects very few outlandish prices in central Germany. Just dropping seven observations out of more than 5500 would slash the rate of convergence to a paltry -0.09% per year. The stagnation was total in the international market (the row “countries” in table 2), while there is evidence of integration within Austria-Hungary and Sweden. However, only this last result is robust to even small changes in the composition of the sample. In fact, with the larger “late eighteenth century sample”, the rate is not significant for Austria, but becomes significant for the United Kingdom and Spain [13].

The early 1790s marked a dramatic change. In just three years, from 1791 to 1793, the coefficient of variation jumped by almost 60%, from 0.25 to 0.39 [14]. The Quandt-Andrews procedure selects 1793 as the strongest break point throughout the whole period 1750-1870. The difference between the coefficient of variation in 1786-1791 (0.24) and in 1793-1798 (0.37) is significant at 1%. However much of this growth reflects a sharp increase in dispersion between countries. At a national level, the coefficient of variation shows a significant increase only in Austria-Hungary, Germany and France – and in the two latter cases the difference is significant at 10% only. In Sweden, the dispersion is significantly lower in 1793-1798 than in 1786-1791.

The price dispersion remained high until the end of the French Wars. Short-term fluctuations are so wide to make it difficult to select the best end-date with the standard statistical tests [15]. However, the year 1815 is so full of political implications to be an obvious choice. As Table 2 shows, most coefficients for the period 1793-1815 are negative but one only, for the domestic integration of the French market, is significant, and even in that case results are not robust to very small changes in the dates [16]. The “French wars” sample confirms these results:

[13] The yearly rate of σ-convergence over the period 1750-1788 was -0.45% for all markets (not significant), -0.66% in Spain (significant at 1%), -0.31% in Sweden (significant at 5%) and -1.31% in the United Kingdom (significant at 1%), -0.54 in Austria-Hungary -1.18% in Belgium, -0.30% in France, -0.60% in Germany, -0.30% in Italy -0.37% in the Netherlands and -0.12% in Switzerland (none significantly different from zero). The price data for 32 French “generalites” by Labrousse (1933) yield a rate of convergence -0.64%, not significant

[14] In those years, the number of series falls by a quarter, from 107 to only 76. Anyway, the coefficient of variation for a comparable sample of 75 series rises from 0.26 to 0.35 (i.e. by a 40%). Results for the “French wars sample” are almost identical. The coefficient of variation increases from 0.25 in 1791 to 0.38 two years later or from 0.25 in 1789-91 to 0.36 in 1793-1798

[15] According to the Chow test, all the years from 1805 to 1825 inclusive would be significant breakthroughs in a regression for the period 1793-1870, while the Quandt-Andrews procedure picks 1824 as the most significant breakthrough. On the other hand, the coefficient of the time trend variable is not significant if the end-point is 1816 (or earlier), while it becomes negative and significant if the period ends in 1817 (or later).

[16] The coefficient becomes not significant if the regression is run over the period 1795-1810 - dropping the years 1793-1794 and 1811-1815. The coefficient of variation was exceptionally high in 1793-1794, possibly as a consequence of the state intervention on prices (the so called Maximum). It was quite low in 1813-1814.

the rate of change is negative but not significant (-0.49%) and all coefficients are not significantly different from those of the “long run” sample.

The coefficient of variation continued to fluctuate widely even after Waterloo, and in 1825 it even exceeded the pre-war peak. It returned permanently to its pre-1791 levels by the late 1830s and since then prices went on converging until the late 1860s. The process of integration was somewhat faster among countries than within countries. The rates of σ-convergence in domestic markets vary a lot, but only in Sweden and Belgium they are not significant. Results are robust to any change in dates and also in market coverage. The all-market rate is slightly lower (-1.51%) if computed with the “early nineteenth century sample” than if computed with the “long run” one, but the difference is not significant. Nor is significant the difference for any country, except Switzerland and the United Kingdom[17]. These results are broadly consistent with those by Jacks (2005), who uses a band-TAR model. According to his estimates, from 1815-1825 to 1860-1870, the width of “wheat points” roughly halved in international trade and in the domestic one for three countries out of four [18].

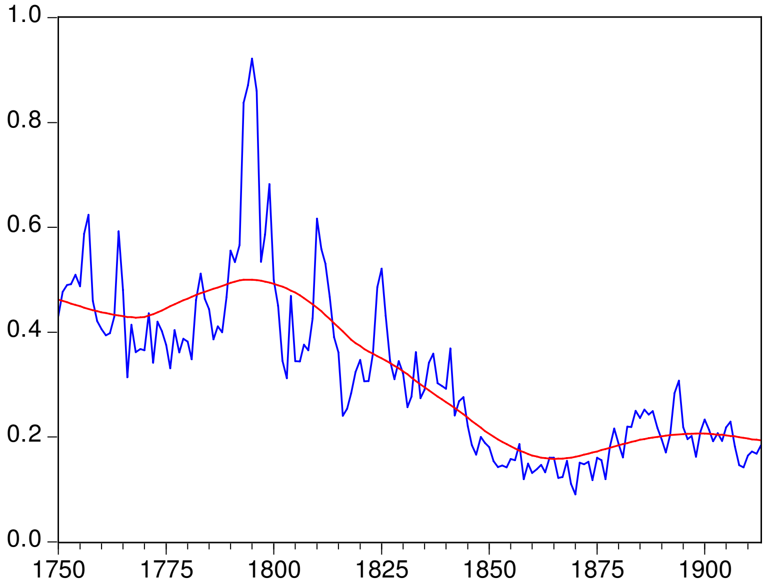
The strength of the process of market integration in the first half of the 19th century can be better appraised with a quick comparison with what happened after 1870. Jacks’s online data-base provides wheat price series for some ninety European markets, and it is possible to piece together a “very long run” sample of 32 markets from 1750 to 1914 [19]. The results show how impressive was σ-convergence in the long-run. The yearly rate (-0.82%), cumulated over 164 years corresponds to a 75% fall in dispersion.

Graph 5
Trends in coefficient of variation, wheat, “very long-run” sample, 1750-1914

[17] According to the “early nineteenth sample”, price dispersion remained flat in Switzerland (a rate 0.14% p.a., not significant) and declined rather fast in the United Kingdom (rate -1.24%, significant at 1%). The number of markets is decidedly higher than in the “long run sample” – respectively 5 instead of 2 in Switzerland and 14 instead of 5 in the United Kingdom.

[18] All data from Jacks’ website (www.sfu.ca/~djacks/). The three countries were the United Kingdom, Austria-Hungary and France, while “commodity points” declined only by one third in Spain. These figures are averages of estimates of “wheat” points for different pairs of markets. Jacks covers all possible combinations of markets within each country, while for international integration he considers only differentials between each market and five main trading centres (London, Bruges, Lwow, Marseilles and New York).

[19] His data-base is available on-line at www.sfu.ca/~djacks/. The series have been revised with the original data kindly provided by the author to ensure the greatest comparability with the current data-base.

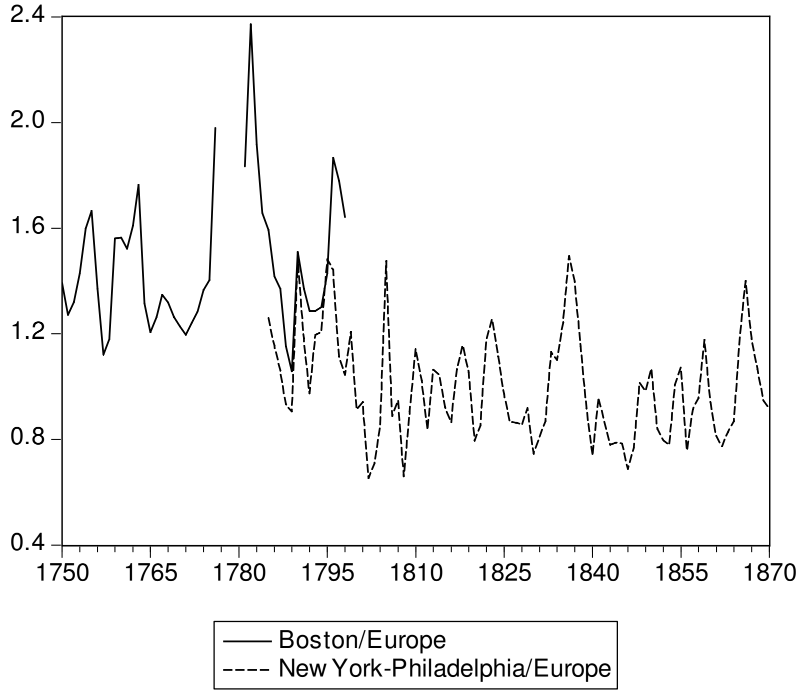


The results (Graph 5) confirm the first half of the 19th century as the key period of integraton of the European wheat market. The coefficient of variation had been fluctuating between 0.40 and 0.55, with spikes up to 0.8 until the mid 1820s. Since then, prices converged steadily, down to minimum dispersion in 1869-1871 (a coefficient of variation around 0.12). The protectionist backlash brought dispersion back in the mid 1880s to the level of the mid 1840s. In spite of a modest fall, on the eve of World War One, the coefficient of variation (0.17) was still almost 50% higher than forty years earlier. The exact dating of peaks and troughs and the size of the movements are admittedly sensitive to changes in sample of markets, but there is no doubt about the main message.

On the other hand, the period to 1870 did not feature any trend towards globalization, or even towards greater integration in the Atlantic economy. The ratio between prices on the East Coast of the United States and the average price in Europe fluctuated wildly without any significant trend (Graph 6) [20]

Graph 6
Price ratios, wheat United States/Europe

[20] The East Coast prices are proxied for the period 1750-1784 by the Boston prices from Crandall (1934), and by a simple average of prices in Philadelphia (Besanzon et al 1937) and New York (Cole 1937) for the period 1785-1870. The "European" price is the average for the "long-run" sample. The yearly rate of change is +0.22% for the Boston/Europe ratio and -0.15% for the New York and Philadelphia/Europe ratio. Neither coefficient is significant and the New York and Philadelphia/Europe series is stationary at 1%.



These data confirm that "the really big leap to more globally integrated commodity and factor markets took place in the second half of the century" (O'Rourke and Williamson 1999 p.2).

5) Robustness checks

A priori, there is some ground for optimism about the robustness of these results. First, as said, differences in sample coverage have a negligible impact on most of them, although admittedly none of the samples is really representative. Second, the literature on agricultural technology and market organization rules out a major cause of concern, the possibility of systematic changes in relative quality of wheat, which would have added spurious trends. Wheat quality was to start improving later, in the late 19th century, after the diffusion of "industrial" varieties of seeds and the introduction of grading in transactions on the main markets for wheat (Federico 2005, Federico-Persson 2007). To be sure, this does not rule out permanent quality differences among traditional varieties, nor, a fortiori, measurement errors in single years [21]. However, as argued in Section 2, these errors are likely to have offset each other in such a big sample.

[21] The evidence on quality differentials, as proxied by price ratios for different qualities on the same market, is scarce and mixed. On the Amsterdam market (Posthumus 1943), ratios between "Konigsberg" or Polish and local wheat were small on average but fluctuated widely, without any

These reassuring inferences about the robustness of results can be supplemented by a formal comparison in trends in dispersion
tests. It is possible to compute alternative series of the coefficient of variation, under more stringent assumptions, and compare them with those from the baseline ("long-run" sample)

i) It is plainly impossible to correct directly errors in sources (including quality differentials) or in processing of data. It is however possible to try to minimize their impact on the results. Jacks (2004) suggests to reduce variability by using logs of prices ("log series"). As an alternative, one can plausibly assume that the most egregious mistakes appear as outliers in the data-base and drop them ("no-outliers sample"). An observation will be defined as an outlier if it exceeds two standard deviations from the mean. There are 560 outliers in the whole data-base, equivalent to 4.5% of observations.

ii) The simplest way to avoid biases from missing observations is to drop incomplete series. As said, dropping all series with a single missing observation would leave a rump sample. Thus, as a compromise, the threshold for inclusion in the sample is raised to 5% (i.e. 6 missing observations out of 121). The resulting ("consistent") sample includes 69 markets, with 8186 observations (98.1% of the potential). As an alternative, one can impute the missing observations with a three-step procedure

a) compute the ratio $R^i_t = x^i_t/\mu_t$ for all available observations for the i-th market;

b) compute $R^i_{AV} = (\Sigma R^i_{t+m+3} + \Sigma R^i_{t-n-3})/6$ as the average of the ratios for the six years straddling the missing observation(s) $R^i_{t-n} \ldots R^i_{t+m}$ (e.g. to impute the missing values for Prague in 1770-71, R^i_{AV} is obtained as a simple average of ratios for 1767-1769 and 1772-1774)[22];

c) compute the missing price as $P^i_t = \mu_t * R^i_{AV}$

This procedure yields an "integrated sample" with as many series as the baseline one, but with no gaps.

iii) A representative sample can be obtained by paring down the number of markets until the distribution is not statistically different from that of the universe (i.e. the population of the countries of the sample). The largest feasible "representative" sample consists of 30 series, six for France and Germany, five for Austria-Hungary, four for Italy and the United Kingdom, three for Spain and one for Belgium[23]

As Graph 7 shows, the six alternatives ones differ from the baseline series in levels, and the difference is very large for the "logs" series [24].

---

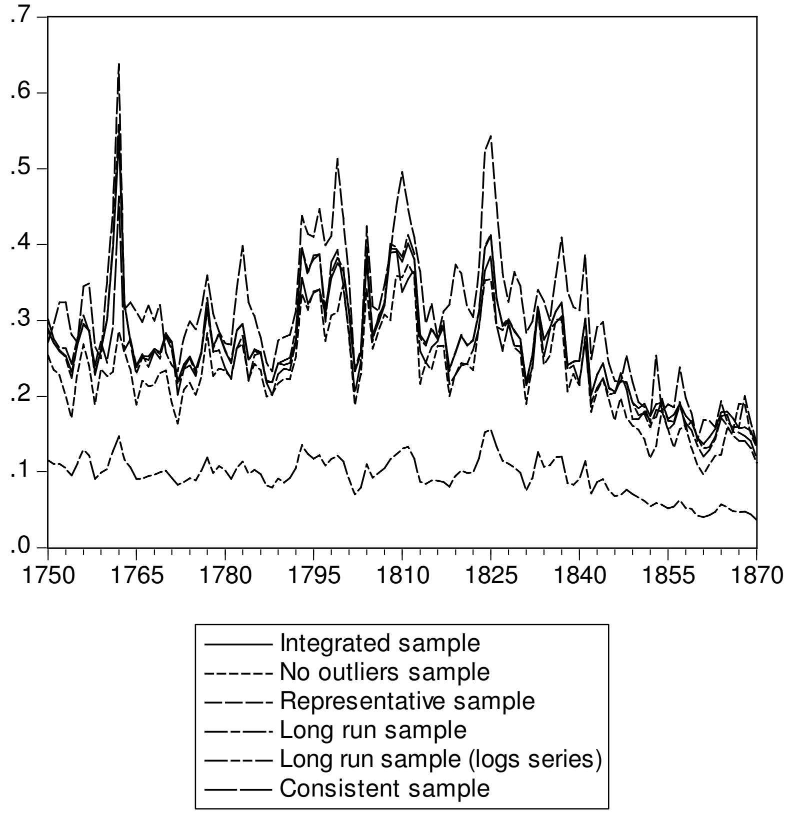
trend. On the Utrecht market (Posthumus 1964) the "red" wheat cost ca 15% less than the white one, 1787-1814, and the ratio remained fairly stable.

[22] If the missing observations are at the end or at the beginning of the period, R^i_{AV} is computed as an average of the six closest values of R^i_t.

[23] The sample must omit Russia because its inclusion would have been made it necessary to cut the number of series to 6-7 (Russia accounted for about a third of European population). In all quoted countries but Austria-Hungary, there are more series than necessary. The series are chosen according to three criteria – the length, the number of observations and the location of markets. See the Data Appendix for a list of markets

[24] The average ratio to the baseline ("long-run") series is 1.00 for the "integrated" sample, 0.97 for the "consistent" one, 1.16 for the "representative", 0.83 for the "no-outliers" and 0.35 for the "long-run (log series)" sample. All these ratios but the first are significantly different from one.

Graph 7
Robustness tests: alternative series of coefficient of variation, wheat



Yet, trends seem very similar. This first impression can be buttressed by a statistical pair-wise comparison of each alternative series to the "long run" one. The series, with one exception, are co-integrated at least at 5% (Table 3 column a), the rates are not significantly different (Table 3 column b) and, last but not least, the coefficients of correlation are quite high, both in levels (Table 3 column c) and in first differences (Table 3 column d).

Tab.3
Robustness test: differences between baseline and alternative series

	a)	b)	c)	d)
Long run sample (logs series)	No	-0.73***	0.920	0.876
No outliers sample	Yes**	-0.42***	0.908	0.767
Consistent sample	Yes***	-0.50***	0.964	0.938
Integrated sample	Yes**	-0.50***	0.995	0.993

Representative sample	Yes***	-0.55***	0.940	0.831

Significant at * 10%; ** 5%: *** 1%

In short, although the data-base is far from perfect, the main results seem remarkably robust.

6) Candles and rye: an “enlightening” interlude?

As shown in Table 1, the number of price series for rye is fairly large, but all markets but two (Milan and Vercelli) are located in North and Central Europe. A straightforward comparison with wheat might be biased: for this reason, Table 4 reports rates also for a common sample of 48 markets, which are present in both data-bases.

Table 4
Rates of σ-convergence, wheat and rye

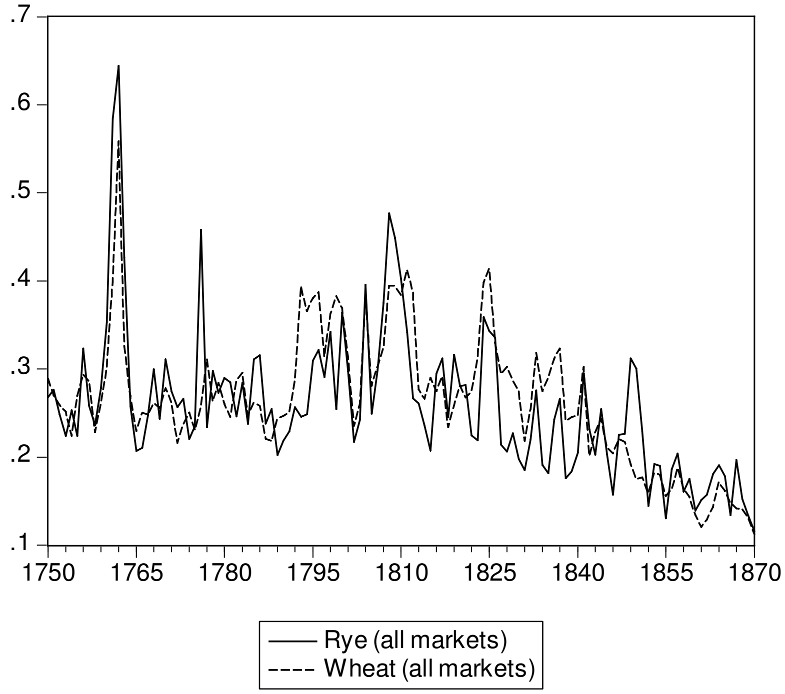
	1750-1792	1793-1815	1816-1870	1750-1870
All markets				
Rye	-0.46	-0.54	-1.29***	-0.54***
Wheat	-0.23	-0.82	-1.90***	-0.62***
Same sample				
Rye	-0.62	-0.60	-1.43***	-0.63***
Wheat	-0.28	0.34	-1.43***	-0.46***

Significant at * 10%; ** 5%: *** 1%

As expected, differences are fairly small even for the non-adjusted samples. The rates of σ-convergence are not significantly different in the long run, and in all periods but 1816-1870, and the two series are cointegrated at 1%. For the common sample, the rates are equal in all periods Also short term movements are very similar (Graph 8), although not wholly identical [25].

Graph 8
Trends in coefficient of variation, wheat and rye, 1750-1870

[25] For instance, in Sweden rye prices converged from 1793 to 1815 (rate -1.40%, significant at 10%) and from 1815 to 1870 (rate -1.05%, significant at 1%) but not from 1750-1788. In other words, the market for rye integrated somewhat later than the market for wheat.



In the full sample the discontinuity of the 1790s appears less steep than for wheat and the price dispersion a bit lower in the 1820s and 1830s. However, these differences disappear once adjusted for the market coverage[26].

One could argue that rye is too similar to wheat to add much new information. What about candles? Unfortunately, although the number of series is fairly large (Table 1), most of them are rather short and it is impossible to extract a consistent sample over the whole period. Furthermore, the geographical coverage of the sample is highly unbalanced. There are series for Austria, Germany, France, Italy, Russia and Spain, a substantial group for Southern England (Beveridge 1965) but most data refer to Swedish markets (Jorberg 1972). A simple average would grossly over-represent Sweden. The simplest way to tackle the problem is to average prices in Swedish markets and to use the results as a single observation (the series is labelled “Adjusted for Sweden” in Table 5).

Table 5
Rates of σ-convergence, candles

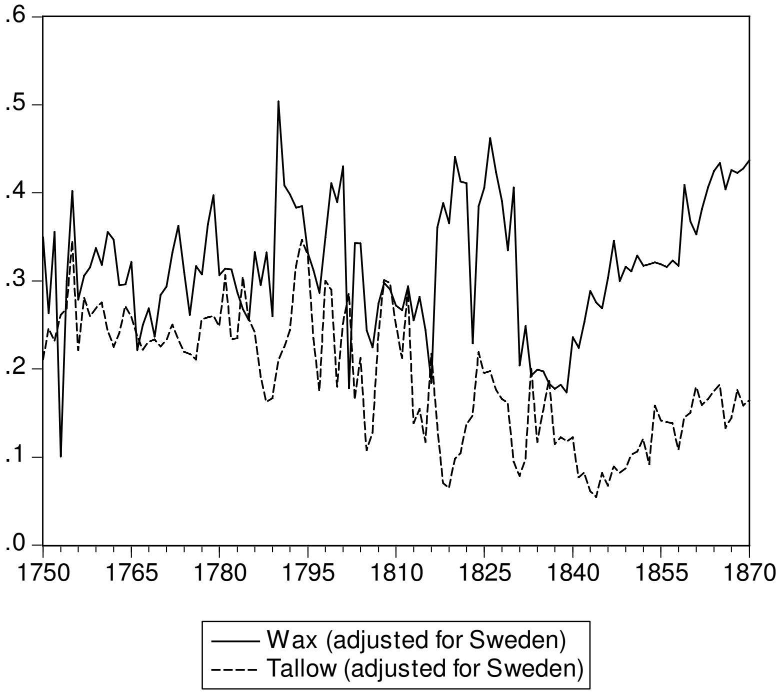
	1750-1792	1793-1815	1816-1870	1750-1870

[26] If one considers all the available markets, the coefficient of variation is 7% higher in 1793-1797 than in 1786-1790 for rye and 53% for wheat, while for the common sample the figures are 33% and 42%. The average coefficient of variation in 1820-1840 is somewhat higher for wheat (0.29) than for rye (0.24), and the different is significant at 1%. However, the difference becomes not significant for the common sample (0.24 versus 0.225).

Wax				
All series	0.68**	-3.16***	-0.17	-0.24***
Adjusted for Sweden	0.49*	-1.68**	0.53	0.12
Tallow				
All series	0.18	-4.17***	-1.14***	-1.32***
Adjusted for Sweden	-0.48*	-2.46**	0.36	-0.82***

Significant at * 10%; ** 5%: *** 1%

Graph 9
Trends in coefficient of variation, wax and tallow candles, 1750-1870



Trends in the market for tallow candles are broadly consistent with those in the cereal market (Graph 9). The rate of σ-convergence is somewhat higher, even discounting the Sweden effect, and, above all, the process of integration started earlier, in the 18th century, without any clear upward jump at the outbreak of the war. Price dispersion touched a minimum in the 1840s and then it rebounded. [27]. The differences with wheat in timing and speed of integration are not really surprising. On average tallow candles cost almost 7 times more than wheat, and thus were more tradable. Indeed the coefficient of variation was on average about 30% lower than that for wheat, and in the 1830s and 1840s it was 60%

[27] This increase is not easy to explain. The most obvious hypothesis, the effect of a different sample, can be easily ruled out. The coefficient of variation increases also for an entirely consistent, although admittedly small, sample of four markets

lower. By the same token, one would expect an even earlier and faster integration in the market for wax candles, which were even more expensive (they cost 23 times wheat). Yet this is not the case: once adjusted for the domestic integration in Sweden, there is no evidence of σ-convergence over the whole period 1750-1870 [28]. This result is difficult to explain without a specific analysis of the market for wax candles. One might hypothesize that the price dispersion reflects quality differences, which are likely to have been greater for a quasi-luxury good than for a mass-consumption one, such as tallow candles.

7) On the causes of integration

7.1 As said in Section 2, the variance analysis measures the contribution of different sources to price convergence or divergence. Table 6 (and Graph 10) reports the key results for the "long-run" sample. The computation takes into account twelve different sources of variance – "domestic" (for the ten countries with more than one market), "within Continental Europe" and "between Continental Europe and the United Kingdom". The table reports the initial and final standardized variance and its changes and, in italic, the countribution of each source to changes in total variance.

Table 6
Variance analysis, wheat: long-term changes

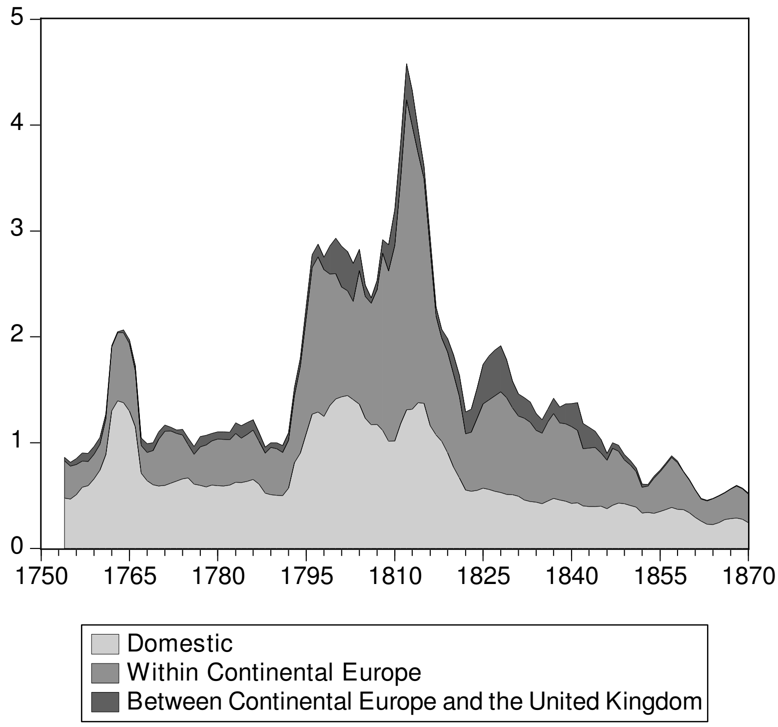
	Initial	Changes					Final
	1750-52	1750-52 to 1788-90	1788-90 to 1793-95	1793-95 to 1816-18	1816-18 to 1868-70	1750-52 to 1868-70	1868-70
Total variance	0.97	0.07	2.00	-0.89	-1.77	-0.59	0.39
	100	*100*	*100*	*100*	*100*	*100*	*100*
International integration							
Total	0.46	0.10	1.14	-0.5	-1.01	-0.28	0.18
	47.2	*141.2*	*56.9*	*56.2*	*57.3*	*47.0*	*45.2*
Within Continental Europe	0.43	0.06	1.07	-0.47	-0.91	-0.26	0.18
	44.5	*85.0*	*53.6*	*53.4*	*51.6*	*43.5*	*44.0*
Between Continental Europe and UK	0.03	0.04	0.07	-0.02	-0.1	-0.02	0.00
	2.7	*56.2*	*3.3*	*2.8*	*5.7*	*3.5*	*1.2*
Domestic integration							
Total*	0.52	-0.03	0.86	-0.39	-0.76	-0.31	0.20
	52.8	*-41.2*	*43.1*	*43.8*	*42.7*	*53.0*	*54.8*
(France)	0.24	-0.08	0.25	-0.19	-0.19	-0.20	0.03

[28] The coefficient remains trend-less even by adding a dummy for the years 1850-1870

	23.2	*-112.7*	*12.5*	*21.4*	*10.6*	*34.8*	*8.5*
(Spain)	0.04	0.02	0.29	-0.14	-0.19	-0.03	0.01
	3.9	*27.3*	*14.4*	*16.1*	*10.7*	*4.3*	*3.4*
(Germany)	0.04	0.03	0.11	0.00	-0.18	-0.04	0.00
	4.3	*40.9*	*5.5*	*-0.3*	*10.0*	*6.3*	*1.5*
(Italy)	0.12	-0.01	0.14	-0.08	-0.07	-0.03	0.09
	12.5	*-17.6*	*7.0*	*9.4*	*4.1*	*4.7*	*24.9*

* sum of domestic integration in Austria-Hungary, Belgium, France, Germany, Italy, the Netherlands, Spain, Sweden and Switzerland

Graph 10
Variance analysis, wheat



The fall in variance “within Continental Europe”, the single most important source of decline in dispersion in the long-run, reflects the convergence of average prices by country towards the mean price for the whole Continent[29]. The second most important source of overall convergence is domestic integration in France, while all other factors, including the convergence of British prices toward the Continental average, accounted for about a fifth of total decline. The relative importance of different sources may seem surprising but it is not very far the shares on total variance in 1750-1752. As a consequence, the distribution of variance over the long-run has remained remarkable stable. The division in periods adds some important insights. Clearly, there was not much action before the French revolution. In contrast, changes were very large in each of the three subsequent stages, the sudden disintegration of the early 1790s, the ups and

[29] Somewhat unexpectedly, the most important country comes out to have been Switzerland: its average price fell from being 80% higher than the Continental average in 1750-1752 to being “only” 20% higher, and this movement accounts for 23.9% of total fall in variance. Prices converged towards the European average also in Austria-Hungary (accounting for 9.4% of total convergence), France (8.0%), Sweden (5.5%), Germany (5%) and Russia (0.5%). In all other countries, prices diverged from the Continental average, increasing total variance. However, the movements were small, with a maximum of 3.8% in the case of the Netherlands.

downs during the French wars and the integration in the fist half of the 19th century. The change in standardized variance in each of these three periods exceeds the change over the full period 1750-1870. Clearly, international movements are more important than domestic ones in each of the three periods: trends in variance "within Continental Europe" account for slightly more than half the total change[30]. The contribution of changes in domestic market was substantial in France, Spain and to a lesser extent, Germany. However, each of these countries had its own distinctive experience. In France price dispersion was high in the 18th century, increased after the Revolution then it started to decline. In Spain, price dispersion was initially low but increased hugely in the early 1790s and, as in France, it declined steadily until the 1860s. In Germany, price dispersion was initially low, increased somewhat (but much less than in Spain or France) in the 1790s and declined only after the end of the war.

7.2 It would be easy to interpret domestic integration as caused by falling transportation costs (and possibly by growing market efficiency) and the cycle in international integration as determined by political events (wars, changes in boundaries) and by trade policy. However, as warned in Section 2, the coefficient of variation is sensitive to changes in prices, and the average "European" price fluctuated widely in this period [31]. Furthermore, the very distinction between domestic and international is somewhat moot in a period of changing political boundaries. It seems thus advisable to buttress this interpretation with additional evidence

7.2.1 We know very little about the operational efficiency of markets in history. The speed of circulation of information has surely increased thanks to the telegraph (Duboff 1983, Headrick 1988, Fields 1992). Hoag (2006) estimates that the lay-out of transatlantic cable in 1866 immediately cut the time of transmission of financial news between New York and London from about nine days to one. However, Kaukiainen (2001) has shown that the improvement had started even before the lay-out of the telegraph network. The average delivery time of a letter from Europe to London fell from a maximum of 4-5 weeks in the 1820s to ten days in 1860. One would expect that these improvements increased the speed of adjustment of prices and that such an increase would show up in econometric estimates of speed. Unfortunately, the results by Jacks (2005) are erratic, to say the least [32]. The half-life of price shocks in international trade fluctuated around 25 days with a maximum of 45 in 1845-1855 and a minimum of 16 in the next

[30] The contribution of each country to this movement differs remarkably among periods. Spain was by far the most important country both for the divergence of the 1780s and for the modest convergence during the French wars, accounting for 16% and 45% of total changes respectively. In contrast, almost all countries contributed to the decrease in dispersion from 1815 to the end of the period

[31] Nominal prices rose from about 13-14 shilling/q.le in the 1750s to well above 30 during the French wars. They returned almost back to the pre-war levels in the 1820s, to rise slowly but steadily up to 25 shillings at the end of the period.

[32] The half-life of shocks is computed as ln(0.5)/ln(φ) where φ is the speed of adjustment from Jacks (www.sfu.ca/~djacks/). He reports data by country: the figure in the text is a simple average of half-lives for Austria-Hungary, France, Belgium, the United Kingdom and (since 1815-1825) Spain. The very long half-life for domestic integration in the 1840s reflects the extremely high value of φ for the United Kingdom (0.98 in 1840-1850, corresponding to a half-life of 57 months).

decade, while in domestic trade it averaged around 100 days, with a peak of 460 in 1840-1850. Anyway, it is unclear how much an improvement in circulation of information can account for convergence if measured with yearly prices. Unfortunately, the evidence about other parameters, such as cost of transmitting information, brokerage fees, liquidity and so on, is almost non existent.

7.2.2. The conventional wisdom about transport costs in the period at hand can be summed up in four statements: i) traditionally transport costs were lower at sea than on land, and on internal waterways than on the road; ii) maritime freights declined in the long-term, at least in the 19th century iii) overland transport costs decreased thanks to the construction of canals and later of railways. These trends are believed to have contributed mightily to market integration (Price 1982)

This conventional wisdom is based on a huge anecdotal literature about the transport revolution, including many 19th century sources, and also on some recent econometric work. The typical approach involves running regression with a measure of integration as dependent variable and proxies for transport costs. Keller and Shiue (2008) find a very strong negative effect of the existence of a railway connection on price differentials between markets in 19th century Germany. Federico (2007) uses the price differential as well, but he measures rail costs with city-pair specific fares and adds also a measure of freight index to take into account the contribution of coastal trade, of particular importance in a country with 8000 chilometers of coastline. Indeed, the fall in freights account for a sizeable share of price convergence, while the effect of railways is limited to near-by markets in the Po valley. Jacks (2006) uses the estimates of transport costs and speed and adjustment from his own TAR model as dependent variable, with dummies for the existence of railways connection and of possibility of water transport between each pair of cities as measure of transport costs. He finds that better transportation reduced price dispersion and increased the speed of adjustment. These econometric results works are suggestive but not conclusive, for a number of reasons. First, all regressions cover also the second half of the century, and thus the coefficients might capture developments after 1870 [33]. Second, Italy and Germany might be not representative of the whole Europe, while Jack's dependent variable might differ from actual transaction costs for the reasons set forth in Section Two. Last but not least, the use of time-invariant dummies to proxy changes in the supply of transport ignores the effect of changes in relative prices of transportation between different means.

The resort to dummies as proxies for transport costs is not causal. The data on transport costs, especially overland, in 19th century Europe are far from abundant (Table 7)

Table 7
The cost of overland transport

[33] The time span is 1830-1890 for Federico (2007), 1800-1895 for Keller and Shiue (2008) and 1800-1914 for Jacks (2006). Keller and Shiue test separately the effect of railways in the first twenty-five years after their construction. They estimate that these short-run effects account fot about two thirds of the total effect of railways.

	Indexes			Freight factor		
	Road	Rail	Inland navigation	Road	Rail	Inland navigation
a) Sweden						
1810	66.9		69.0	8.24		0.81
1830	95.5		90.8	9.49		0.86
1850	100.0		100.0	10.30		0.98
1873	196.7		68.0	14.23	3.47	0.47
b) France						
1815-24	132.0			11.26		
1825-34	100.0		126.1	9.43		2.19
1841-44	100.0	166.7	115.2	9.38	5.44	1.99
1845-54	100.0	121.8	117.4	9.13	3.87	1.97
1855-64	100.0	100.0	100.0	8.29	2.88	1.52
1865-74	100.0	86.2	76.1	8.60	2.58	1.20

Source: Toutain 1967 p.279 and Thorburn 2000 p.158

The right-hand part of the table reports indexes of nominal transport costs for a standard 100 km. trip and the left-hand part the share on the average price of wheat in Sweden and France respectively. This measure, the so called "freight factor" (Hummels 2007), is both more theoretically sound and factually more accurate than a deflation of costs with a generic price index. It is consistent with the standard iceberg approach to modeling trade costs and, as it measures the cost would-be arbitrageurs had to incur. The data confirm that road transport was extremely expensive and probably almost prohibitive beyond a certain distance, although the increase is not necessarily linear (Thorburn 2000 p. 68). The huge growth in road haulage costs in Sweden might reflect the boom in real wages, as labour costs were by far the biggest item [34]. The substantial fall in costs of rail transport in France might be partially spurious, as it is not controlled for changes in length of the trip or in the mix of transported goods (Toutain 1967 p. 163). In most countries, railways rates changes had to be approved by government officials, and thus were fairly infrequent. However, the effect of these changes on the freight factor could be substantial. For instance, a change in Italy in 1866 halved the costs [35]. The most solid result seems to be the decline in the cost of

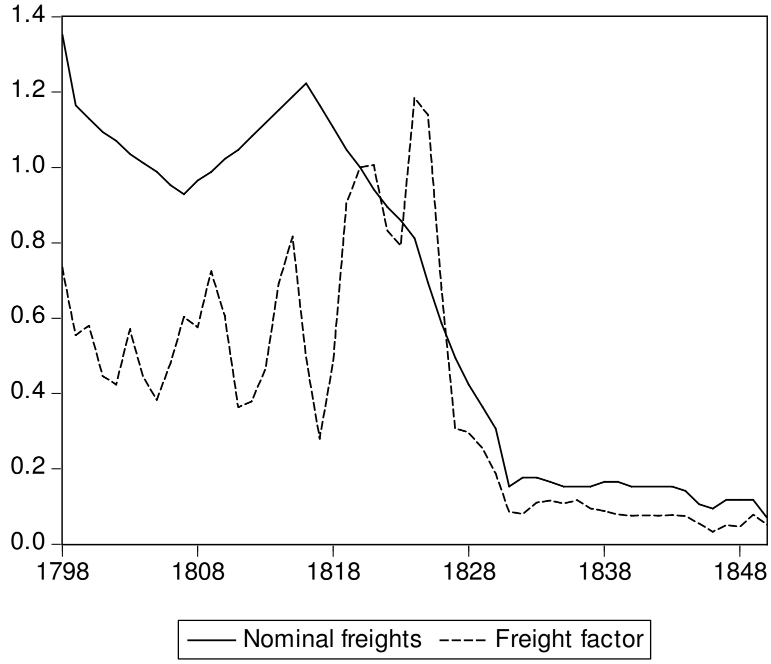
[34] Thornburn's original data are in hours of work for unskilled workers and he reports the relative wage (2000 p.302). His data imply a 20% increase in real wages from 1810 to 1830 and a further 80% increase from 1850 to 1873 (consumer prices kindly provided by Lennart Schon).

[35] Rates had remained constant since 1853, the opening of the Genoa-Turin line, the first one linking two main Italian cities. Then the freight factor fell from about 5.5% to 3.2% on that line (152 km), and from 15% to 7.7% on the Milan-Florence (351 km). Data from Federico (2007), averages of prices in 1864-1866 and 1867-1870.

inland navigation. Such a trend shows also in the trends of freights and freight factor for the navigation on Rhine [36].

[36] The series of freights (Horlings 1995 pp.413-417) refers to a downstream navigation from Rotterdam to Frankfurt (559 km) and omits duties. Wheat accounted for about a fourth of the downstream flows, while it was not transported upstream. The freight factor is computed with prices in Mannheim because the Frankfurt series stops in 1820. The city lies on the river Main, a tributary of the Rhine, 570 km. from Rotterdam. Missing prices in 1798-1805 and 1810-1813 are interpolated with Frankfurt ones.

Graph 11
Freight for navigation on the Rhine (1820=1)



As expected, the freight factor declined in the long run, from 60% in the mid 1800s (80% including duties) down to less than 5% (12.5% with duties) forty years later. However the graph highlights two less trivial points. First, the decline in nominal freights is concentrated in the fifteen years after the end of Napoleonic wars. The French data suggest a much smoother trend, and thus the collapse on the Rhine might reflect some specific circumstances. Second, movements in prices did affect the freight factor a lot. The very low prices of the early and mid 1820s more than offset the fall in freights, so that in 1824-1825 transporting grain to the cost and paying dues cost one and half times the price in Mannheim. Such a level of costs made arbitrage very difficult. Deflating nominal freights with a price index would not capture this spike, unless the wheat price relative to the deflator remained constant.

The data on maritime freights confirm the decline after the end of the Napoleonic wars. According to the old series by North (1958), they fell from from almost 40% in the 1820s to about 8% in 1868-1870 for imports in the United Kingdom from the Baltic and from two thirds to slightly less a quarter for imports from the Black Sea[37]. In absolute terms, they fell to 20-30% of their 1820s level.

[37] The freight factors have been re-computed using Konigsberg or Odessa prices as denominator, instead of the Gazette price as in North (1958)

The low level of the "freight factor" for the Black Sea trade in the 1870s is confirmed the independent estimate by Harlaftis-Kostelenos (2007), who add that the freight factor for the Leghorn trade was, as expected, even lower, around 7% and that it had fallen by 80% since the 1830s. Unfortunately, none of these product-specific series extend back in time before 1815. The only series encompassing the second half of the 18th century refers to transport of coal from Tyneside to London (Harley 1988). The ratio(s) to London wheat price fluctuated widely without any trend, with peaks in the late 1750s-early 1760s, late 1770s, early 1790s and in the second half of the 1800s, to be back close to its initial level in the early 1820s The overall impression of stagnation in the second half of the 18th century is confirmed also by the scattered information by Knoppers (1976) on freights from Russia to the Netherlands[38].

Summing up, the evidence suggests that maritime transport cost fell and that costs on waterways fell as well. The information on costs of road and rail transport is not consistent and abundant enough to prove a downward trend. However, the overall costs of overland transport would decline even if they remained constant to the extent that cheaper ways of transportation substituted more expensive ones. Thorburn (2000) attributes the integration of the Swedish market in the 1820s and 1830s, well before the construction of railways, to the opening of new canals. Actually, railways can explain only the last stage of domestic integration. In France, by 1850 the network was about 7-8% of its 1913 length, the average trip was about 100 km and the network transported "only" 4 million tons of goods, about two thirds of the total wheat output (Toutain 1967 p. 144 and 157). At that date, the length of the railways network attained one third of the 1913 length in the United Kingdom. This milestone was to be attained in all the other twelve countries only by 1870 (Mitchell 1998 tab. G 1).

This, albeit incomplete, evidence would imply, ceteris paribus, that price dispersion was among markets on the coast than in the interior, that it declined within both groups of markets. It is possible to test directly these implications by comparing price dispersion in coastal and interior markets of the long run sample (Graph 12)[39]. There are some difference, but smaller than expected. The

[38] The data are collected from actual contracts for importation of rye from five ports (Reval, St Petersburg, Vyborg, Archangel and Riga) for the period 1688-1785. Since 1750, the data-base consists of 27 city quotations, out of the possible maximum of 175 and only in 1784 it includes a quotation for each ports. In that year, transport costs accounted for 20-30% of the Amsterdam rye price (Posthumus 1943), net of costs themselves.The overall index is computed as an unweighted average of city indexes and then it is divided by the similar index of Amsterdam prices. The resulting series covers 14 years out of 35. It fluctuates without any trend, with a minimum in 1771 (63.5) and a maximum nine years later (215.8). A comparable computation with data from Van Tielhof (2002) suggests that the freight factor might have been lower in the 17th century than in the 18th.

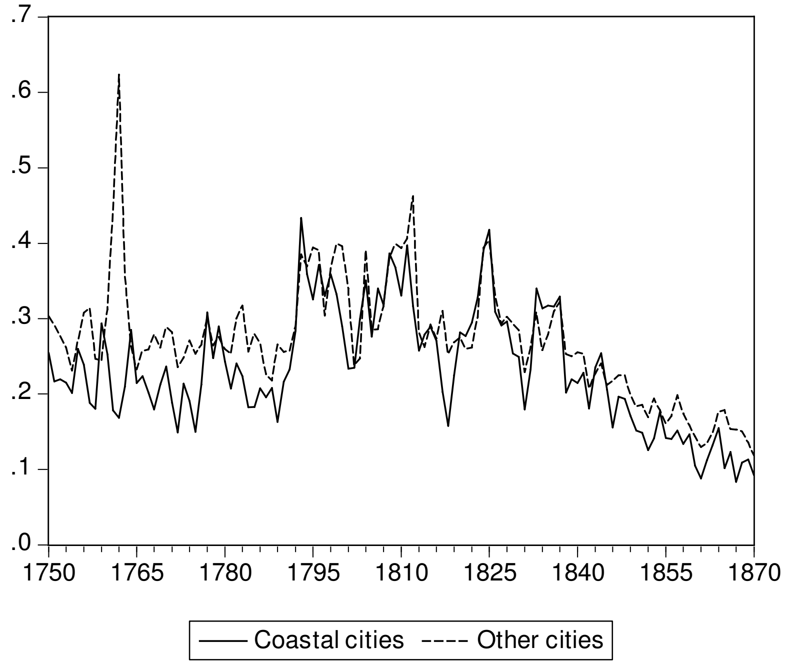
[39] Coastal markets are Copenhagen Aude, Bouches du Rhone, Calvados, Cotes du Nord Gard, Gironde, Hérault, Ille et Villaine, Manche, Nord, Pas de Calais, Seine Inférieure, Somme and Var, Bremen, Danzig, Hamburg Konigsberg, Palermo, Amsterdam, Lisbon, Barcelona Stockholm Sodermaland, Ostergotland and London**.** Interior market are Vienna, Ljubljana, Prague, Krakow, Rattenberg, Bruxelles, Brugges, Ghent, Liege,Corrèze, Drộme, Eure et Loir, Haute Garonne, Indre, Isere, Jura, Loire, Haute Loire, Haute Marne, Haute Vienne, Maine et Loire, Mayenne Oise, Rhộne, Seine, Seine et Oise, Tarn, Tarn et Garonne, Vienne, Augsburg, Berlin, Braunschweig, Celle, Dresden, Duderstadt, Gottingen, Hannover, Koln, Liepzig, Luneburg, Munchen, Munster,

average coefficient for coastal cities (0.23) is lower than the corresponding average for interior cities (0.27) and the σ-convergence in the period after Waterloo is indeed faster [40].

Osnabruck, Paderborn and Waake, Acquaviva, Arezzo, Brescia , Firenze, Mantova, Milano, Pisa, Roma, Rovigo, Torino, Udine, Vercelli, Arnheim, Dordrecht, Groningen, Nijmegen, Utrecht, Warsaw, Gerona, La Coruña, Lleida, Pamplona, Rioseco, Segovia, Tolosa, Uppsala, Kalmar, Halland, Skaraborg, Narke, Nora, Linde and Karkskoga, Vastmanland, Gastrikland, Halsingland, Luzern, Zurich Exeter, Cambridge, Newcastle and Southern Ireland

[40] The yearly rates over the whole period are -0.54 (significant at 10%) for coastal cities and -0.60 for interior ones (significant at 1%), and -2.22 and -1.78 (both significant at 1%) respectively for 1815-1870.

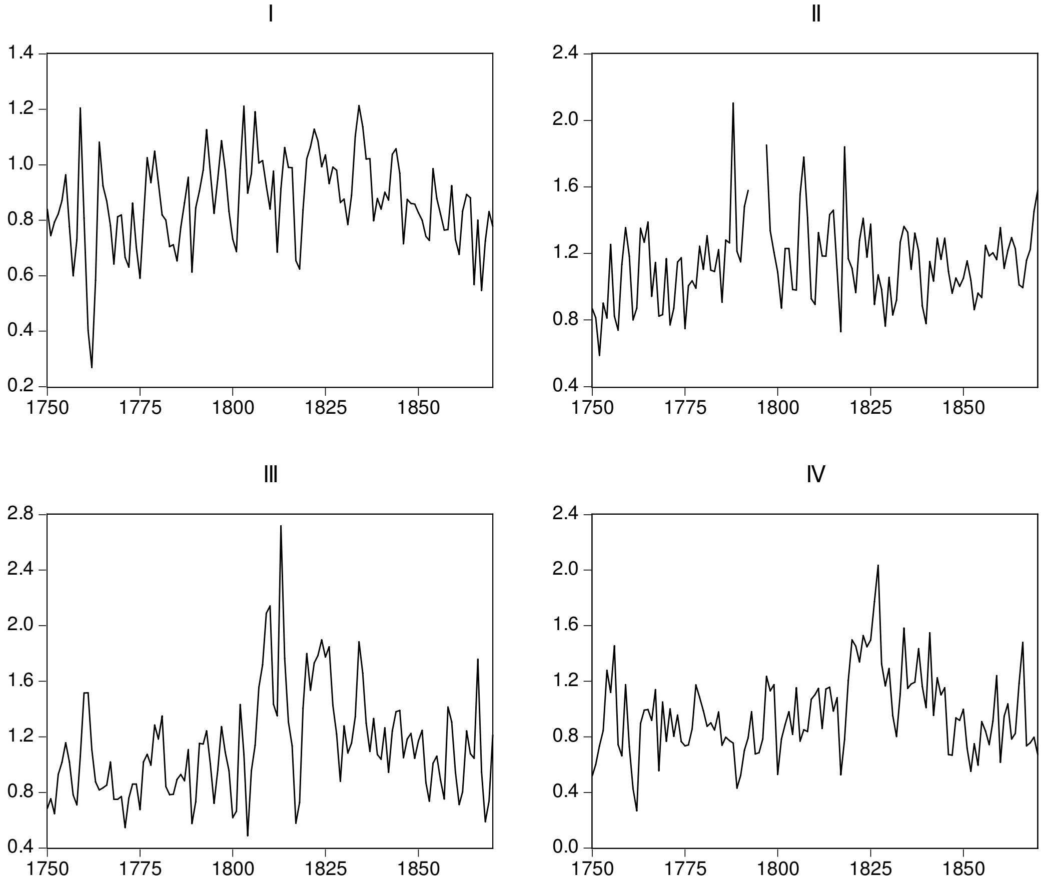
Graph 12
Coefficient of variation, coastal and other cities, long-run sample



One might surmise that the effect of differentiated change in transport costs on sea and land is swamped by that of trade policy political changes or that results are biased by the inclusion in the "coastal" sample of markets (or areas) with poor harbour facilities and not developed commerce. To discuss these claims, Graph 13 focuses on selected sub-samples markets, reporting for each of them the ratio of "coastal" to "interior" markets. Graph 13 i) reproduces the overall ratio (from Graph 12) for comparative purposes. Graph 13 ii) considers only French markets, where, obviously, there was no while the two other contrasts dispersion among ten big ports with as many big cities in the interior and ten randomly chosen markets in the interior [41].

[41] The ten big cities on the coast are Amsterdam, Barcelona, Bouches du Rhone (Marseilles), Bremen, Danzig, Gironde (Bordeaux), Hamburg, Konigsberg, London, Palermo. The ten big cities in the interior are Berlin, Bruxelles, Koln, Haute Garonne (Toulouse), Milano, Munchen, Segovia, Seine (Paris), Vienna and Zurich. The ten randomly chosen "interior" markets are Correze, Dresden, Lleida, Luzern, Oise, Osnabruck Ostergotland, Roma, Tolosa Waake

Graph 13
Ratios of coefficient of variation, coastal and other cities



All rates fluctuate wildly, without a clear long-term trend, and the long term averages are not very far from one. Actually, in two cases, Graph 13 ii) and iii), they exceeded one (i.e. price dispersion was greater among coastal markets than in interior). This evidence is clearly not enough to state that the conventional wisdom is wrong. However, it does suggest that all means of transportation contributed to the integration of markets in the early 19th century.

7.2.3 The disrupting effect of wars on the market is all too evident in the period at hand. Prices in Central Germany in 1761-1763 were so high because these areas were by then battlegrounds in the Seven Years' War. The most obvious explanation for the dis-integration of the European market in the early 1790s is the outbreak of revolutionary wars. In the following years, France extended its political and commercial influence all over Central and Western Europe. French conquest is said to have fostered the creation of an integrated market within the Empire, and at the same time to have deepened the differences with the rest of the continent, especially after the proclamation of the Continental System in

1806. This claim can be assessed by re-arranging markets from the "French wars" sample, according to the (admittedly shifting) political boundaries, in three groups - the French Empire (France at its pre-revolutionary borders, Switzerland, Netherlands, Italy, Belgium and the so-called Confederation of the Rhine in West Germany), the "Other Europe" (Prussia, Spain, Russia etc.) and the United Kingdom. The results tally only partially with the expectations (Table 8)

Table 8
Variance analysis, wheat: the effect of French wars

	Initial	Changes			Final
	1789-1792	1789-92 to 1807-09	1807-09 to 1818-20	1789-92 to 1818-20	1818-1820
Total variance	1.13	2.38	-1.99	0.39	1.52
	100	*100*	*100.0*	*100.0*	*100.0*
International integration					
Total	0.29	2.20	-1.84	0.35	0.64
	25.3	*92.4*	*92.5*	*90.6*	*42.3*
Between Continental Europe and UK	0.11	0.60	-0.29	0.31	0.42
	9.7	*25.2*	*14.4*	*79.8*	*27.6*
Within Continental Europe	0.03	0.65	-0.67	-0.02	0.02
	2.7	*27.4*	*33.4*	*-3.9*	*1.0*
Within Other Europe	0.15	0.95	-0.89	0.06	0.21
	12.9	*39.8*	*44.7*	*14.7*	*13.6*
Domestic					
Within Other Europe	0.19	0.25	-0.21	0.04	0.23
	16.8	*10.3*	*10.5*	*9.3*	*14.8*
Within French Empire	0.66	-0.06	0.06	0.00	0.66
	58.0	*-2.5*	*-3.1*	*0.1*	*43.2*

Source: see text

As expected, from 1790 to 1807, total international variance increased hugely, and all its three components contributed to this growth roughly in the same proportion, even if wheat was exempt from some of the harshest measures against trading with the enemy [42]. What is missing is the integration within the French Empire: the sign is negative, as expected, but the size of the effect is negligible.

[42] British governments allowed import of wheat under license, while France encouraged these exports in order to drain bullion away from the United Kingdom (Galpin 1925, Olson 1963, Davis and Engerman 2006).

The effect of another political event, the creation of the Zollverein, has been studied by Shiue in two papers, which use a different method. In the first one (Shiue 2005) she used an Engel-Rogers framework and finds that the Zollverein accounted for about a half of the fall in "border" coefficient Later, Keller and Shiue (2008) have explored the power of a Zollverein dummy to explain changes in price differentials, finding it to have been rather weak relative to that of railways. The variance analysis confirms these latter results. The reduction of price differentials among "Zollverein" states accounts for about a third of price convergence among "German" market from 1831 onwards, but the timing does not tally with that of accession to the custom union[43]. The integration of German market was caused by the domestic integration, partly balanced by price divergence between non-Zollverein states. The stark contrast between these results might be to some extent explained by differences in coverage, but it also reflects the differences in approach. The border variable is in-fact bound to pick all the effects of the unobserved changes in transaction costs.

7.2.4 The period since 1750 featured a major change in the nature of grain policy – from a (urban) consumer-centered to a producer-oriented one. The traditional market-regulating institutions aimed at guaranteeing a steady supply of wheat to urban consumers at "just" prices. They were strongly criticized by 18th century economists, most notably the Physiocrats, who argued that the free circulation of grain could stimulate agricultural production and increase the welfare of the whole population (Persson 1999). Some European governments followed their advice, albeit very cautiously. In Austrian Lombardy, exports were partially liberalized only in 1785 (Grab 1985), twenty years after the first proposal. In France grain markets were liberalized in 1763 but freedom lasted only seven years (Kaplan 1975-1976). The effects were correspondingly modest if any at all: the coefficient of variation, during the free-trade period 1764-1770 was only 8% lower than in the previous seven years and 14% higher than in 1771-1777. During Revolutionary and Napoleonic years the regulation of grain markets was slowly loosened, with relapses at every subsistence crisis (e.g. in 1793-1794 or in 1812), to be eventually dismantled only in the late 1810s (Miller 1999).

After the end of the French wars, prices seemed set to fall very quickly, and many countries reacted by imposing protective duties (Federico 2008). As early as 1815, the United Kingdom prohibited imports if domestic prices did not exceed the 80 shilling per quarter (Barnes 1930), a level which had never been attained before the war[44]. The extremely poor 1816 crop caused prices to rise almost up to the war-time peak (Post 1977), but afterwards the expected decline materialized, prompting new protectionist measures. France introduced a sliding

[43] The eleven German markets in the "early 19th century sample" are first grouped according to time of accession of each state to the Zollverein. Then the effect of accession of each group is measured by the contribution of the convergence of its average price towards the "Zollverein" mean in the period from its accession to the next round of enlargement. The accession of Saxony in 1830 offset about 4% of the increase in domestic dispersion in other states in next five years. The two next rounds of enlargement, in 1834-1835 (Baden and Bavaria) and 1851 (Hannover), had almost no effect. The "Zollverein" markets contributed to the overall integration of the German market mainly before their accession to the custom union.

[44] The average price is the so called Gazette one (Mitchell-Deane 1976)

scale in 1819 (Ame 1876), Spain prohibited imports altogether in 1820 (Gallego Martinez 2004 and 2005) and so on. However, the protectionist policies did not last for long, in clear contrast with the late-century backlash. Since the mid-1820s most countries reduced and ultimately abolished duties on wheat. The 1828 British Corn Laws were decidedly more liberal than the 1815 version (Sharp 2006). Their abolition in 1843 was not the starting point, but only a step of a long-run pan-European process of liberalization of trade (Accominotti and Flandreau 2006).

The twin role of the United Kingdom as a major importer of grain and as the leading economy in the world make the effect of Corn Laws a prime candidate for a variance analysis of the impact of trade policy. To this aim, total variance (from the "early 19th century sample") is split between the convergence between the United Kingdom and Continental Europe and a residual, including all other sources (Table 9)

Table 9
Variance analysis, wheat: the effect of Corn Laws

	Initial	Changes				Final
	1815-17	1815-17 to 1828-30	1828-30 to 1843-45	1843-45 to 1868-70	1815-17 To 1868-70	1868-1870
Total variance	2.13	-0.62	-0.64	-0.54	-1.80	0.33
	100	*100*	*100*	*100*	*100*	*100*
Between UK and Continental Europe	0.05	0.20	-0.19	-0.06	-0.04	0.00
	2.3	*-32.6*	*29.3*	*10.3*	*2.3*	
Residual	2.08	-0.82	-0.45	-0.48	-1.76	0.33
	97.7	*132.6*	*70.7*	*89.7*	*97.7*	

The effect of British policy is minimal in the long-run, but not in the short run. Without the 1815 Corn Laws, in the 1820s price dispersion all over Europe would have fallen by a third more and the 1828 liberalization accounted for a third of total convergence in the next fifteen years. The impact of the final Repeal is smaller but still noticeable.

8) On the welfare effects of market integration

Economists and economic historians strongly believe in benefits of market integration, as a necessary condition for specialization and Smithian growth. Yet, and somewhat strinkingly, estimates, even partial or provisional, of these benefits are very scarce. Two very recent papers deal with very specific issues [45]. O'Rourke (2007) estimates that the trade wars of the 1810s, the British embargo to French and American trade, and French Continental system, reduced GDP by 4% in the United States, by 2.5% in France and by 1.9% in the United Kingdom. According to Ejrnæs and Persson (2006), the increased speed of transmission of information between the United Stated and the United Kingdom augmented American wheat exports from 1857-1862 (without a telegraphic cable) to 1883-1889 (with telegraph) by a minimum of 3.6% and a maximum of 9.4%, equivalent to 0.03-0.07% of American GNP [46]. The welfare effects of integration in the long run can be modelled as a fall in tariffs. In empirical economics, the issue is usually tackled with computable general equilibrium models. However, they need input-output tables, which are not available for any country in the period before 1870 [47] O'Rourke (2007) assumes the existence of two goods only, an exportable and a non-traded one, but this brilliant solution is clearly not suitable for the analysis of integration in the market for a single product. Thus, the gains will be estimated in a partial equilibrium framework, using a modified version of the well-known Haberger's triangles, which allows prices differential not to disappear completely [48]. The welfare effect of price convergence (divergence) is equal to

$$DWG/GNP = \Delta P/P_0 * \mid \alpha - \beta \mid + 0.5 * (\Delta P/ P_0)^2 * [\eta * \alpha + \varepsilon * \beta] \quad 18)$$

Where α and β are the ratios of consumption and production to GNP at time zero, η and ε the demand and supply elasticities. It is assumed that the market was "semi-strongly" efficient, so that the European average price captured the effects of supply and demand on prices. It is thus possible to single out the effects of integration by using the changes in the differential relative to the European average (μ^0_W) as a measure of price change

$$\Delta P/P_0 = (|p^t_i - \mu^t_W| - |p^0_i - \mu^0_W|)/ p^0_i \quad 19)$$

The baseline case uses the all-market average for $\Delta P/P_0$, and it assumes η and ε to be 0.3 and both consumption and production to account for 25% of GDP each at time zero – i.e. no trade. The formula is computed separately for the changes to 1808-1812, the five-year period of highest dispersion, and hence to 1866-1870, as well as for the whole period (Table 10).

Table 10
The welfare effects of integration: a partial equilibrium estimate

[45] It is also worth quoting the work of O'Grada (2005 and 2007) on famines, which entailed a massive loss of welfare. He shows that markets performed quite well and concludes that, contrary to widespread allegations at the time, speculation could not have been the cause of famines.
[46] Wheat exports in the 1880s totalled 82 million dollars (Historical Statistics 1975 series F 1) and GNP about 11.2 billions (Historical Statistics 1975 series U 280).
[47] The British table for 1841 by Horrel et al (1994) is not suitable. England was surely not a typical country and the table lumps together all agricultural products.
[48] See Appendix I for a formal derivation, inspired by Hufbauer-Wada-Warren 2002 pp.77-83.

	Price convergence as share of initial price			Gains/Losses as share of initial GDP		
	1750-54 To 1808-12	1808-12 To 1866-70	1750-54 To 1866-70	1750-54 To 1808-12	1808-12 To 1866-70	1750-54 To 1866-70
i) Baseline	50	-25	-2	-1.9	0.5	0.0
ii) Elastic supply and demand	50	-25	-2	-3.1	0.8	0.0
iii) Not self-sufficient	50	-25	-2	-4.2	1.7	0.1
iv) Top ten changes	90	-50	-30	-6.1	1.9	0.7
v) Cumulative	90	-50	-30	-13.6	5.3	2.5

Sources: see text

Losses from disintegration and gains from integration are sizeable but not huge and above all they would almost entirely cancel each other out in the long run. Admittedly, these assumptions are quite conservative. Indeed, the size of gains and losses would be greater if demand and supply elasticities were both 0.5 (row ii) or trade featured a deficit or surplus equivalent to 5% of consumption or production (row iii). Yet, the differences with the baseline estimate are not so large and long-run gains remain stubbornly low. The reason is evident from column 3. In the long-run, differentials relative to the European average price remained almost constant, although accounting for a falling proportion of prices [49]. A look at the distribution shows substantial differences among markets, with a majority of negative cases (a decline in absolute price differentials) but also some positive ones (i.e. increasing differentials). This implies substantial differences in welfare effect among areas. To highlight this point, row iv) selects the top 10 quartile of the distribution by size of the change in price differentials. The effects are greater, and they are even larger if one assumes some trade and elastic demand and supply (row v).

These results are clearly only tentative. Partial equilibrium analyses yield only lower bounds of the impact of integration, as they omit the general equilibrium effects. One should add gains and losses from movements in the market for other gods. Last but not least, the whole analysis neglects the dynamic effects of integration, which are notoriously difficult to measure.

9) Conclusions

One can sum up the historical results in five main points

[49] The average difference with the European mean jumped from 2.6 shilling/q.le in 1750-1754 (22% of market price) to 9.4 (36% of the price) in 1808-1812 to fall back to 2.4 in 1868-1870. But by then, it accounted for only 10.5% of the price.

i) In the long run the wheat (and rye) market featured a massive process of integration, down to an all-time low in the late 1860s
ii) Price dispersion remained roughly constant in the second half of the 18th century and increased sharply in the early 1790s. The pre-war level of dispersion was attained again in the 1830s, and the σ-convergence in the next three decades was an additional one
iii) Both domestic and international markets contributed roughly to the same extent to changes in total dispersion in the long run, but the contribution of the latter was decidedly larger in the medium run.
iv) Most changes seem to have been driven by political events. The outbreak of the French wars caused a sharp increase in dispersion, which was perpetuated for a while by a short-lived protectionist backlash. The liberalization of the 1830s was instrumental to foster the integration. The fall in freights contributed substantially to this latter, while railways might have helped only at the very end of the period
v) The welfare gains (losses) were substantial whenever and wherever price convergence (divergence) was sizeable.

This analysis suggests two key items for a further research. First, it is absolutely necessary to extend the range of commodities, especially for maufactures. The case of candles shows how fruitful, but also difficult this task would be. Second some work on welfare effects is badly needed to buttress the claims about the key role of market integration for modern economic growth. The exercise of the last Section is a starting point, but it will be necessary to improve it, with some imaginative efforts to overcome the shortage of hard data. The rewards from further research can be substantial: in the history of market integration there is much more than the 1870-1913 globalization followed by a backlash

Data Appendix
Sources and methods

1) Introduction

This Appendix lists the sources of price series and illustrates the methods to convert the data, often reported in local currencies, silver or gold for local weight units, into shilling per metric units (quintals for cereals and kilograms for candles) and to build market price series.

In principle, series refer to the calendar year. Some sources report only one figure per year with no information on how they are obtained. In these cases, prices are used as they are, on the assumption they refer to annual prices. If the source states explicitly that the figure refer to crop year, data are converted into calendar years as a weighted average of two consecutive years. The weights are the number of months of each calendar year divided by 12. For instance, if the crop year spans the period from July to June next year, the calendar year is the simple average of the two years. If the crop year started in October, the weights are 0.25 and 0.75. If the source reports monthly or weekly data, the yearly figure is obtained as simple averages. A small number of series is computed as an average of fewer observations, down to a minimum of four (i.e. every three months). Series based on one or two only observations per year are omitted.

Almost all information about local weights is available from the sources, with the exception of the capacity of the quarter. One imperial quarter of eight bushels (of 0.3637 cubic meters) is assumed to be equivalent to 2.9096 hl and one Winchester quarter to be 97% of the imperial quarter (i.e. 2.82 hl). The overwhelimg majority of sources on cereals reports capacity measures, which are converted into (metric) weights assuming assuming one hectoliter to equal 0.75 quintals for wheat and to 0.715 quintals for rye. The use of a common coefficient might be contested, as notoriously the specific weight of wheat and rye differed among markets and across time for the same market. But it seems likely that these differences were taken into account by traders while setting prices as ultimately the commercial worth of wheat depended on the amount of flour which could be extracted. Part of the price rise in 1816-1817 reflected the very low weight of wheat (Post 1977 p.41).

The next Section deals with the sources of prices of precious metals and exchange rates. The next four sections list the available series for wheat, rye, wax and tallow candles, arranged by “country” and market, reporting for each of them the essential information about the coverage, the sources and the methods of elaboration of then[50]. Finally, Section Seven lists the markets which each sample consists of.

2) Silver prices and exchange rates

[50] The coverage reports the initial and final year of each series and, between brackets, missing years. The information on sources and methods is complete for the sources which have been used, while discarded series are simply quoted in footnotes without much detail.

As it is well known, the Committee for Price History in the 1930s (Cole and Crandall, 1964), with very few exceptions, chose silver as the monetary standard for its work. This decision established a tradition, which is still respected by some authors (e.g. Gerhard-Kaufhold 1990). On the other hand, many recent work report data in local currencies. Thus, some prices must be converted into sterling from silver or gold, others from a number of local currencies.

3.1 The conversion of gold and silver into sterling is based on the actual price of the metal, which differed slightly from the official parity. The series of gold content for pound, 1750 to 1914, has been provided by M.Dincecco. The price of silver has been obtained from Mc Cusker (1978 tab 5.1) for the period 1750-1775. Data for later years are available from two different sources, Schneider et al (1991 I, 1 pp.286-290), which covers the period from 1777 to 1910, and Jastram (1981), for 1800-1977. The two series are very close: the coefficient of correlation among unadjusted data is 0.992. The final price is taken from Schneider et. al whenever possible, while the data from Jastram have been used to fill the (few) gaps, by computing

$P_F=\pi_{Sc}*P_J/\pi_J$

Where P is the price i year t, π is the interpolated price and subscripts Sc and J refer to Schneider et al and Jastram respectively.

3.2 Whenever possible, prices in local currencies have been converted into pound sterling with actual exchange rates. Whenever it has not been possible to find suitable exchange rates, currencies have been first converted into silver (or gold) and then into sterling. Sources for the conversion are as follows

Austria-Hungary. Data in Konvention Kreuzer (1750-1819), in Wiener kreuzer (1820-1858) and in Empire kreuzer (1859-1870) are converted in silver with data from Pribram (1938 pp.71-84).

Belgium The silver content of the patard and gros is obtained from Verlinden (1959-1973 vol I p.16). Some sources report prices in Belgian Francs even before 1830, when technically this currency did not exist. These data have been converted into silver at the official post-1830 parity (4.5 grams of silver per Belgian France). Afterwards, the exchange rate of Belgian Franc is assumed equal to that for the French Franc

Finland Exchange rate of the Finnish Markka for 1861-1870 has been obtained as a cross rate (Markka/$ and $/£) from Globalfinancialdata (www.globalfinancialdata.com, accessed on February 15, 2007). For earlier years, the data is assumed to have been constant at the 1860 parity.

France Prices in livre tournois (until 1795) and French Francs (1796-1870) are converted into sterling with the series of two months' exchange rates from www.globalfinancialdata.com (accessed in March 2007).

Germany

All prices have been converted first in silver and then into pound sterling. Most sources, notably Gerhard-Kaufhold (1990), provide information on the silver content of local currencies. The silver content of the Reichsmark (5.556 grams) and the so called Konvention gulden (11.7 grams) have been kindly provided by Mark Spoerer and are assumed constant over the period.

Ireland

The Irish pound differed until 1825 from the British sterling. The rate of exchange for 1750-1766 are from McCusker (1978), while that for 1767-1825 has been kindly provided by Peter Solar

Italy

The Neapolitan ducato (100 grani) has been converted into pound with exchange rate ducato/pound from Schneider et al 1991 for the period 1796-1862. The exchange rate has been assumed constant from 1750 to 1795.

The Tuscan lira has been converted into Silver with the official parity before 1777 and since then into pound sterling with the exchange rate lira/pound sterling from Schneider et al 1991. After 1861, Tuscan lire are converted into Italian ones with coefficient 1 Tuscan lire=0.84 Italian lira (Giusti 1957)

The Milanese lira has been converted into gold with data from De Maddalena (1974 table 43).

Several sources quote prices in "Italian" lire for pre-Unification years. The currency did not exist before 1861: the prices have been obtained by converting the local currencies into lire at the parity set at the time of Unification. The figures do not take into account the fluctuations in prices of silver before the Unification. These fluctuations can be measured by the exchange rate of pre-Unification currencies with a silver-denominated currency such as the Austrian florin (gulden). Prices for the t-year are thus computed as

$P^t_{adj} = P^t * (Ef^t/Ef^{1861})$

Where P is the original price, Ef is the exchange rate to the Austrian lira on the Milan market from Giusti (1957) for the period 1825-1859. The 1825 adjustment coefficient is then extrapolated backwards to 1814 with an index of exchange rate of pre-Unitary currencies to pound sterling (Schneider et al 1991) – i.e.

$P^t_{adj} = P_{adj}^{1825} * (S^t/S^{1825}) * (Ex^t/Ex^{1825})$

Where S^t is the price of sterling in silver and Ex is the exchange rate of local currencies in sterling[51]. The series so obtained in lire 1861 are finally converted back into sterling at the 1861 parity (1 £=25.33 lire).

The exchange rate for the lira after 1861 is obtained from Ciocca and Ulizzi 1990 tab 1.

Netherlands

The series of the exchange rate of the gulden to pound is taken from Mc Cusker 1978 tab. 5.1 for the period 1750-1775 and from www.globalfinancialdata.com (accessed on February 15, 2007) for the period since 1776. The figures refer to the so called banko gulden, which, in normal years, was traded at an agio over the current gulden (Mc Cusker 1978). The exchange rate is correspondingly adjusted with the series of the agio from Mc Cusker 1978 and Posthumus 1943 annex I.

Norway

The exchange rate of kroner into sterling has been taken from www.globalfinancialdata.com (accessed on February 15, 2007).

Portugal

[51] Using Genoa for Turin, Leghorn for Florence, Naples for Sicilian markets before 1817

The silver content of the reis, from 1750 to 1850 is obtained from (http://gpih.ucdavis.edu/files/Portugal_1750-1855.xls). The series is then extrapolated to 1870 with the rate of exchange of milreis into pound in Lisbon from Schneider et al (1991)

Spain

Data on the silver content of currencies are taken from Hamilton (1947) for the Castellan real and maravedì from and from Feliu (1991) for the Catalan sous. The data in "pesetas" (a currency which was actually established only in 1868) are converted into pounds with a series of exchange rate obtained by linking data provided by L.Prados for the period 1784-1820 and the series for 1821-1870 from Carreras and Tafunell (2005 tav 9.19). The series is then extrapolated backwards to 1750 with the index from Globalfinancialdata (www.globalfinancialdata.com, accessed on February 15, 2007)

Sweden

The prices in daler (1750-1775), riksdaler (1776-1802) and Kronor (1803-1870) have been converted in grams of silver with the series of silver prices from Jorberg 1972 pp. 578-580

Switzerland

All prices in Francs have been converted into sterling with the silver content of Franc (4.5 grams)

3) Sources: Wheat

3.1 Austria-Hungary

Budapest [1801-1871] All data from Board of trade (1904) in shillings/quarter[52]

Fiume [1788-1826] All data from Consular report (1826) in shilling/imperial quarter

Ljubljana [1758-1870 (missing 1772-1774)] All data from Valencic (1977) in "Krajcarjih" for "mernik" (1758-1784) e "goldinar" for "vagan" (1785-1870), converted into shilling/q.le with information provided by the author

Lwow [1750-1870 (missing 1752-1760, 1762, 1767-1768, 1771-1772, 1784-1785, 1787-1797, 1799)]. All data from Hoszowski (1934 pp.8 and p.98) in gram silver per Korzec (1.25 hl).

Krakow [1750-1870 (missing 1754-1757,1760-1761, 1764,1771)]. Data 1750-1795 from Tomaszewksi (1934) in gram silver/hl and 1796-1914 from Gorkiewicz (1950 pp.238-239) in grams gold/hl

Prague [1750-1872 (missing 1770-1771)] All data from Schebek (1873) – in kreuzer for Metzen (0.615 hl)

Rattenberg [1750-1861 (missing 1757, 1759, 1763-1764)] All data from Schmelzer (1972) in grams silver/hl

St Polten [1750-1784]. All data from Pribram (1938) – in kreuzer for Metzen (0.615 hl).

Trieste [1800-1823] All data from Consular report (1826) in shilling/quarter

[52] Other series (1819-1870) Foldes 1905

Weyer [1750-1784 (missing 1759)] All data from Pribram (1938) – in kreuzer for Metzen (0.615 hl)
Wien [1750-1870] All data from Pribram (1938) – in kreuzer for Metzen (0.615 hl)[53]

3.2 Belgium

Antwerp [1765-1850]. Data for 1765-1772 from Vandenbroeke (1973) – in patards/rasiere (0.486 hl), for 1773-1807 from Craeybeckx (1959b pp.509-512) – in patards/viertel (0.771 hl), and for 1808-1850 from Scholliers (1965 p. 942) in Dutch gulden/hl[54]. Prices in 1794 are obtained by interpolating the series with the data from Consular Report (1826).
Brussels [1750-1870 (missing 1794-1799)]. Data for 1750-1793 from Craeybeckx (1959 a pp. 494-495) and Craeybeckx (1965 pp.1300-1302) both in patards/setier (0.486 hl) and
and for 1800-1870 from Vandenbroeke (1973) in patards/rasiere (0.487 hl). The figures for 1752-1761 have been obtained by interpolating the market series with prices for setting yearly rents (calendar year series obtained as simple average of two crop year prices) from Craeybeckx (1959b).
Brugges [1750-1870 (missing 1793-1795)] Data 1765-1792 from Vandenbroeke (1973) – in patards/rasiere (0.486 hl) and for 1800-1870 Vanderpijpen (1973) – data in Francs/q.le for “white wheat”. Then the resulting series is extrapolated backwards to 1750 with a series of prices in silver/hl from Korthals Altes (1996)
Eeklo [1750-1792] All data from Coppejans-Desmedt (1965) in gros of Flanders per sack (1.083 hl).
Dienst [1756-1816 (missing 1760-1765)] All data from van Buyten (1966) in Brabant florins per halster (0.303 hl.), converted into silver/hl with information about the silver content from the author.
Ghent [1765-1870 (missing 1785, 1787, 1790, 1793-1799)] Data for 1765-1792 from Vandenbroeke (1973) – in patards/rasiere (0.486 hl) and for 1800-1870 from Vandenbroeke and Vanderpijpen (1972) – in Francs per quintals.
Louvain [1750-1825] All data from Consular report (1826) – data in Shilling/quarter [55]
Luik [1750-1870 (missing 1794)] All data from Pyens-Tijims (1993) - 1750-1792 data in Luik guldens/setier (0.312 hl.) converted into silver/hl with information about the silver content from the author; 1795-1870 data in Belgian Francs/hl.
Luxembourg [1750-1792] All data from Helin (1966) – data in Luxemburg setier (0.204 hl). Unfortunately the author provides little and confused information about the currency. The data are converted into silver/hl under the assumption that the prices are expressed in Brabant patards
Namur [1750-1840] Data for 1750-1773 from Ledrier (1966) – series for “effraction” prices for crop year in setier of Namur (0.302 hl)- and for 1774-1840 from Genicot (1940) – data in patards/setier of Namur (0.302 hl) for crop year.

[53] Other series (1801-1870) Foldes 1905
[54] Other series (1780-1825) Consular Reports (1826)
[55] Other series (1765-1793) from Vandenbreoeke (1973).

Ledrier does not state clearly his weight and currency, but the two series are very close in 1774-1800, when they overlap. It is thus assumed that they are expressed in the same currency.
Ruremonde [1750-1795] All data from Ruwet (1966) - data in Ruremonde Florins per malder (1.724 hl), converted into silver/hl with information about the silver content from the author.

3.3 Denmark

Copenhagen [1750-1870 (missing 1810-1818)] 1750-1800 data from Friis-Glamann (1958) for Holstein wheat in grams of silver/hl; 1801-1870 data from Board of trade (1904) in shillings/quarter

3.4 Finland

Helsinki [1801-1870] All data from Foldes (1905) in Markka for tynnyry (1.64 hl)

3.5 France

French wheat prices are exceptionally abundant (Labrousse 1933). Since 1667, the local authorities were compelled to register prices and compile “mercuriales”, which were then collected in regional and national averages. Labrousse, Romano and Dreyfus (1970) have published averages by “departments” from 1797 to 1870 [56]. These series extended to the period since 1750 with series from a variety of sources.
Ain [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Aisne [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Allier [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Alpes Maritimes [1800-1870 (missing 1813-1860] average for the department from Labrousse et al (1970) in Francs/hectoliter
Ardéche [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

[56] One has to mention two other collection of data from “mercuriales”, by Labrousse (1933 pp. 106-113) and Drame et al (1991). The former reports prices in livre per Paris setier (1.56 hl) for 32 “generalites” from 1757 to ??. These data have not been used because the “generalité” were fairly large territorial units, and thus prices are not really comparable with other series in the data-base. Drame et al covers 53 markets from 1825 to 1913 (Albertville, Albi, Angers, Annecy, Angouleme, Arras, Avignon, Auxerre, Bayeux, Bar-le-Duc, Beaugency Bernay, Blois, Bourges, Bourdeaux, Carcassonne, Chalons sur Marne, Charleville, Chateauroux, Chartres, Chateaudun, Cherbourg, Clermont, Evreux, Dieppe, Digne, Douai, Laval, Le Mans, Le Puy, Lille, Louviers, Luneville, Lyon, Macon, Marans, Marmande, Marseille, Mende, Montauban, Montbrison, Nantes, Pau, Peyrehorade, Pont-l’Abbe, Rouen, Saint-Breuc, Saint-Lo, Soissons, Toulouse, Tulle, Vannes, Vitre). These prices coincide almost perfectly with figures from Labrousse et al 1970.

Ardennes [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

Ariége [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

Aube [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

Aude [1750-1870 (missing 1790-1796)]: Data 1750-1790 average of prices for Narbonne (1751-1781) from Géraud-Parracha (1956) in livre tournois /setier (0.706 hl), Castelnaudary (1750-1778) in livre tournois /setier (0.603 hl) and Carcassonne (1750-1792) – data in livre tournois /setier (0.865 hl) -from Freche (1967b); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter

Aveyron [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

Bas Rhin [1750-1870 (missing 1794-1796)] Data for 1750-1793 for Strasbourg from Hanauer 1878 in Francs/q.le [57]; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter

Basses Alpes [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

Basses Pyrenées (now Pyrenees Atlantiques) [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

Bouche du Rhone [1750-1870 (missing 1790-1796)]: Data 1750-1790 average of prices for Arles (1750-1790) – data in livre/setier (0.578 hl) and Aix (1750-1790) – data in livre tournois/charge (1.632 hl) from Baerhel (1961) [58]; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter

Calvados [1750-1870 (missing 1790-1796)]: 1750-1792 average of price for Bayeux (1750-1790) from Hauser (1936) in livre/bousseau (0.292 hl) and for Caen (1750-1792) from Perrot 1975 in livre/bousseau (0.195 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter

Cantal [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

Charente [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

Charente-Inférieure [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

Cher [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

Corrèze [1750-1870 (missing 1793-1796)] Data 1750-1792 average of prices for Tulle (1750-1792) from Boutier (1976) in livre tournoise/hectoliter and for Puy (1750-1792) from Freche (sd) – in livre/carton (0.208 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter

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[57] The data from Hanauer (1878) for Colmar (1820-1875) and Mulhouse (1798-1875) have not been used as they overlap with the Labrousse et al (1870) series for the whole Department. The French Franc has been converted into shilling at silver parity of the franc (4.5 grams), under the assumption that Hanauer had used its silver parity

[58] The series for Marseille is discarded as it covers only the years 1750-59, 1776-78 and 1786-89 is full of gaps and it refers to imported wheat

Corse [1800-1870 (missing 1802-1804)] average for the department from Labrousse et al (1970) in Francs/hectoliter
Cote-d'Or [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Cotes-du-Nord (nowadays Cote-d'Armor) [1750-1870 (missing 1795-1796)] Data 1750-1794 for Saint-Brieuc from Meyer (1966) – in livre/boisseau, which is assumed to be equivalent to 0.30 hl on the basis of a comparison with prices from Labrousse series for the overlapping years; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Creuse [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Deux Sèvres [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Dordogne [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Doubs [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Drome [1750-1870] Data 1750-1793 average of prices for Buis les Baronnies (1750-1793) in livre/emine (0.228 hl) and Romans (1750-1793) in livre/setier (0.840 hl), from Hauser (1936); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Eure [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Eure-et-Loir [1750-1870 (missing 1796)] Data for 1750-1796 average of prices for Chartres (1750-1789) from Aclocque (1910) and for Magny (1750-1790) from Dupaquier et al (1968), both in livre tournoises/setier (1.56 hl) and for Chateaudun (1750-1868), from de Belfort (1863-1869) in livre tournoises/hl [59]; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Finistere [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Gard [1750-1870 (missing 1751, 1764, 1794-1796)] Data for 1750-1794 for Pont-Saint-Esprit from Géraud-Parracha (1956) in livre tournoises/salme (1.99 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Gers [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Gironde [1750-1870] Data 1780-1796 for Bordeaux from Consular Report (1826) - in shilling per imperial quarter; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Haut Rhine [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Hautes Alpes [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

[59] The series for Chateaudun is assumed to be in livre/hl on the basis of a comparison of levels with other series

Haute Garonne [1750-1870 (missing 1793-1796)] Data for 1750-1793 average of prices for Toulouse (1750-1792) from Freche (1967a) in Francs/q.le and Grenade (1750-1793) from Freche (1969) in livre tournoises /setier (1.02 hl) and Revel (1750-1773) from Freche (1967a) –in livre tournoise/setier (0.932 hl);1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Haute Loire [1750-1870 (missing 1791-1796)] Data for 1750-1790 for Brioude from Freche (sd) in livre tournoise/carton (0.218 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Haute Marne [1750-1870 (missing 1793-1796)] Data for 1750-1794 for Langres from Daguin (1894) in Francs/hl[60]; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Hautes Pyrenées [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Haute Saône [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Haute Savoie [1801-1870 (missing 1814-1859)] average for the department from Labrousse et al (1970) in Francs/hectoliter
Haute Vienne [1750-1870 (missing 1793-1796)] Data 1750-1792 for Limoges from Duffaud (1861) in livre tournoise/setier (0.512 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Herault [1750-1870 (missing 1793-1796)] Data for 1750-1793 average of prices for Beziers (1750-1792) in livre tournoises/ setier (0.656 hl) and Montpellier (1750-1770) in livre tournoises/ setier (0.489 hl)-, both from Géraud-Parracha (1956); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Ile et Vilaine [1750-1870 (missing 1775-1776, 1782, 1787-1796)] Data for 1750-1786 for Rennes from Hauser (1936) in livre tournoise/mine (2.00 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Indre [1750-1870 (missing 1782-1796)] Data for 1750-1781 for Fontenay from Dehergne (1963) in livre tournoise/boisseau (0.341 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Indre et Loire [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Isere [1750-1870 (missing 1786-1796)] Data for 1750-1781 for Grenoble from Hauser (1936) in livre tournoise/quartal (0.183 hl) [61]; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Jura [1750-1870 (missing 1790-1796)] Data for 1750-1789 for Dole from Lefebvre-Teillard (1969) in livre tournoise/setier (1.56 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Landes [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

[60] The Franc has been converted at its silver parity (cf. footnote?)
[61] Hauser provides two series for Grenoble, from the Enquete de consuls and from the Archives departamentales. Here used the former as five years longer in the relevant period and somewhat better correlated to other Dauphine series (coefficient of correlation 0.835).

Loir et Cher [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Loire [1797-1870 (missing 1794-1796)] Data for 1750- 1790 for Saint-Etienne – in livre/boisseau (0.197) from Gras (1906); average for the department from Labrousse et al (1970) in Francs/hectoliter
Loire Inférieure (now Loire Atlantique)_ [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Loiret [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Lot [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Lot-et-Garonne [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Lozère [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Maine et Loire [1750-1870 (missing 1790-1796)] Data for 1750-1789 for Angers from Hauser (1936) in livre tournoise/boisseau (0.17 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Manche [1750-1870 (missing 1779-1796)] Data for 1750-1778 for Coutances from Hauser (1936) in livre tournoise/boisseau (0.328 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Marne [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Mayenne [1750-1870 (missing 1794-1796)] Data for 1750-1793 for Chateau-Gontier (1750-1793) from Hauser (1936) in livre tournoise/boisseau (0.385 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Meurthe [1801-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Meuse [1801-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Morbihan [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Moselle [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Nièvre [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Nord [1750-1870 (missing 1792-1796)] Data for 1750-1791 average of prices for Lille (1750-1790) from Levèfre (1925) in livre tournoise/rasiere (0.701 hl) and Douai (1750-1791) from Mestayer (1965) in patard/rasiere (0.8425 hl), for crop years [62]; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter

[62] This series has been preferred to an earlier version of the Douai series by the same author (Mestayer 1963) as this latter would imply a too low level of prices. This choice is buttressed by a comparison with the series by Usher (1931 tab 6).

Oise [1750-1870 (missing 1792-1796)] Data for 1750-1791 for Chamount-en-Vexinfrom Dupaquier et al (1968) in livre tournoise/setier (1.56 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Orne [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Pas de Calais [1750-1870 (missing 1793-1796)] Data for 1750-1796 for Boulogne-sur-Mer from Consular Reports (1826) – data in livres/setier (1.6887 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Puy-de-Dome [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Pyrenées Orientales [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Rhône [1750-1870 (missing 1779-1796)] Data for Lyon for 1750-1778 from Rambaud (1911) in livre/bichet (0.343 hl) ; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Saône et Loire [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Sarthe [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Savoie [1801-1870 (missing 1814-1859)] average for the department from Labrousse et al (1970) in Francs/hectoliter
Seine [1750-1870 (missing 1789-1796)] Data for 1750-1788 for Paris from Baulant (1968) in livre tournoises/r setier (1.56 hl)[63]; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Seine et Marne [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Seine et Oise [1750-1870 (missing 1793-1796)] Data for 1750-1792 average of prices for Gonesse (1750-1790) – in livre tournoise/setier (1.56 hl) Meulan (1750-1792) – in livre/setier (1.473 hl) and Pontoise (1750-1790) in livre tournoise/setier (1.56 hl)- all from Dupaquier et al 1968 in livre tournoise tournoise/hectoliter; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Seine Inférieure (now Seine Maritime) [1750-1870 (missing 1791-1796)] Data for 1750-1790 average of prices for Eu (1767-1781), Cany (1777-1790), Havre (1760-1786) and Rouen (1750-1790) all from (Vovelle 1989) in livre tournoise/hectoliter; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Somme [1750-1870 (missing 1794-1796)]: Data for 1750-1796 for Abbeville (1750-1801) from Pannier (1865) in livre tournoise/setier (1.333 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Tarn [1750-1870 (missing 1794-1796)] Data for 1750-1793 average of prices for Albi (1750-1793) – in livre/setier (1.21 hl) and Lavaur (1750-1793) –in livre/setier (1.18 hl), both from Freche (1967a) and for Castres (1751-1789) in livre/setier

[63] Other series from Hauser (1936)

(1.56 hl to 1764 and 1.07 afterwards) from Freche (1967a and 1969); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Tarn et Garonne [1750-1870 (missing 1790-1797)] Data for 1750-1789 for Montauban in livre/setier (1.561 hl) from (Freche-Freche 1967??) – in livre tournoise/hectoliter; 1809-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Var [1750-1870 (missing 1791-1796)] Data for 1750-1790 for Draguignan from Baerhel (1961) - in livre tournoise/charge (1.68 hl); 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Vaucluse [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Vendée [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Vienne [1750-1870 (missing 1796)] Data for 1750-1796 for Poitiers from Raveau (1931) in Francs/hectoliters; 1797-1870 average for the department from Labrousse et al (1970) in Francs/hectoliter
Vosges [1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter
Yonne 1797-1870] average for the department from Labrousse et al (1970) in Francs/hectoliter

3.6 Germany

Aachen [1816-1860] All data from Engel (1861 p.257) prices in taler per scheffel converted into silver per quintal according to the silver content of the thaler (16.667 grams) and the weight of the Prussian scheffel (1.93 hl.)
Augsburg [1750-1855 (missing 1783, 1811)] Data for 1750-1820 from Elsas (1936-40) – prices in gulden per scheffel (2.05 hl) converted into gram of silver per hectoliter with coefficients provided by the author; 1821-1855 data from Seuffert (1857), in gulden per Bavarian scheffel, converted into silver/hl with the silver content of the gulden and weight of the scheffel (2.225 hl.) from Elsas (1936).
Bamberg [1815-1855] All data from Seuffert (1857) in gulden per Bavarian scheffel converted into silver/hl as for Augsburg
Bayreuth [1815-1855] All data from Seuffert (1857) in gulden per Bavarian scheffel converted into silver/hl as for Augsburg
Berlin [1750-1870 (missing 1762-1765)] Data for 1750-1791 from Getreidepreise (1935a) and for 1792-1870 from Getreidepreise (1935b) in "Marks" per ton converted, into silver assuming a content of 5.556 grams
Bremen [1750-1850] All data from Gerhard Kaufhold (1990) in Reichstaler per Bremen last (2.96 hl) , converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content) [64]

[64] The authors report two different figures for yearly average, labelled D (data taken from the source) and R (computed by the authors with the data from the source). Here used the former. Alternative series Consular Report (1826).

Breslau [1816-1860] All data from Engel (1861 p.257) in taler per scheffel converted into silver per hectoliter as for Aachen
Brunswick [1750-1856] All data from Gerhard Kaufhold (1990) in Reichstaler per Brunswick Scheffel (3.11 hl) converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content). Then the series is extrapolated to 1856 with data from Soetbeer (1858)
Celle [1750-1870 (missing 1767-1771)]. All data from Gerhard Kaufhold (1990) in Mariengroschen and (after 1818) Gutengroschen per Hannover himtel (0.31 hl), converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content)[65]
Danzig [1750-1860 (missing 1804)] Data for 1750-1815 for Furtak (1935) in grams of silver per last (1860 kg.); for 1816-1860 from Engel (1861) in taler per scheffel converted into silver per hectoliter as for Aachen
Detmold [1750-1850] All data from Gerhard Kaufhold (1990) in Reichstaler per Lippische scheffel (0.443 hl), converted into silver/hl with converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content)
Dresden [1750-1854] Data for 1750-1819 Consular reports (1825) in shilling per Dresden scheffel (1.06 liters) [66]; 1820-1854 data in silver/hl kindly provided by Spoerer
Duderstadt [1750-1850] All data from Gerhard Kaufhold (1990) in Reichstaler per malter (1.804 hl), converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content)
Emdem [1750-1850 (missing 1758-1770, 1807-1813)]. All data from Gerhard Kaufhold (1990) in Gemeneir taler and (after 1838) Reichstaler per last (2.838 hl), converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content)
Erbing [1815-1855] All data data from Seuffert (1857) in gulden per Bavarian scheffel converted into silver/hl as for Augsburg
Frankfurt Am Main [1750-1820] All data for Elsas (1936-40) in pfenning per malter (1.078 hl) converted into silver/hl with silver content of the pfenning from the same author
Gottingen [1750-1867] All data from Gerhard Kaufhold (1990) in Reichstaler per malter (1.87 hl), converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content) [67]
Hamburg [1750-1870] Data for 1792-1870 Getreidepreise (1935b) in Marks/ton. The series is extrapolated backwards to 1750 with the series from Consular Reports (1825) [68]

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[65] For the period 1835-1845 the source reports two set of data – called S prices (averages from selected actual data) and M prices ("Martini" – or early November). The former are used.
[66] Data from Ricard ? This coefficient is consistent with the ratio 1 scheffel=3.05 Winchester bushels suggested by Consular reports (1825)
[67] Gerhard-Kaufhold provided two data for the years 1750-1766. We have used the upper row as it seemed closer to other series in the same years for nearby markets
[68] These series have been preferred to Gerhard-Kaufhold (1990) as this latter feature some gaps. The coefficient of correlation between the two series is 0.981.

Hannover [1750-1856 (missing 1756)] Data for 1750-1795 and 1810-1850 from Gerhard Kaufhold (1990) in Mariengroschen and (after 1818) Gutengroschen per Hannover himtel (0.310 hl), converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content). The missing data for 1796-1809 and 1851-1856 have been interpolated with the series from Soetbeer (1858).
Herford [1771-1850 (missing 1775)] All data from Gerhard Kaufhold (1990) in Reichstaler per Berliner scheffel (0.549 hl), converted into silver/hl with information from the same source (pp. 398-411 for weights hatand 413-417 for silver content)
Hesse [1822-1850] prices in silver/hl kindly provided by Spoerer
Holstein [1757-1825] All data from Consular reports (1826) in shillings/quarter
Kempten [1815-1855] All data from Seuffert (1857) in gulden per Bavarian scheffel converted into silver/hl as for Augsburg. The data refer to "kern", so they are decreased by 4%, as implicit in the ratio wheat/kern in Augsburg (Elsas 1936-40).
Koln [1750-1870 (missing 1788-1789, 1791-1815)] Data for 1750-1796 from Ebeling-Irsigler (1976) in gulden per malter (1.64 hl.) converted into silver/hl with information from the same source; 1816-1870 Getreidepreise (1935b) data in Marks/ton converted into silver/qle as for Berlin.
Konigsberg [1750-1870 (missing 1757-1758, 1764)] Data for 1797-1870 from Getreidepreise (1935b) in Marks/ton converted into silver/qle as for Berlin. The series is extrapolated backwards to 1750 with Consular Reports (1826)
Landshuit [1815-1855] data from Seuffert (1857) in gulden per Bavarian scheffel, converted into silver/hl as for Augsburg
Liepzig [1750-1870] Data for 1750-1820 from Elsas (1936-40) in pfenning per Dresden scheffel (1.366 hl) as an average of the series for two hospitals; 1846-1870 data from Getreidepreise (1935b) in Marks/ton converted into silver/qle as for Berlin. The years 1821-1845 have been interpolated with a series from Dittman (1889).
Lindau [1815-1855] All data from Seuffert (1857) in gulden per Bavarian scheffel, converted into silver/hl as for Augsburg. The prices refer to a mixture of "weizen und kern". With no further information, each cereal is assumed to account for half the total. Thus, the original prices are decreased by 2%, according to the ratio wheat/kern in Augsburg (Elsas 1936-40).
Luneburg [1750-1850 (missing 1756,1762-1763, 1765)] All data from Gerhard Kaufhold (1990) in Mariengroschen and (after 1818) Gutengroschen per Luneburg himtel (0.310 hl), converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content).
Madgeburg [1816-1860] All data from Engel (1861 p.257) in taler per scheffel converted into silver per hectoliter as for Aachen
Mannheim [1791-1870 (missing 1794, 1796, 1798-1805, 1810.1813)] All data from Getreidepreise (1935b) in Marks/ton converted into silver/qle as for Berlin
Mecklemburg [1792-1850] All data for 1792-1825 from Consular Reports (1825) in shilling/quarter. The data are then extrapolated to 1850 with data kindly provided by Spoerer

Memmingen [1815-1855] All data from Seuffert (1857) in gulden per Bavarian scheffel, converted into silver/hl as for Augsburg. Data for "kern" adjusted as for Kempten
Minden [1775-1850] All data from Gerhard Kaufhold (1990) in Reichstaler per Berlin scheffel (0.585 and 0.55 since 1785), converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content)
Munchen [1750-1870] Data for 1750-1790 from Seuffert (1857) in gulden per Bavarian scheffel, converted into silver/hl as for Augsburg [69]; 1791-1870 from Getreidepreise (1935b) in Marks/ton converted into silver/qle as for Berlin
Munster [1750-1863] All data from Gerhard Kaufhold (1990) in Reichstaler per Munster malter (2.79 hl), converted into silver/hl., with information from the same source (pp. 398-411 for weights and 413-417 for silver content). Some missing data have been interpolated with prices from Engel (1861)
Nordlingen [1815-1855] All data from Seuffert (1857) in gulden per Bavarian scheffel converted into silver/hl as for Augsburg. The data are an average for "weizen und kern", adjusted as for Lindau
Nurberg [1815-1855] All data from Seuffert (1857) in gulden per Bavarian scheffel converted into silver/hl as for Augsburg.
Oldenburg [1796-1825] All data from Consular Report (1826) in shilling/quarter
Osnabruck [1750-1861] All data from Gerhard Kaufhold (1990) in Reichstaler per Osnabruck malter (3.44) converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content).
Paderborn [1750-1850] All data from Gerhard Kaufhold (1990) in Reichstaler per Paderborn scheffel (0.41 hl until 1813 and 0.547 afterwards), converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content)
Posen [1816-1860] All data from Engel (1861 p.257) in taler per scheffel converted into silver per hectoliter as for Aachen
Regensburg [1815-1855] All data from Seuffert (1857) in gulden per Bavarian scheffel converted into silver/hl as for Augsburg
Steim am Rhein [1750-1810 (missing 1783,1785)] All data from Gottmann (1991) – in gram silver/hl for "kern", adjusted as for Lindau
Stettin [1816-1860] All data from Engel (1861 p.257) in taler per scheffel, converted into silver per hectoliter as for Aachen
Straubing [1815-1855] All data from Seuffert (1857) in gulden per Bavarian scheffel, converted into silver/hl as for Augsburg
Waake [1750-1850] All data from Gerhard Kaufhold (1990) in Mariengroschen and (after 1818) Gutengroschen per Hannover himtel (0.314 hl), converted into silver/hl with information from the same source (pp. 398-411 for weights and 413-417 for silver content).
Wurzburg [1750-1820] All data from Elsas (1936-40) in denars per malter (172.8 liters), converted into silver/hl with coefficients provided by the author

[69] The data from Seuffert have been preferred to those by Elsas (1936) as they are almost identical to those from Getreidepreise (1935b) when they overlap

3.7 Italy

Acquaviva delle Fonti [1750-1870] All data from Palumbo (1981 tab.1) in Neapolitan ducati/ tomolo (0.6 hl).
Ancona [1750-1825 (missing 1798-1807)] All data from Consular Reports (1826) in shilling/imperial quarters
Arezzo [1750-1870 (missing 1810-1829)] Data for 1750-1809 – in in grams of silver/hl- have been kindly provided by Epstein and for 1830-1870 from Atti Jacini (1881) in “Italian” lire/hl, converted into grams of silver with the official silver parity of the lira in 1861 and then into pound
Bologna [1824-1859 (missing 1844-1846)] All data from Pinchera (1957) in 1861 Italian lire/hectoliter
Brescia [1750-1870] All data from MAIC (1886) in 1861 “Italian” lire/ hectoliter
Catania [1801-1870 (missing 1867-1869)] All data from Petino (1959) in 1861 “Italian” lire/hectoliter
Cagliari [1832-1870] All data from Delogu (1959) in 1861 “Italian” lire/ hectoliter
Ferrara [1786-1870] All data from MAIC (1886) in 1861 “Italian” lire/ hectoliter
Firenze [1750-1870] Data for 1750-1804 from Mauri et al (1970) in Tuscan lire/staio (0.24 hl) and for 1815-1870 from Bandettini (1957) in 1861 “Italian” lire/ hectoliter. The data for 1805-1814 have been interpolated with the series in lire toscane per staio from the same source
Genova [1829-1870 (missing 1793-1828, 1855)] Data for 1750-1792 from Giacchero (1979) in and for 1829-1870 from Felloni (1957a) in 1861 “Italian” lire per hectoliter
Milan [1750-1870] Data for 1750-1860 from De Maddalena (1974) in lire milanesi/moggio (0.146 hl) converted into gold/hl with information from the same source. The series has then been extrapolated to 1870 with the data from De Maddalena (1957).
Mantua [1752-1870]. Data for 1752-1795 from Vivanti (1958 tab 1) in Mantua lire/sacco (1.03 hl) converted into Piemontese lira with coefficient from the same source and then into Italian lira with coefficients from Vivanti 1959 and Prato 1908 p.18; data for 1796-1870 from MAIC (1886) in “Italian” lire per hectoliter
Naples [1750-1870 (missing 1807-1861)] Data for 1750-1806 from Romano (1965) in Neapolitan ducati/tomolo (0.505 hl) and for 1862-1870 MAIC (1886) in Italian lire/hectoliter
Padua [1800-1870] All data from MAIC (1886) in “Italian” lire/hectoliter
Palermo [1750-1870 (missing 1842, 1845-1846, 1848, 1867-1868)] Data for 1750-1801 in grams silver/hl kindly provided by Epstein and for 1802-1870 from (Petino 1959) in “Italian” lire/hectoliter
Parma [1821-1870] All data from Spaggiari (1959) in “Italian” lire/hectoliter
Pesaro [1750-1825] All data from Consular Reports (1826) - in shilling/imperial quarters
Pisa [1750-1850] All data from Malanima (1976) in Tuscan lire/staio (0.24 hl) [70]
Porrona [1790-1870 (missing 1804-1805, 1810, 1816-1817,1819-1821, 1837)] All data from Barsanti-Rombai (1981 pp.169-171) – in Tuscan lire/staio (0.24 hl)

[70] Alternative series in Mauri et al 1970

Portogruaro [1825-1870] All data from MAIC (1886) in “Italian” lire/hectoliter
Rome [1750-1870 (missing 1798-1803, 1810. 1814-1815)] All data from MAIC (1886) in “Italian” lire/hectoliter
Rovigo [1773-1870] All data from MAIC (1886) in “Italian” lire/hectoliter
Sassari [1828-1870] All data from Delogu (1959) in “Italian” lire/hectoliter
Senigallia [1780-1825 (missing 1781-1782)] All data from Consular Reports (1826) in shilling/imperial quarters
Siena [1750-1800 (missing 1766)] All data from Mauri et al (1970) in Tuscan lire/staio (0.24 hl)
Turin [1750-1870 (missing 1794-1814)] Data for 1750-1793 from Prato (1908): data 1750 to 1783 for Turin market in Piedmontese lira, extrapolated to 1793 with the series of purchases for the army. The original figures, in Piedmontese lira/emina (0.23 hl) are converted into grams of silver/q.le with the coefficient from Pugliese (1908 p.18). Data 1815-1870 from Felloni (1957b) in “Italian” lire/hectoliter
Udine [1750-1870] All data from MAIC (1886) in “Italian” lire/hectoliter
Vercelli [1750-1870] All data from Pugliese (1908) in “Italian” lire/ hectoliter

3.8 Netherlands

Amsterdam [1750-1870 (missing 1809-1817, 1823 and 1827)] All data for “Frisian” wheat (series 1) in gulden/last from Posthumus (1943)[71]. Some missing years are interpolated with data for other qualities from the same source or for data for “average” wheat from Consular Reports (1826)
Arnheim [1750-1870] All data from Verrin Stuart (1903) – in gram silver/quintal, downloaded from Unger and Allen website (http://www2.history.ubc.ca/unger/htm_files/wheat.htm, accessed May 12, 2006)[72].
Brabant [1816-1849] All data in gulden/hl from Van Riel’s data base (http://www.iisg.nl/hpw/brabant-market-prices.xls) accessed May 12, 2006
Dordrecht [1750-1870] All data from Priester (1998) in gulden/hl
Groningen [1750-1870 (missing 1802-1803, 1806, 1856-1860, 1867-1869] Data 1750-1855 in gulden per mud (0.91 hl) from Tijims data-base (http://www.rug.nl/let/onderzoek/onderzoekcentra/nahi accessed on May 20, 2006) extrapolated to 1870 with the series from Van Riel (http://www.iisg.nl/hpw/monthly-grain-groningen.xls, accessed May 12, 2006)
Leiden [1750-1800] All data are simple average of purchase prices from three hospitals from Posthumus (1964) –in gulden/bag (0.662 hl) or gulden/last (2.92 hl)
Nijmegen [1750-1870 (missing 1811-1813,1823-1824)] All data from Tijms (1983) in gulden per malder (166.68 liters)

[71] The last weighed 27 muds (i.e. 27 hl) until 1823, and 30 thereafter (Posthumus 1943 p. LV)
[72] This series, from a 1903 statistical collection, has been preferred to those from the Board of Trade (1904) and also to the more recent one by Tijims (1977) as it covers the whole period. The coefficients of correlation with the two other series are 0.966 and 0.898 respectively

Rotterdam [1769-1825] All data from Consular Report (1826) in shilling/quarter
Utrecht [1750-1870] Data for_1760-1814 from Posthumus (1964) prices of "red wheat" in gulden per mud (1.16 hl). They have been interpolated backwards to 1750 with data for St Bartholomew hospital from the same source and then forward to 1870 with the series of wheat prices from Van Zanden (http://www.iisg.nl, accessed May 12, 2006)
Zeeland [1819-1853] All data from Van Riel's data base http://www.iisg.nl/hpw/zeeland-market-prices.xls (accessed May 12, 2006) in gulden/hl

3.9 Norway

Bergen [1830-1870] All data in Kroner/q.le from www.sfu.ca/~djacks/ (accessed 15 September 2006)
Oslo [1786-1870 (missing 1826-1829)] Data for 1786-1825 from Consular Reports (1826) data in shilling/quarter; data for 1830-1913 from www.sfu.ca/~djacks/ (accessed 15 September 2006)

3.10 Portugal

Lisbon [1750-1870] yearly prices in reis/hl from de Coruche (1894)

3.11 Russia

Archangelsk [1802-1825 (missing 1807)] All data from Consular Reports (1826) in shilling/quarter
Odessa. [1815-1870 (missing 1855)] Data for 1815-1831 from Fairlie (1965) in shilling/quarter and for 1843-1870 from Board of trade (1904) in shilling/quarter The Fairle data have been extrapolated for 1814 and 1828-30 with an index from De Hagemeister 1835 (average among four quarters, average of soft and hard grain)[73].
Warsaw [1750-1870 (missing 1751-1754, 1756-1759, 1764-1765, 1767, 1771, 1773, 1775, 1777-1778, 1782-1784)] Data for 1750-1796 from Siegel (1936) and for 1816-1870 from Siegel (1949) – in grams of gold gr per korzec (1.25 hl.). The missing data for 1797-1815 are interpolated according to Jacob (1826)[74]
St Petersburg [1791-1825 (missing 1823-24)] All data from Consular Reports (1826) in shilling/quarter

3.12 Spain

Alcala de Henares [1750-1799 (missing 1757, 1778, 1784-1786, 1796-1797)] All data from Hamilton (1947) in reales/fanega (0.555hl)

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[73] Another series from Harley (1980) in gold dollars/bushel
[74] The Jacob (1826) data are obtained as average of two consecutive crop years. Preferred to substitute orginal Siegel (1936) data for 1797-1800 as Jacob's ones are more plausible –price rising as in all other markets of the Baltic area

Alicante [1790-1849 (missing 1836-1840, 1842-1843)] All data from Consular Reports (1826) in shilling/quarter
Almaden [1750-1827 (missing 1767, 1770. 1776-1778, 1786, 1788-1789, 1792, 1797-1803)] Dobado Gonzalez 1982 in reales/fanega (0.555 hl)
Barcelona [1750-1870 (missing 1809-1812)] Data for 1750-1808 from Feliu (1991) in grams silver/hl and for 1813-1870 from Sardà (1998) - index 1913=100 converted in gram silver/hl according to coefficients provided by Spoerer
Bilboa [1765-1827 (missing 1787-1788)] All data from Consular Reports (1826) in shilling/quarter
Burgos [1800-1870]. Data for 1800-1813 from Martinez Vara (1997) in reales/fanega (0.55 hl) and for 1813-1870 from Barquin Gil (2001) –in "Spanish" pesetas/hl [75]
Cervera [1750-1799] All data from Feliu (1991) in grams silver/hl
Cordoba [1816-1870 (missing 1821-1832, 1836-1837, 1845-1847)] All data from Barquin Gil (2001) –in "Spanish" pesetas/hl [76]
Coruña [1750-1870 (missing 1833)] Data for 1750-1832 from Consular Reports (1826 and 1828-1832) in reales/100 ferrados, converted into shilling/quarter with the coefficients provided by the source; data for 1841 -1870 Barquin Gil (2001) – in "Spanish" pesetas/hl. The series for 1834-1840 are interpolated with data from Consular Reports from Barquin Gil (2001 p. 167)
Fernan-Nunez [1753-1808 (missing 1755, 1761-1766)] All data from Ponsot (1987) in reales/fanega (0.555hl)
Fraga [1822-1858 (missing 1827 and 1850-1856)] All data from Barquin Gil (2001) –in "Spanish" pesetas/hl
Gerona [1750-1870 (missing 1810-1814)] Data 1765-1870 from Barquin Gil (2001) –in "Spanish" pesetas/hl. The series is extrapolated backwards to 1750 with data from Feliu 1991 [77]
Granada [1814-1870] All data from Barquin Gil (2001) –in "Spanish" pesetas/hl [78]

Leon [1800-1870 (missing 18111)] Data 1829-1870 from Barquin Gil (2001) –in "Spanish" pesetas/hl extrapolated backwards to 1800 with the series from Martinez Vara (1997) [79]
Lerida [1814-1846] All data from Barquin Gil (2001) –in "Spanish" pesetas/hl.
Lleida [1750-1863] Data for 1750-1799 from Vicedo Ruis (1983a) and for 1800-1845 from Vicedo Ruis (1983b) – in sous/quartera (0.733 hl). The series is then extrapolated to 1864 with data for Balaguer from Vicedo Ruis (1983b).
Lorca [1829-1870 (missing 1832)] All data from Barquin Gil (2001) –in "Spanish" pesetas/hl.
Madrid [1750-1799 (missing 1757, 1775, 1778, 1784-1786, 1796-97]. All data kindly supplied by Epstein

[75] Other series for 1856-1870 in Sanchez Albornoz (1975) –in "Spanish" pesetas/hl
[76] Other series for 1856-1870 in Sanchez Albornoz (1975) –in "Spanish" pesetas/hl
[77] Other series for 1856-1870 in Sanchez Albornoz (1975) –in "Spanish" pesetas/hl
[78] Other series for 1856-1870 in Sanchez Albornoz (1975) –in "Spanish" pesetas/hl
[79] The coefficient of correlation between the two series when overlapping is 0.96, but the prices by Martinez Vara (1997), in reales/fanega are on average 28% higher than the Barquin Gil (2001) ones. Other series for 1856-1870 in Sanchez Albornoz (1975) –in "Spanish" pesetas/hl

Mallorca [1750-1800] All data from Benassar (1987) – in sous/quartera (0.733 hl)
Merida [1842-1870] All data from Barquin Gil (2001) –in “Spanish” pesetas/hl
Murcia [1750-1870 (missing 1757-1759, 1761-1777, 1781-1788)] data for 1750-1796 from Lopez (1985) – in reales/fanega (0.555hl) and for 1836-1870 Barquin Gil (2001) –in “Spanish” pesetas/hl. [80]
Oviedo [1786-1870 (missing 1810-1811)] Data for 1801-1870 from Barquin Gil (2001) –in “Spanish” pesetas/hl., extrapolated to 1786 and in 1812-1813 with the index from Martineza Vara (1997) [81]
Pamplona [1750-1870 (missing 1810-1813)] Data for 1765-1870 from Barquin Gil (2001) –in “Spanish” pesetas/hl. The data are extrapolated backwards with the series from Cela (1989).
Ribera de Sort [1750-1798] All data from Duran (1958) – in sous/quartera (0.695 hl)
Rioseco [1766-1870] All data from Barquin Gil (2001) in “Spanish” pesetas/hl, except 1810-1813 from Martinez Vara (1997) in reales/fanega (0.555 hl).
Sandoval-Oriente [1750-1808] All data from Sebastian Amarila (1992) in reales/fanega (0.444 hl).
Santander [1800-1870] Data for 1800-1820 and 1835 from Martinez Vara (1997) in reales/fanega (0.555 hl), for 1821-1859 from Barquin Gil (2001) in “Spanish” pesetas/hl extrapolated to 1870 with prices from Sanchez Albornoz (1975)
Segovia [1750-1870] Data for 1750-1800 kindly supplied by Epstein and for 1801-1870 from Barquin Gil (2001) –in “Spanish” pesetas/hl. Prices for 1810-1813 are interpolated with data from Martinez Vara (1997) in reales/fanega [82]
Seu d'Urgell [1753-1793 (missing 1761, 1763, 1769, 1776,1782)] All data from Duran (1958) in sous/quartera (0.691 hl)
Sevilla [1750-1833 (missing 1776-1781, 1787, 1792, 1796-1798, 1812, 1814, 1824-1825)] All data from Hamilton (1947) in real/fanega (0.547 hl)
Tarrega [1750-1808] All data from Garrabou (1970) in sous/quartera (0.691 hl)
Toledo [1750-1870 (missing 1757. 1775, 1778, 1784-1786, 1796-1797, 1800-1836 1850)] Data for 1750-1799 from Hamilton (1947) in real/fanega (0.547 hl); data for 1836-1870 from Barquin Gil (2001) –in “Spanish” pesetas/hl [83]
Tolosa [1821-1870 (missing 1783-1787, 1810-1813)] All data from Barquin Gil (2001) in “Spanish” pesetas/hl
Tudela [1814-1870] All data from Barquin Gil (2001) in “Spanish” pesetas/hl
Valencia [1750-1808] All data from Palop Ramos (1975) in reales/barcilla (0.1675 hl)
Vitoria [1829-1870] All data from Barquin Gil (2001) in “Spanish” pesetas/hl
Zaragoza [1784-1870] All data from Peiro (1987) in “Spanish” pesetas/hl [84]

3.13 Sweden

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[80] Other series for 1856-1870 in Sanchez Albornoz (1975) –in “Spanish” pesetas/hl
[81] Martinez Vara (1997) reports prices in reales for “copin”, but he does not provide a coefficient of conversion. Other series for 1856-1870 in Sanchez Albornoz (1975) –in “Spanish” pesetas/hl
[82] Other series for 1856-1870 in Sanchez Albornoz (1975) –in “Spanish” pesetas/hl
[83] Other series for 1856-1870 in Sanchez Albornoz (1975) –in “Spanish” pesetas/hl
[84] Other series Barquin Gil (2001) for 1785-1859 and Sanchez Albornoz (1975) for 1856-1870 – both in pesetas/hl

Alvsborg [1830-1870] All data from Jorberg (1972) in kronoer/hl
Angelhom [1839-1870] All data from Jorberg (1972) in kronoer/hl for 1803-1870
Blekinge [1849-1870] All data from Jorberg (1972) in kronoer/hl for 1803-1870
Gastrikland [1750-1870] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Goteborg [1853-1870] All data from Jorberg (1972) in kronoer/hl for 1803-1870
Gotland [1840-1870] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Halland [1750-1870] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Halsingland [1750-1870] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Jokoping [1855-1870] All data from Jorberg (1972) in kronoer/hl for 1803-1870
Kalmar [1776-1870] All data from Jorberg (1972) in riksdaler/barrel (1.65hl) for 1776-1802 and kronoer/hl for 1803-1870
Kopparberg [1750-1782] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel for 1776-1802
Kristiansand [1839-1870] All data from Jorberg (1972) in kronoer/hl for 1803-1870
Malmous [1840-1870] All data from Jorberg (1972) in kronoer/hl for 1803-1870
Narke [1750-1870] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Nora, Linde and Karkskoga [1750-1870] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Oland [1750-1870] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Ostergotland [1820-1870] All data from Jorberg (1972) in kronoer/hl for 1803-1870
Simrishamn [1839-1870] All data from Jorberg (1972) in kronoer/hl for 1803-1870
Skaraborg [1750-1870 (missing 1762)] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Sodermaland [1750-1870] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Stockholm [1750-1870 (missing 1755, 1762)] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Uppsala [1750-1870 (missing 1804-1808)] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870
Varmland [1851-1870] All data from Jorberg (1972) in kronoer/hl for 1803-1870
Vastmanland [1750-1870 (missing 1755)] All data from Jorberg (1972) in daler/barrel (1.65hl) for 1750-1775, riksdaler/barrel 1776-1802 and kronoer/hl for 1803-1870

3.14 Switzerland[85]

Appenzell [1750-1810] All data from Gottman sd in Schwabian gulden/hl, converted into silver with data provided from the source. Data for “kern” adjusted by decreasing by 4% as implicit in the data from Elsas (1936)
Argovia [1750-1770] All data from Pfister (1940) in silver/hl Data for “kern” adjusted as for Appenzell
Bern [1799-1862 (missing 1817-1845)] All data from Brugger (1968) – in Swiss Francs/q.le
Geneve [1750-1870 (missing 1792-1819, 1841-1851) Data for 1750-1791 from Wiedmer (1993) in florins/coupe (0.79 hl), converted into silver with data provided from the source. Data for 1820-1870 from Brugger (1968) - prices in Francs/q.le
Konstanz [1775-1795] All data from Gottman sd in Schwabian gulden/hl, converted into silver with data provided from the source. Data for “kern” adjusted as for Appenzell
Lausanne [1750-1870 (missing 1797-1802)] Data for 1750-1796 kindly provided by Epstein; data for 1803-1866 from Brugger (1968) - prices in Francs/q.le
Luzern [1750-1870] All data from Haas-Zumbul (1903) in Francs/viertel (0.346 hl). Data for “kern” adjusted as for Appenzell
St-Gallen [1814-1870] All data from Ritzmann-Blickenstorfer (1996 tab. H1) - prices in Francs/q.le
Schaffausen [1750-1799] All data from Gottman sd in Schwabian gulden/hl, converted into silver with data provided from the source. Data for “kern” adjusted as for Appenzell
Ueberlingen [1750-1799] All data from Gottman sd in Schwabian gulden/hl, converted into silver with data provided from the source. Data for “kern” adjusted as for Appenzell
Zurich [1750-1870] All data from Mueller (1877) in French Francs/quintal. Data for “kern” adjusted as for Appenzell

3.15 United Kingdom

Belfast [1785-1870] All data kindly provided by Solar in shilling/Hundredweight (0.38 hl)
Cambridge [1750-1870 (missing 1866)] Data for 1750-1800 kindly provided by Epstein (from Beveridge papers in the LSE Archives), adjusted from crop (Oct-Sept) to calendar year; data for 1800-1870 in shilling/quarter kindly provided by Jacks [86]

[85] Ritzmann-Blickenstorfer (1996 tab. H1) publish a Country average in Francs/q.le for the period 1783-1870
[86] These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals

Carmarthen [1800-1870 (missing 1866)] All data in shilling/quarter kindly provided by Jacks [87]
Dover [1800-1870 (missing 1866)] All data in shilling/quarter kindly provided by Jacks [88]
Dublin [1815-1870 (missing 1822-1823, 1842-1848)] Data for 1815-1841 In Irish pounds per barrel (0.952 hl) from PP 1834; data for 1849-1870 in shilling per quarter from Board of trade (1904)
Exeter [1750-1870 (missing 1866)] Data for 1750-1799 from Beveridge (1929) in shilling/Winchester quarter; 1800-1870 data in shilling/quarter kindly provided by Jacks [89]
Gloucester [1800-1870 (missing 1866)] All data in shilling/quarter kindly provided by Jacks [90]
Leeds [1800-1870 (missing 1866)] All data in shilling/quarter kindly provided by Jacks [91]
Lincoln [1750-1824 (missing 1770)] All data from Hill (1966 p.305) – in shilling "strike", assumed to be a Winchester quarter [92]
Liverpool [1800-1870 (missing 1866)] All data in shilling/quarter kindly provided by Jacks [93]
London [1750-1870 (missing 1794-1799, 1866)] data for 1750-1793 from Beveridge (kindly provided by Epstein) – in shilling/Winchester quarter, adjusted from crop (Oct-Sept) to calendar year[94]; data for 1800-1870 in shilling/quarter kindly provided by Jacks [95]
Maidstone [1750-1791] All data in shilling/hl, kindly provided by Epstein (from Beveridge papers in the LSE Archives)
Manchester [1800-1870 (missing 1866)] All data in shilling/quarter kindly provided by Jacks [96]
Newcastle [1750-1870 (missing 1765 and 1866)] Data for 1750-1799 in shilling/hl kindly provided by Epstein; data for 1800-1870 in shilling/quarter kindly provided by Jacks [97]
Norwich [1800-1870 (missing 1866)] All data in shilling/quarter kindly provided by Jacks [98]
Oxford [1750-1793] All data kindly provided by Epstein in shilling/quarter
Shwresbury [1758-1800 (missing 1762, 1774, 1780-1786. 1789. 1794, 1797)]
Southern Ireland [1767-1870] All data in shilling/barrel (0.952 hl) kindly provided by Solar

87 These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals
88 These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals
89 These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals
90 These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals
91 These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals
92 The evidence for this conversion from Granger-Elliott 1967 /C/
93 These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals
94 Alternative series Usher (1931)
95 These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals
96 These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals
97 These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals
98 These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals

Winchester [1750-1816] All data kindly provided by Epstein (from Beveridge papers in the LSE Archives) in shilling/quarter
Windsor [1750-1820] All data from Usher (1931) in shilling/Winchester quarter
Worcester [1800-1870 (missing 1866)] All data in shilling/quarter kindly provided by Jacks [99]
York [1751-1799 (missing 1752-1753, 1758, 1760. 1763-1779)] All data in shilling/hl, kindly provided by Epstein

4) Rye

4.1 Austria-Hungary

Ljubljana [1758-1870 (missing 1772-1774)] All data from Valencic (1977), as for wheat
Lwow [1754-1870 (missing 1755-1760, 1762, 1767-1768, 1771, 1774-1785, 1787-1797, 1799)]. All data from Hoszowski (1934 pp.8 and p.98) as for wheat
Krakow [1750-1870]. Data 1750-1795 from Tomasewksi (1934); data for 1796-1914 from Gorzkiewicz (1950 pp.238-239) – as for wheat
Prague [1750-1870 (missing 1770-1771)] Data from Schebek (1873) – as for wheat
Rattenberg [1750-1861 (missing 1763, 1805, 1813-1815, 1846-1847)] All data from Schmelzer (1972) as for wheat
St Polten [1750-1784]. All data from Pribram (1938) – as for wheat
Weyer [1750-1784] All data from Pribram (1938) – as for wheat
Wien [1750-1870] All data from Pribram (1938) – as for wheat

4.2 Belgium

Aalst [1750-1801 (missing 1785-1788, 1791-1792, 1794-1795)] All data from Wyffels (1959) in petard/havot (0.1774 hl).
Antwerp [1750-1850] Data for 1750-1807 from Consular Reports (1825) in gulden/mud (1 hl); data for 1808-1850 from Scholliers (1965) in gulden/hl[100]
Brugges [1765-1870 (missing 1787, 1790, 1793-1795)] Data for 1765-1792 from Vanderbroecke (1973) and for 1796-1870 from Vanderpijpen (1973) – both as for wheat
Brussels [1750-1870 (missing 1794-1800)] Data for 1750-1793 from Craeybeckx (1959a and 1965) – interpolated 1752-1761 with Craeybeckx (1959b); data for 1801-1870 from Vanderbroeke (1973)[101].
Deinze [1750-1793] All data from Coppejans-Desmedt (1972) in gros/halster (0.761 hl)
Dienst [1757-1817 (missing 1761-1766)] All data from van Buyten (1966) as for wheat

[99] These data are also available on his website (www.sfu.ca/~djacks/) in dollars/quintals
[100] Other series from Crayebeck 1959b (1773-1816) and Vandenbroecke 1973 (1765-1792)
[101] Other series from Vanderbroecke 1973 (1765-1792)

Eeeklo [1750-1830 (missing 1793-1795)] All data from Coppejans-Desmedt 1965 as for wheat
Ghent [1750-1870 (missing 1785-1787, 1790, 1797-1799)] Data for 1750-1792 from Vanderbroeke (1973) in patards/rasiere (0.486), interpolated 1750-1762 with data from Deprez 1959 (prices for setting yearly rents); data for 1800-1870 from Vanderbroeke and Vanderpijpen (1972) in Francs/q.le
Leuven [1750-1825 (missing 1816 1820-1822)] All data from Consular Reports (1825) in quarters/shilling[102]
Lillo [1750-1785] All data from Wyffels (1959) in petard/viertel (0.882 hl)
Luik/Liege [1750-1800 (missing 1793-1794)] All data from Pyens-Tijms (1993) as for wheat
Luxembourg [1750-1779] All data from Helin (1966) as for wheat
Namur [1750-1800] All data from Ledrier (1966) as for wheat
Ruremonde [1750-1795] All data from Ruwet (1966) as for wheat

4.3 Denmark

Copenhagen [1750-1870 (missing 1810-1818)] Data for 1750-1799 from Friis-Gallman (1958) in silver/hl; data for 1801-1870 from Foldes (1905) in rigsdaler/toned (1.39 hl)

4.4 Finland

Helsinki [1801-1870] All data from Foldes (1905) in markka/tynnyri (1.64 hl)

4.5 France

Abbeville (Somme) [1750-1800] All data from Pammier (1865) as for whear
Angers (Maine et Loire) [1750-1789] All data from Hauser (1936) as for wheat
Bayonne (Basses Pyrenees) [1801-1825 (missing 1814)] All data from Consular Report (1825) in Francs/hl
Bordeaux (Gironde) [1794-1825] All data from Consular Report (1825) in Winchester quarter/shilling
Caen (Calvados) [1812-1825] All data from Consular Report (1825) in Francs/hl
Charleville (Ardennes) [1750-1792] All data from Morineau (1974-1975) 1750-1792 in livre/quartal (0.27 hl) 1806-1821 livre/double bousseau (0.25 hl)
Chateaudun (Eure et Loire) [1750-1867] All data from De Belfort (1864-1869) as for wheat
Chateau-Gontier (Mayenne) [1750-1793 (missing 1783)] All data from Hauser (1936) as for wheat
Chaumont (Oise) [1750-1791 (missing 1764-1786)] All data from Dupaquier et al (1968) as for wheat
Coutances (Manche) [1750-1774] All data from Hauser (1936) as for wheat
Douai (Nord) [1750-1790] All data from Mestayer (1965) as for wheat

[102] Other series from Vanderbroecke 1973 (1769-1792)

Grenoble (Isere) [1750-1781] All data from Hauser (1936) as for wheat
Havre (Seine Inferieure) [1802-1825] All data from Consular Report (1825) in Francs/hl
Magny (Eure et Loire) [1750-1790] All data from Dupaquier et al (1968) as for wheat
Meulan (Seine et Oise) [1750-1792] All data from Dupaquier et al (1968) as for wheat
Mulhouse (Haut Rhine) [1798-1870] All data from Hanauer (1878) as for wheat
Nantes (Loire Inferieure) [1808-1825] All data from Hanauer (1878) as for wheat
Paris (Seine) [1750-1778 (missing 1773)] All data from Hauser (1936) in livre tournoises/setier (1.56 hl).
Romans (Drome) [1750-1793] All data from Hauser (1936) as for wheat
Saint-Etienne (Loire) [1750-1798 (missing 1794-1795)] All data from Gras (1906) as for wheat
Strasbourg (Bas Rhin) [1750-1870 (missing 1793-1799)] All data from Hanauer (1878) as for wheat
Tolouse (Haute-Garonne) [1750-1849 (missing 1755, 1793-1796)] All data from Freche (1967a) 1750-1799 in livre/setier (0.932 hl) and 1800-1840 in Francs/hl

4.6 Germany

Augsburg [1750-1855 (missing 1759, 1771)] Data for 1750-1820 from Elsas (1936) and for 1821-1855 from Seuffert (1857) as for wheat
Bamberg [1815-1855] All data from Seuffert (1857) as for wheat
Berlin [1750-1870 (missing 1762-1765)] Data for 1750-1791 from Getreidepreise (1935a) and for 1792-1870 from Getreidepreise (1935b)
Braunschweig [1750-1850 (missing 1823)] All data from Gerhard-Kauffhold (1990) as for wheat.
Bremen [1750-1850 (missing 1770, 1790)] All data from Gerhard-Kauffhold (1990) as for wheat.
Celle [1750-1870 (missing 1754, 1767-1771)] All data from Gerhard-Kauffhold (1990) as for wheat.
Danzig [1750-1816] All data from Furtak (1935) as for wheat
Detmold [1767-1850 (missing 1808)] All data from Gerhard-Kauffhold (1990) as for wheat.
Dresden [1750-1824] All data from Consular Report (1825) as for wheat
Duderstadt [1750-1850] All data from Gerhard-Kauffhold (1990) as for wheat.
Emdem [1750-1850 (missing 1756, 1758-1770, 1807-1813)] All data from Gerhard-Kauffhold (1990) as for wheat.
Erbing [1815-1855] All data from Seuffert (1857) as for wheat
Frankfurt [1750-1820 (missing 1755, 1758, 1766-1767, 1774-1777, 1780, 1785, 1803)] All data from Elsas (1936) as for wheat
Gottingen [1750-1867] All data from Gerhard-Kauffhold (1990) as for wheat.
Hamburg [1750-1870] Data for 1792-1870 Getreidepreise (1935b), extrapolated backwards to 1750 with the series from Consular Reports (1825), as for wheat

Hannover [1750-1850 (missing 1796-1800)] All data from Gerhard-Kauffhold (1990) as for wheat; 1801-1810 interpolated with data from Seuffert (18157)
Herford [1771-1850 (missing 1775)] All data from Gerhard-Kauffhold (1990) as for wheat
Kempten [1815-1855] All data from Seuffert (1857) as for wheat
Koln [1750-1870 (missing 1788-1789, 1798.1815)] Data for 1750-1796 from Ebeling-Irsigler (1976) and 1816-1870 Getreidepreise (1935b) as for wheat
Konigsberg [1750-1870 (missing 1757-1758, 1764)] Data for 1797-1870 from Getreidepreise (1935b) interpolated backwards to 1750 with the series from Consular Reports (1825)
Landshut [1815-1855] All data from Seuffert (1857) as for wheat
Liepzig [1750-1850 (missing 1767, 1821-1844)] Data for 1750-1820 from Elsas (1936) and for 1845-1870 from Getreidepreise (1935b) as for wheat
Lindau [1815-1855] All data from Seuffert (1857) as for wheat
Luneburg [1750-1850 (missing 1756, 1762-1763, 1765)] All data from Gerhard-Kauffhold (1990) as for wheat
Mannheim [1791-1870 (missing 1794, 1796, 1798-1805, 1810.1812)] All data from Getreidepreise (1935b) as for wheat
Mecklemburg [1792-1825] All data from Consular Reports (1825) as for wheat
Memminger [1815-1855] All data from Seuffert (1857) as for wheat
Minden [1775-1850] All data from Gerhard-Kauffhold (1990) as for wheat
Munchen [1750-1870] Data for 1750-1790 from Seuffert (1857) and for 1791-1870 from Getreidepreise (1935b) as for wheat
Munster [1750-1863 (missing 1846, 1848-1849, 1853, 1855)] All data from Gerhard-Kauffhold (1990) as for wheat
Nordlingen [1815-1855] All data from Seuffert (1857) as for wheat
Nurberg [1815-1855] All data from Seuffert (1857) as for wheat
Oldenburg [1796-1858] Data for 1796-1825 from Consular report (1825) as for wheat; data for 1826-1858 in gram silver/hl kindly provided by Spoerer
Osnabruck [1750-1861] All data from Gerhard-Kauffhold (1990) as for wheat
Paderborn [1750-1856] All data from Gerhard-Kauffhold (1990) as for wheat
Regensburg [1815-1855] All data from Seuffert (1857) as for wheat
Steim am Rhein [1750-1810 (missing 1759, 1781, 1785, 1796)] All data from Gottman (sd) as for wheat
Straubing [1815-1855] All data from Seuffert (1857) as for wheat
Waake [1750-1850 (missing 1762, 1785)] All data from Gerhard-Kauffhold (1990) as for wheat
Wurzburg 1750-1855 [(missing 1779, 1791, 1800-1814)] Data for 1750-1799 from Elsas (1936) and for 1815-1855 from Seuffert (1857) as for wheat

4.7 Italy

Firenze [1750-1768] All data from (Mauri et al 1970) as for wheat
Milan [1750-1860] De Maddalena 1974 as for wheat
Pisa [1750-1805] Mauri et al 1970 in Tuscan lire/sacco (0.731)

Udine [1752-1825] All data from Consular report (1825) in Winchester quarter/sterling
Vercelli [1750-1870] All data fron Pugliese (1908) as for wheat
Torino [1815-1870] All data from Felloni (1957b) in lit/hl

4.8 Netherlands

Amsterdam [1750-1870 (missing 1759, 1809-1810, 1868)] All data for "Prussian" rye (series 8) from Posthumus (1943), as for wheat
Arnheim [1750-1870] All data from Verrin Stuart (1904), downloaded from Unger and Allen website (http://www2.history.ubc.ca/unger/htm_files/wheat.htm, accessed April 7, 2007) as for wheat
Brabant [1816-1849] All data from Van Riel's data base (http://www.iisg.nl/hpw/brabant-market-prices.xls accessed April 12, 2007) as for wheat
Breda [1750-1870] All data from Tijms (1977) in gulden/viertel (0.857 hl)
Drente [1750-1870 (missing 1800)] All data from Bieleman (1987) in gulden/hl
Groningen [1785-1870 (missing 1854-1860, 1867-1869)] All data in gulden/hl from Van Riel on-line data-base ((http://www.iisg.nl/hpw/monthly-grain-groningen.xls) accessed May 12th, 2006
Leiden [1750-1800 (missing 1762)] All data from Posthumus (1964) as average of prices paid by two hospitals in gulden/last (2.92 hl)
Njimegen [1750-1870 (missing 1811-1813, 1823, 1861-1864)] All data from Tijms (1977) as for wheat
Rotterdam [1769-1825] All data from Consular report (1825) as for wheat
s'Hertogenbosch [1750-1816] All data from Tijms (1977) in gulden/hl
Utrecht [1750-1833] All data from Posthumus (1964) as for wheat
Zeeland [1819-1854] All data from Van Riel's data base http://www.iisg.nl/hpw/zeeland-market-prices.xls (accessed April 10, 2007) for wheat

4.9 Norway

Oslo [1820-1870] All data from Foldes (1905) in Kroner/hl

4.10 Russia

Archangel [1802-1825 (missing 1812)] All data from Consular reports (1825) as for wheat
St Petersburg [1813-1820] All data from Consular reports (1825) as for wheat
Warsaw [1750-1870 (missing 1752-1753, 1755-1757, 1759, 1764-1765, 1767, 1778, 1781, 1783-1785, 1791)] Data from Siegel (1936 and 1949), interpolated for 1797-1815 from Jacob (1826) as for wheat

4.11 Spain

Coruna [1750-1826] All data from Consular Report (1825) as for wheat
Tarrega [1750-1811] All data from Garrabou (1970) as for wheat

4.12 Sweden

Alvsborg [1750-1870] All data from Jorberg (1972) as for wheat
Angelhom [1750-1870] All data from Jorberg (1972) as for wheat
Angermanlad [1750-1773] All data from Jorberg (1972) as for wheat
Blekinge [1750-1870 (missing 1763)] All data from Jorberg (1972) as for wheat
Gastrikland [1750-1870] All data from Jorberg (1972) as for wheat
Goteborg [1750-1870] All data from Jorberg (1972) as for wheat
Gotland [1750-1870 (missing 1756)] All data from Jorberg (1972) as for wheat
Halland [1750-1870] All data from Jorberg (1972) as for wheat
Halsingland [1750-1870] All data from Jorberg (1972) as for wheat
Harjedalen [1776-1870] All data from Jorberg (1972) as for wheat
Jamtland [1750-1769 (missing 1757-1761, 1767-1768)] All data from Jorberg (1972) as for wheat
Jokoping [1750-1870] All data from Jorberg (1972) as for wheat
Kalmar [1750-1870] All data from Jorberg (1972) as for wheat
Kopparberg [1750-1870] All data from Jorberg (1972) as for wheat
Kristiansand [1750-1870] All data from Jorberg (1972) as for wheat
Kronoberg [1750-1870] All data from Jorberg (1972) as for wheat
Malmous [1750-1870] All data from Jorberg (1972) as for wheat
Medelpad [1750-1773] All data from Jorberg (1972) as for wheat
Narke [1750-1870] All data from Jorberg (1972) as for wheat
Nora, Linde and Karkskoga [1750-1870] All data from Jorberg (1972) as for wheat
Norbotten [1752-1767] All data from Jorberg (1972) as for wheat
Oland [1820-1870] All data from Jorberg (1972) as for wheat
Ostergotland [1750-1870] All data from Jorberg (1972) as for wheat
Simrishamn [1750-1870] All data from Jorberg (1972) as for wheat
Skaraborg [1750-1870 (missing 1762)] All data from Jorberg (1972) as for wheat
Sodermaland [1750-1870] All data from Jorberg (1972) as for wheat
Stockholm [1750-1870 (missing 1755,1762)] All data from Jorberg (1972) as for wheat
Uppsala [1750-1870] All data from Jorberg (1972) as for wheat
Varmland [1750-1870] All data from Jorberg (1972) as for wheat
Vasterbotten [1750-1767] All data from Jorberg (1972) as for wheat
Vasternorrland [1775-1870] All data from Jorberg (1972) as for wheat
Vastmanland [1750-1870] All data from Jorberg (1972) as for wheat

4.13 Switzerland

Bern [1800-1870 (missing 1818-1831)] All data from Brugges (1968) as for wheat

Schaffausen [1750-1870] Data for 1800-1870 from (Brugges 1968) in Fr/q.le interpolated backwards to 1750 with data from Gottmann (1991)
Ueberlingen [1750-1810] All data from Gottmann (1991) as for wheat

4.14 United Kingdom

Lincoln [1750-1834 (missing 1770, 1792-1793, 1799)] All data from Hill (1966) as for wheat

5) Tallow Candles

5.1 Austria-Hungary

Krakow [1810-1870 (missing 1858-1862)] All data from Gorzkiewicz (1950) in grams gold/kg)
Wien [1750-1789 (missing 1751, 1753, 1757, 1761, 1765, 1782-1785, 1787-1788)] All data from Pribram (1938) in "Konvention kreuzer"/pound (0.45 kg)
Weyer [1750-1790 (missing 1751-1752, 1765, 1777, 1779, 1786] All data from Pribram (1938) in "Konvention kreuzer"/pound (0.45 kg)

5.2 Belgium

Antwerp [1756-1833 (missing 1784, 1787-1799, 1802-1803, 1812, 1817-1818, 1820, 1820, 1831-1832)] All data from Scholliers (1965) in patard/livre (0.453 kg)
Brabant [1824-1849] All data in gulden/kg from Van Riel's data-base http://www.iisg.nl/hpw/brabant-market-prices.xls , accessed April 10,2007

5.3 France

Paris [1750-1791] All data from Hauser (1936) in grams silver/livre (0.489 kg)
Saint-Antonin [1752-1780 (missing 1754-1757)] All data from Hauser (1936) in grams silver/livre (0.489 kg)
Strasbourg 1750-1870 (missing 1755, 1760, 1763. 1769. 1777-1778, 1790-1796, 1825-1836, 1841, 1846)] All data from Hanauer (1878) in Francs/kg [103]

5.4 Germany

Augsburg [1763-1807 (missing 1772-1773, 1788, 1800-1802)] All data from Elsas (1936-1940) in gulden/pfund (0.473 kg) converted into shillings with the data provided by the author

[103] The French Franc has been converted into shilling at silver parity of the franc (4.5 grams), under the assumption that Hanauer had used its silver parity

5.5 Italy

Naples [1750-1800] All data from Romano (1965) in grani/"libbra" (0.45 kg.)

5.6 Netherlands

Utrecht [1750-1798 (missing 1772)] All data from Posthumus (1964) in gulden/pound (0.453 kg.)
Zeeland [1824-1854] All data in gulden/kg from Van Riel's data-base (http://www.iisg.nl/hpw/zeeland-market-prices.xls), accessed April 10,2007

5.7 Russia

Warsaw [1816-1870] All data from Siegel (1934) in grams gold/funt (0.405 kg)

5.8 Spain

New Castile [1750-1800] All data from Hamilton (1947) in maravedì/25 pounds (11.5 kg)

5.9 Sweden

Angelhom [1782-1868 (missing 1815)] All data from Jorberg (1972) in riksdaler/lipsund (8.5 kg.) 1782-1802 and kronoer/kg. for 1803-1868.
Blekinge [1782-1870 (missing 1790)] All data from Jorberg (1972) in riksdaler/lipsund (8.5 kg.) 1782-1802 and kronoer/kg. for 1803-1870.
Gastrikland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Goteborg [1803-1870] All data from Jorberg (1972) in kronoer/kg
Gotland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Halland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Halsingland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Harjedalen [1810-1870] All data from Jorberg (1972) in kronoer/kg
Jamtland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Jokoping [1803-1870] All data from Jorberg (1972) in kronoer/kg
Kalmar [1803-1870] All data from Jorberg (1972) in kronoer/kg
Kopparberg [1803-1870] All data from Jorberg (1972) in kronoer/kg
Kristiansand [1782-1870 (missing 1815)] All data from Jorberg (1972) in riksdaler/lipsund (8.5 kg.) 1782-1802 and kronoer/kg. for 1803-1870
Kronoberg [1803-1870] All data from Jorberg (1972) in kronoer/kg
Malmous [1803-1870] All data from Jorberg (1972) in kronoer/kg
Narke [1803-1870] All data from Jorberg (1972) in kronoer/kg
Nora, Linde and Karkskoga [1803-1870] All data from Jorberg (1972) in kronoer/kg
Norbotten [1811-1870] All data from Jorberg (1972) in kronoer/kg
Oland [1820-1870] All data from Jorberg (1972) in kronoer/kg
Ostergotland [1803-1870] All data from Jorberg (1972) in kronoer/kg

Simrishamn [1782-1868 (missing 1815)] All data from Jorberg (1972) in riksdaler/lipsund (8.5 kg.) 1782-1802 and kronoer/kg. for 1803-1868
Skaraborg [1803-1870] All data from Jorberg (1972) in kronoer/kg
Sodermaland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Stockholm [1803-1870] All data from Jorberg (1972) in kronoer/kg
Uppsala [1803-1870] All data from Jorberg (1972) in kronoer/kg
Varmland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Vasterbotten [1803-1870 (missing 1812)] All data from Jorberg (1972) in kronoer/kg
Vasternorrland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Vastmanland [1803-1870] All data from Jorberg (1972) in kronoer/kg

5.10 United Kingdom

Chatham [1751-1811 (missing 1752, 1756-1761, 1768-1769, 1776, 1780, 1782, 1787-1788, 1791-1796. 1803-1805, 1810)] All data from Beveridge (1965 vol I) in shilling/dozen pounds (0.453 kg)
Chelsea hospital [1750-1809 (missing 1756-1761, 1766, 1768-1779, 1776-1777, 1789)] All data from Beveridge (1965 vol I) in shilling/dozen pounds (0.453 kg)
Deptford [1750-1808 (missing 1753, 1756-1762, 1769, 1772, 1775-1778, 1780-1784, 1788, 1791-1796, 1803-1805)] All data from Beveridge (1965 vol I) in shilling/dozen pounds (0.453 kg)
Eton [1750-829 (missing 1753-1754, 1756-1757, 1760, 1762-1763, 1766, 1768-1769, 1773-1781, 1783-1784, 1787, 1790-1791, 1798, 1802, 1812, 1821, 1826-1827)] All data from Beveridge (1965 vol I) in shilling/dozen pounds (0.453 kg)
Greenwich hospital [1750-1827 (missing 1764, 1767-1769, 1782)] All data from Beveridge (1965 vol I) in shilling/dozen pounds (0.453 kg)
Plymouth [1750-1810 (missing 1751-1752, 1754, 1760-1761, 1769, 1773-1774, 1780-1781, 1791, 1794-1796, 1803-1805, 1809)] All data from Beveridge (1965 vol I) in shilling/dozen pounds (0.453 kg)
Portsmouth [1750-1810 (missing 1752, 1756, 1760-1762, 1765, 1768-1770, 1775-1777, 1780-1784, 1787-1788, 1793, 1796, 1803-1805)] All data from Beveridge (1965 vol I) in shilling/dozen pounds (0.453 kg)
Royal household [1760-1828 (missing 1765-1770, 1774-1775, 1788-1789, 1791-1792, 1795)] All data from Beveridge (1965 vol I) in shilling/dozen pounds (0.453 kg)
Winchester [1750-1782] All data from Beveridge (1965 vol I) in shilling/dozen pounds (0.453 kg)

6) Wax Candles

6.1 Austria-Hungary

Wien [1750-1771 (missing 1753, 1756-1758, 1761, 1765-1766, 1768)] All data from Pribram (1938) in “Konvention kreuzer”/pound (0.45 kg)

Krakow [1750-1795 (missing 1780, 1787, 1789-1790, 1794)] All data from Tomasewski (1934) in grams gold/funt (0.405 kg)

6.2 Belgium

Antwerp [1788-1816 (missing 1789-1802, 1814)] All data from Scholliers (1965) in patard/livre (0.453 kg)

6.3 France

Paris [1760-1790 (missing 1764-1765, 1768, 1770-1774)] All data from Hauser (1936) in grams silver/livre (0.489 kg)
Strasbourg [1804-1870 (missing 1823-1824, 1827-1830, 1833-1839)] All data from Hanauer (1878) in Francs/kg [104]

6.4 Germany

Danzig [1750-1815 (missing 1761, 1791, 1793, 1813)] All data from Furtak (1935) in grams silver/"funt" (0.434 kg)
Wurzburg [1750-1799 (missing 1751, 1753, 1766-1767, 1789-1790)] All data from Elsas (1936) in denars/pfund (0.477 kg) converted int silver with the series provided by the author

6.5 Italy

Naples [1750-1805 (missing 1763-1764, 1771-1774, 1787)] All data from Romano (1965) in grani/"libbra" (0.45 kg.)
Milan [1750-1860] All data from De Maddalena (1974) in lire milanesi/10 "libbre piccole" (0.3267 kg)

6.6 Russia

Warsaw [1816-1870] All data from Siegel in grams gold/funt (0.405 kg)

6.7 Sweden

Angelhom [1782-1868 (missing 1787, 1797, 1815)] All data from Jorberg (1972) in riksdaler/lipsund (8.5 kg.) 1782-1802 and kronoer/kg. for 1803-1868.
Blekinge [1782-1870 (missing 1787, 1790, 1797)] All data from Jorberg (1972) in riksdaler/lipsund (8.5 kg.) 1782-1802 and kronoer/kg. for 1803-1870.
Gastrikland [1803-1870 (missing 1815)] All data from Jorberg (1972) in kronoer/kg.
Goteborg [1803-1870] All data from Jorberg (1972) in kronoer/kg.

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[104] The French Franc has been converted into shilling at silver parity of the franc (4.5 grams), under the assumption that Hanauer had used its silver parity

Gotland [1803-1870] All data from Jorberg (1972) in kronoer/kg.
Halland [1803-1870] All data from Jorberg (1972) in kronoer/kg.
Halsingland [1804-1870] All data from Jorberg (1972) in kronoer/kg.
Harjedalen [1810-1870] All data from Jorberg (1972) in kronoer/kg.
Jamtland [1803-1870] All data from Jorberg (1972) in kronoer/kg.
Jokoping [1803-1870] All data from Jorberg (1972) in kronoer/kg.
Kalmar [1803-1870] All data from Jorberg (1972) in kronoer/kg.
Kopparberg [1806-1870] All data from Jorberg (1972) in kronoer/kg.
Kristiansand [1782-1870 (missing 1787, 1797, 1815)] All data from Jorberg (1972) in riksdaler/lipsund (8.5 kg.) 1782-1802 and kronoer/kg. for 1803-1870
Kronoberg [1803-1870] All data from Jorberg (1972) in kronoer/kg.
Malmous [1803-1870] All data from Jorberg (1972) in kronoer/kg
Narke [1803-1870] All data from Jorberg (1972) in kronoer/kg
Nora, Linde and Karkskoga [1803-1870] All data from Jorberg (1972) in kronoer/kg
Norbotten [1811-1870] All data from Jorberg (1972) in kronoer/kg
Oland [1820-1870] All data from Jorberg (1972) in kronoer/kg
Ostergotland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Simrishamn [1782-1868 (missing 1787, 1797, 1815)] All data from Jorberg (1972) in riksdaler/lipsund (8.5 kg.) 1782-1802 and kronoer/kg. for 1803-1868.
Skaraborg [1803-1870] All data from Jorberg (1972) in kronoer/kg
Sodermaland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Stockholm [1803-1870] All data from Jorberg (1972) in kronoer/kg
Uppsala [1803-1870] All data from Jorberg (1972) in kronoer/kg
Varmland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Vasterbotten [1803-1870 (missing 1812)] All data from Jorberg (1972) in kronoer/kg
Vasternorrland [1803-1870] All data from Jorberg (1972) in kronoer/kg
Vastmanland [1803-1870] All data from Jorberg (1972) in kronoer/kg

6.8 United Kingdom

Royal household [1755-1830 (missing 1756-1760. 1762-1772, 1774-1775, 1780-1791. 1795-1798, 1802, 1805-1806. 1816. 1823)] All data from Beveridge (1965 vol I) for white and yellow wax candles, in shilling pounds (0.453 kg)

7) The samples

The samples include the following price series

7.1 Wheat

7.1.2 *Long-run sample (1750-1870)*

7.1.2.1 *Baseline sample*

Austria-Hungary (5): Vienna, Ljubljana, Prague, Krakow and Rattenberg
Belgium (4): Bruxelles, Brugges, Ghent and Liege,
Denmark (1): Copenhagen
France (35) : Aude, Bas Rhine Bouches du Rhone, Calvados, Corrèze, Cotes du Nord , Drộme, Eure et Loir, Gard, Gironde, Haute Garonne, Hérault, Ille et Villaine, Indre, Isere, Jura, Loire, Haute Loire, Haute Marne, Haute Vienne, Maine et Loire, Manche, Mayenne, Nord, Oise, Pas de Calais, , Rhộne, Seine, Seine Inférieure, Seine et Oise, Somme, Tarn, Tarn et Garonne, Var and Vienne
Germany (20): Augsburg, Berlin, Braunschweig, Bremen, Celle, Danzig, Dresden, Duderstadt, Gottingen, Hamburg, Hannover, Koln, Konigsberg, Liepzig, Luneburg, Munchen, Munster, Osnabruck, Paderborn and Waake
Italy (13): Acquaviva, Arezzo, Brescia , Firenze, Mantova, Milano, Palermo, Pisa, Roma, Rovigo, Torino, Udine and Vercelli
Netherlands (6): Amsterdam, Arnheim, Dordrecht, Groningen, Nijmegen and Utrecht
Portugal (1):Lisbon
Russia (1): Warsaw
Spain (8): Barcelona, Gerona, La Coruña, Lleida, Pamplona, Rioseco, Segovia and Tolosa
Sweden (12): Stockholm, Uppsala, Sodermaland, Ostergotland, Kalmar, Halland, Skaraborg, Narke, Nora, Linde and Karkskoga, Vastmanland, Gastrikland and Halsingland
Switzerland (2): Luzern and Zurich
United Kingdom (5): London, Exeter, Cambridge, Newcastle and Southern Ireland

7.1.2.2 *Consistent sample*

Austria-Hungary (2): Vienna, Prague
Belgium (2): Bruxelles, Brugges and Liege,
France (23) : Aude, Bas Rhine Corrèze, Cotes du Nord , Drộme, Eure et Loir, Gard, Gironde, Haute Garonne, Hérault Loire, Haute Loire, Haute Marne, Haute Vienne, Mayenne, Nord, Oise, Pas de Calais, Seine Inférieure, Somme, Tarn, Var and Vienne
Germany (6): Berlin, Celle, Gottingen, Hamburg, Konigsberg and Munchen
Italy (8): Acquaviva, Brescia , Firenze, Mantova, Milano, Palermo, Udine and Vercelli
Netherlands (4): Arnheim, Dordrecht Nijmegen and Utrecht
Portugal (1):Lisbon
Spain (6): Barcelona, Gerona, La Coruña, Lleida, Pamplona and Segovia
Sweden (11): Stockholm, Uppsala, Sodermaland, Ostergotland Halland, Skaraborg, Narke, Nora, Linde and Karkskoga, Vastmanland, Gastrikland and Halsingland
Switzerland (2): Luzern and Zurich

United Kingdom (4): Exeter, Cambridge, Newcastle and Southern Ireland

7.1.2.3 *Representative sample*

Austria-Hungary (5): Vienna, Ljubljana, Prague, Krakow and Rattenberg
France (6) : Bas Rhine, Cotes du Nord, Eure et Loir, Gironde, Haute Garonne, Seine
Germany (6): Berlin, Gottingen, Hamburg, Konigsberg, Munchen and Munster
Italy (13): Acquaviva, Firenze, Milano and Udine
Spain (8): Barcelona La Coruña and Segovia
United Kingdom (4): London, Exeter, Cambridge, Newcastle

7.1.3 *Late eighteenth century sample (1750-1792)*

Austria-Hungary (6): Vienna, Ljubljana, Prague, Krakow, Rattenberg, Saint Polten and Weyer
Belgium (7): Bruxelles, Brugges, Eeklo, Louvain, Liege, Namur and Ruremonde
Denmark (1): Copenhagen
France (31): Aude, Bas Rhine, Bouches du Rhone, Calvados, Corrèze, Cotes du Nord , Drộme, Eure et Loir, Gard, Gironde, Haute Garonne, Haute Vienne Hérault, Ille et Villaine, Loire, Haute Loire, Maine et Loire, Haute Marne, Mayenne, Nord, Oise, Pas de Calais, Seine, Seine Inférieure, Somme, Tarn, Tarn et Garonne, Var and Vienne
Germany (24): Augsburg, Berlin, Braunschweig, Bremen, Celle, Danzig, Dresden, Detmold Duderstadt, Frankfurt am Main, Gottingen, Hamburg, Hannover, Koln, Konigsberg, Liepzig, Luneburg, Munchen, Munster, Osnabruck, Paderborn, Stein am Rhein, Waake and Wurzburg
Luxembourg (1) Luxembourg
Italy (20): Acquaviva, Ancona, Arezzo, Brescia, Como, Firenze, Genoa Mantova, Milano, Napoli, Palermo, Pesaro, Pisa, Roma, Rovigo, Senigallia, SienaTorino, Udine and Vercelli
Netherlands (7): Amsterdam, Arnheim, Dordrecht, Groningen, Leiden, Nijmegen and Utrecht
Portugal (1):Lisbon
Spain (17): Alcala de Henares, Almaden**,** Barcelona, Cervera**,** Gerona, La Coruña, Lleida, Madrid, Mallorca**,** Pamplona, Ribera de Sort**,** Rioseco, Segovia, Seu d'Urgell, Sevilla, Tarrega, Toledo, Valencia
Sweden (12): Stockholm, Uppsala, Sodermaland, Ostergotland, Halland, Skaraborg, Narke, Nora, Linde and Karkskoga, Varmland, Vastmanland, Gastrikland and Halsingland
Switzerland (6): Appenzell, Geneve, Luzern, Schaffeusen, Ueberlingen and Zurich
United Kingdom (9): Cambridge, Exeter, Lincoln, London, Maidstone**,** Newcastle, Oxford, Winchester and Windsor

7.1.4 *Napoleonic sample (1789-1815)*

Austria-Hungary (6): Vienna, Fiume, Ljubljana, Prague, Krakow and Rattenberg
Belgium (6): Antwerpen, Bruxelles, Brugges, Ghent, Liege, Louvain and Namur
France (35) : Aude, Bouches du Rhone, Calvados, Corrèze, Cotes du Nord , Drộme, Eure et Loir, Gard, Gironde, Haute Garonne, Hérault, Ille et Villaine, Loire, Haute Loire, Maine et Loire, Haute Marne, Mayenne, Nord, Oise, Pas de Calais, Bas Rhine, Seine Inférieure, Seine et Oise, Somme, Tarn, Var, Vienne and Haute Vienne
Germany (27): Augsburg, Berlin, Braunschweig, Bremen, Celle, Danzig, Dresden, Duderstadt, Emdem, Frankfurt, Hamburg, Hannover, Herford, Holstein Konigsberg, Liepzig, Luneburg, Mecklemburg, Minden, Munchen, Munster, Oldenburg, Osnabruck, Paderborn and Waake
Italy (13): Acquaviva, Brescia, Ferrara, Firenze, Mantova, Milano, Palermo, Pesaro, Pisa, Rovigo, Senigallia, Udine and Vercelli
Netherlands (6): Arnheim, Dordrecht, Groningen, Nijmegen Rotterdam and Utrecht
Norway (1) Oslo
Portugal (1):Lisbon
Russia (2): St Petersburg and Warsaw
Spain (12): Alicante, Barcelona, Bilboa, Gerona, La Coruña, Lleida, Pamplona, Rioseco, Segovia Sevilla**,** Tolosa and Zaragoza
Sweden (12): Stockholm, Uppsala, Sodermaland, Ostergotland, Kalmar, Halland, Skaraborg, Narke, Nora, Linde and Karkskoga, Vastmanland, Gastrikland and Halsingland
Switzerland (2): Luzern and Zurich
United Kingdom (9): Belfast Exeter, Cambridge, Lincoln London, Newcastle Southern Ireland, Winchester and Windsor

7.1.5 *Early 19th century sample (1797-1870)*

Austria-Hungary (7): Vienna, Budapest Ljubljana, Lwow, Prague, Krakow and Rattenberg
Belgium (4): Bruxelles, Brugges, Ghent and Liege,
Denmark (1): Copenhagen
Finland (1) : Helsinki
France (86): Ain, Aisne, Allier, Ardèche, Ardennes, Ariège, Aube, Aude, Aveyron, Bas Rhine, Basses Alpes, Basses Pyrénées, Bouches du Rhone, Calvados, Cantal, Charente, Charente Infèrieure, Cher, Corrèze, Corse, Cote d'Or, Cotes du Nord, Creuse, Deux Sèvres, Dordogne, Doubs, Drộme, Eure, Eure et Loir, Finistère, Gard, Gers, Gironde, Hautes Alpes, Haute Garonne, Haute Loire, Haute Marne, Hautes Pyrénées, Haut Rhin, Haute Saone, Haute Vienne Hérault, Ille et Villaine, Indre, Indre et Loire, Landes, Loir et Cher, Loire, Loire Infèrieure, Loiret, Lot, Lot-et-Garonne, Lozère, Maine et Loire, Manche, Mayenne, Meurthe, Meuse, Morbihan, Moselle, Niévre, Nord, Oise, Orne, Pas de

Calais, Puy de Dome, Pyrénées Orientales, Rhộne, Saone et Loire, Sarthe, Seine, Seine Inférieure, Seine et Marne,Seine et Oise, Somme, Tarn, Tarn et Garonne, Var, Vaucluse, Vendèe, Vienne, Vosges and Yonne
Germany (15): Augsburg, Berlin, Braunschweig, Bremen, Celle, Danzig, Dresden, Gottingen, Hamburg, Hannover, Konigsberg, Liepzig, Mannheim, Munchen, Munster, Osnabruck
Italy (16): Acquaviva, Brescia, Catania, Ferrara, Firenze, Mantova, Milano, Palermo, Padova, Pisa, Porrona, Roma, Rovigo, Torino, Udine and Vercelli
Netherlands (6): Amsterdam, Arnheim, Dordrecht, Groningen, Nijmegen and Utrecht
Norway (1) Oslo
Portugal (1):Lisbon
Russia (2): Odessa, Warsaw
Spain (13): Barcelona, Burgos, Gerona, Granada, La Coruña, Lleida, Oviedo, Pamplona, Rioseco, Segovia, Tolosa, Tudela and Zaragoza.
Sweden (12): Stockholm, Uppsala, Sodermaland, Ostergotland, Kalmar, Halland, Skaraborg, Narke, Nora, Linde and Karkskoga, Vastmanland, Gastrikland and Halsingland
Switzerland (4): Lausanne, Luzern, Sant-Gallen, and Zurich
United Kingdom (14): Belfast, Carmarthen, Cambridge, Dover, Exeter, Gloucester, Leeds, Liverpool, London, Manchester Newcastle Norwich, Southern Ireland and Worcester

7.1.5 *Very long run sample (1750-1914)*

Austria-Hungary (4): Krakow, Ljubljana, Prague, Vienna,
Belgium (3): Brugges, Bruxelles, Ghent
France (9): Bouches du Rhone, Calvados, Cotes du Nord, Gironde, Haute Garonne, Indre, Pas de Calais, Rhộne and Seine
Germany (6): Berlin, Danzig, Koln, Konigsberg, Liepzig, Munchen
Italy (2): Brescia, Roma
Russia (1): Warsaw
Spain (3): Coruña, Gerona, Segovia
United Kingdom (4): Cambridge, Exeter, London, Newcastle

7.2 <u>Rye</u>

7.2.1 *Long-run sample*

Austria-Hungary (5): Vienna, Ljubljana, Prague, Krakow and Rattenberg
Belgium (4): Antwerpen, Brugges, Ghent and Liege,
Denmark (1): Copenhagen
France (3) : Bas Rhin, Eure et Loire, Haute Garonne
Germany (18): Augsburg, Berlin, Braunschweig, Bremen, Celle, Duderstadt, Gottingen, Hamburg, Hannover, Koln, Konigsberg, Liepzig, Luneburg, Munchen, Munster, Osnabruck, Paderborn and Waake

Italy (2): Milano and Vercelli
Netherlands (5): Amsterdam, Arnheim, Breda, Drente and Nijmegen
Russia (1): Warsaw
Sweden (27): Angelhom, Alvsborg Blekinge Stockholm, Uppsala, Sodermaland, Ostergotland, Kalmar, Halland, Harjedalen Malmous Narke, Nora, Linde and Karkskoga, Vastmanland, Goteborg Gastrikland, Gotland Jokoping, Kopparberg Kristiansand Kronoberg Halsingland, Simrishamn, Skaraborg,Varmland Vasternorrland Vasterbotten
Switzerland (1): Schaffeusen

7.2.2 *Late 18th century sample*

Austria-Hungary (6): Vienna, Prague, Krakow, Rattenberg, St Polten and Weyer
Belgium (10): Aalst, Antwerpen, Deinze, Eeeklo, Ghent, Liege, Leuven, Lillo, Namur, Ruremonde
Denmark (1): Copenhagen
France (12): Ardennes, Bas Rhin, Drome, Eure et Loire, Haute Garonne, Loire, Isere, Maine et Loire, Mayenne, Nord Seine et Oise, Somme
Germany (22): Augsburg, Berlin, Braunschweig, Bremen, Celle, Detmold, Dresden, Emdem, Gottingen, Hamburg, Hannover, Koln, Konigsberg, Liepzig, Luneburg, Munchen, Munster, Osnabruck, Paderborn, Stein am Rhein, Waake and Wurzburg
Italy (4): Milano, Pisa, Udine and Vercelli
Luxembourg (1): Luxembourg
Netherlands (8): Amsterdam, Arnheim, Breda, Drente, Leiden, Nijmegen, s'Hertogenbosch and Utrecht
Russia (1): Warsaw
Spain (2): La Coruna and Tarrega
Sweden (27): Angelhom, Alvsborg, Blekinge, Stockholm, Uppsala, Sodermaland, Ostergotland, Kalmar, Halland, Malmous, Narke, Nora, Linde and Karkskoga, Vastmanland, Goteborg Gastrikland, Gotland Jokoping, Kopparberg, Kristiansand, Kronoberg, Halsingland, Simrishamn, Skaraborg and Varmland
Switzerland (2): Schaffeusen and Ueberlingen

7.2.3 *Napoleonic sample*

Austria-Hungary (5): Vienna, Ljubljana, Prague, Krakow and Rattenberg
Belgium (6): Antwerpen, Brugges, Dienst, Eeeklo, Leuven and Liege,
France (3) : Bas Rhin, Eure et Loire, Haute Garonne
Germany (25): Augsburg, Berlin, Braunschweig, Bremen, Celle, Detmold, Dresden, Duderstadt, Emdem, Frankfurt Gottingen, Hamburg, Hannover, Herford Konigsberg, Liepzig, Luneburg, Mecklemburg, Minden Munchen, Munster, Osnabruck, Paderborn and Waake

Netherlands (9): Amsterdam, Arnheim, Breda, Drente, Groningen, Nijmegen, Rotterdam, s'Hertogenbosch and Utrecht
Portugal (1): Lisbon
Russia (1): Warsaw
Spain (1): Coruna
Sweden (28): Angelhom, Alvsborg Blekinge Stockholm, Uppsala, Sodermaland, Ostergotland, Kalmar, Halland, Malmous, Narke, Nora, Linde and Karkskoga, Vastmanland, Goteborg Gastrikland, Gotland Jokoping, Kopparberg, Kristiansand, Kronoberg, Halsingland, Simrishamn, Skaraborg,Varmland, Vasternorrland andVasterbotten
Switzerland (1): Schaffeusen

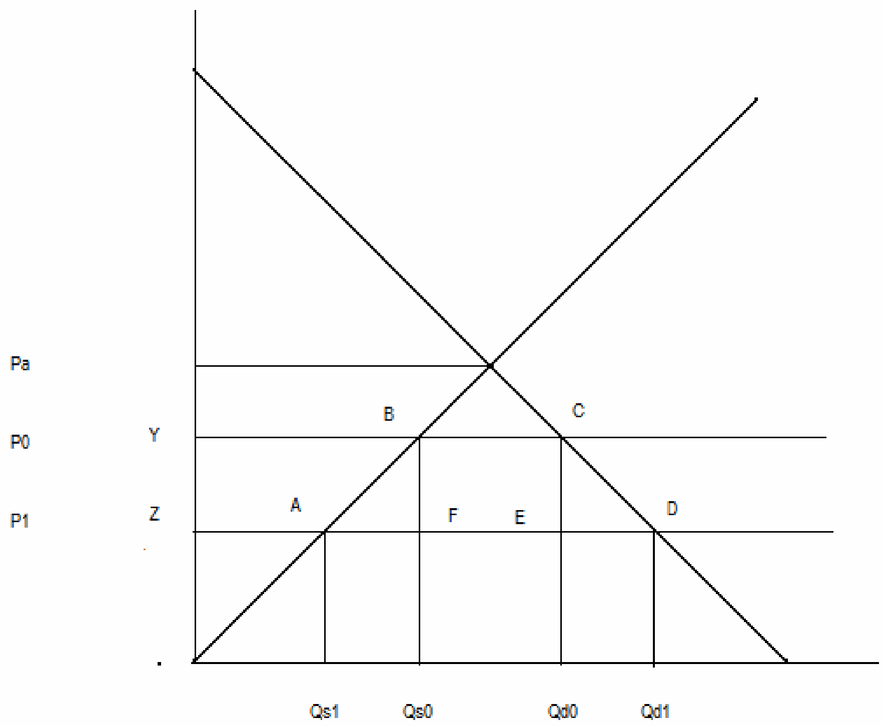
7.2.4 *Early 19th century sample*

Austria-Hungary (6): Vienna, Ljubljana, Prague, Lwow, Krakow and Rattenberg
Belgium (3): Brugges, Ghent and Liege
Denmark (1): Copenhagen
Finland (1) : Helsinki
France (3) : Bas Rhin, Eure et Loire, Haute Garonne
Germany (12): Augsburg, Berlin, Gottingen, Hamburg, Hannover, Koln, Konigsberg, Mannheim, Munchen, Munster, Oldenburg and Osnabruck
Italy (3): Milano, Torino and Vercelli
Netherlands (6): Amsterdam, Arnheim, Breda, Drente, Groningen and Nijmegen
Russia (1): Warsaw
Sweden (29): Angelhom, Alvsborg Blekinge Stockholm, Uppsala, Sodermaland, Ostergotland, Kalmar, Halland, Harjedalen Malmous Narke, Nora, Linde and Karkskoga, Vastmanland, Goteborg Gastrikland, Gotland, Jokoping, Kopparberg, Kristiansand, Kronoberg, Halsingland, Simrishamn, Skaraborg, Varmland, Vasternorrland, Vasterbotten, Jamtland and Norbotten
Switzerland (2): Bern and Schaffeusen

Appendix I
The welfare gains from market integration: a partial- equilibrium estimate

As usual, the static effects of market integration on welfare are estimated as the difference between changes in producers and consumer surplus brought about by price changes. Trade causes initial prices (P_0) to differ from the autarchy ones (P_A) as determined by local supply and demand. Further integration causes prices to move farther away from autarchy levels. It is thus necessary to distinguish "importing" markets, where $P_0 < P_A$ from "exporting" markets, where $P_0 > P_A$

Graph A.1
Welfare gains from integration, importing country



In an "importing" market (Graph A.1) price falls from P_0 to P_1, causing demand to rise from Q_{D0} to Q_{D1}, domestic supply to fall from Qs_0 to Q_{D1} and import to increase from Q_{D0}- Qs_0 to Q_{D1}- Qs_1. The consumer surplus increases from XCY to XDZ (by YCDZ), the producers' surplus decreases from OBY to OAZ (by YBAZ) – so that net gains are equivalent to the area of the trapezoid ABCD. The area can be decomposed in two triangles ABF and CED, which measure the reaction of producers and consumers to change in prices, and in a rectangle BCEF, which measures the benefits for consumers from the reduced prices of wheat. The respective area can be measured as

a) rectangle BCEF $DWG_i= \Delta P *(D_0- S_0)$

b) triangle ABF $DWG_{ii}=0.5* \Delta P * \Delta S$

Given the definition of supply elasticity

$\varepsilon = \Delta S / S_0*P_0/ \Delta P$

$\Delta S= \varepsilon* S_0* \Delta P/ P_0$

So that gains are

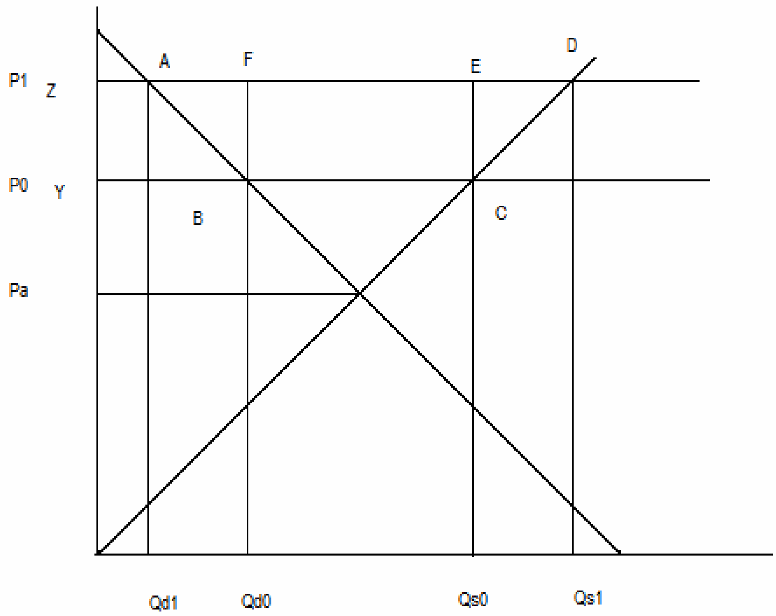
$DWG_{ii}= 0.5* \Delta P^2 *\varepsilon* S_0/ P_0$

c) Similarly for the triangle CED

$DWG_{iii}= 0.5^* \Delta P^2 {}^*\eta^* D_0/ P_0$
Where η is the demand elasticity (in absolute terms)
The total gains are obtained as a sum of the three
$DWG_{total}=DW_i+DWG_{ii}+DWG_{iii}=\Delta P \, ^*(D_0- S_0)+ 0.5^* \Delta P^2 \, ^* \eta^* D_0 / P_0+ 0.5^* \Delta P^2 \, ^* \varepsilon^* S_0 / P_0$
Re-arranging
$DWG_{total} =\Delta P \, ^*(D_0- S_0)+ 0.5^* \Delta P^2/ P_0{}^*(\eta^* D_0+ \varepsilon^* S_0)$
Multiplying by P_0/ P_0 and re-arranging yields
$DWG_{money} = \Delta P/P_0 \, ^*(D_0- S_0)^* P_0+ 0.5^* (\Delta P/ P_0)^{2*}(\eta^* D_0 \, ^*P_0+ \varepsilon^* S_0 \, ^*P_0)$
Then dividing by GNP_0
$DWG/GNP= \Delta P/P_0 \, ^*[(D_0- S_0)^* P_0/GNP_0] + 0.5^* (\Delta P/ P_0)^{2*}[\eta^* (D_0 \, ^*P_0 /GNP_0) + \varepsilon^* (S_0 \, ^*P_0 /GNP_0)]$
Defining $\alpha= (D_0^* P_0)/GNP_0$ and $\beta= (S_0^* P_0)/GNP_0$ as the ratio of total consumption and production on GNP yields the final formula
$DWG/GNP = \Delta P/P_0^* \mid \alpha - \beta \mid + 0.5^* (\Delta P/ P_0)^{2*}[\eta \, ^* \alpha + \varepsilon \, ^* \beta]$

The reasoning is symmetric for an “exporting” country (Graph A.2), where integration causes prices rise from P_0 to P_1. Domestic supply from Q_{S0} to Q_{S1} and exports from Q_{S0}-Q_{D0} to Q_{S1}-Q_{D1}, while domestic consumption decreases from Q_{D0} to Q_{D1}. Consumer surplus decreases from XBY to XAZ (by ZABY), producer surplus increases fro OCY to ODZ (by area YCDZ) and the net gains are ABCD.

Graph A.2
Welfare gains from integration, exporting country



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