The Integration of Grain Markets in the Eighteenth Century: Early Rise of Globalization in the West

Abstract

We present statistical and historical evidence in support of the hypothesis that globalization, if defined as the integration of international commodity markets, started in the 1700s and progressed, not without setbacks, gradually into the 1800s instead of suddenly appearing at some point after the 1820s. We use grain prices in Europe and the Americas to determine the extent and dynamics of market integration throughout the 1700s and 1800s. An innovative methodology, with special attention being paid to changes in residuals' dispersion of the univariate models of relative prices between markets, permits to obtain a measure of market integration over time. Decreasing dispersion –and therefore closer intra- and intercontinental market integration- can be seen until the disruption of the international economy caused by the French Revolutionary and Napoleonic Wars. Neither Argentina nor Mexico participated in the integration of grain markets across Europe and North America. We observe a general and substantial increase in dispersion during the late eighteenth and early nineteenth centuries. After this major backlash, market integration resumed at an unprecedented pace since it was favored by the Industrial Revolution and other changes. The resulting picture is that of globalization as a relatively early, long, non-monotonic and gradual process. Significant levels of intra- and intercontinental market integration had already been reached in the West before the Industrial Revolution.

Keywords: economic history, market integration, globalization, time series analysis
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1 Introduction

We agree with Federico's claim: "*Market integration is one of the hottest topics in economic history*".[1] Indeed, an increasing number of scholars are dealing with it and other related issues. We also share Federico and Persson's (2007) opinion on the pioneer role that the research agenda developed by Jeffrey Williamson has played in the popularization of the two interconnected themes of market integration and globalization.

In this paper, we attempt to empirically test the set of ideas that forms the core of the canonical

1 Federico, 2008, p. 3.

version of globalization as established in O'Rourke and Williamson (1999, 2002, 2004). To these authors, globalization means *'the integration of international commodity markets'*.[2] They do not see evidence of '*significant pre-nineteenth century global price convergence*'.[3] The reason for that is the important role played in their narrative of globalization by the transport revolution of the nineteenth century resulting in the "*amazing*" decline in the cost of moving goods between markets: '*it was falling transport costs that provoked globalization.*'[4] Summarizing the canonical version: '*Globalization became economically meaningful only with the dawn of the nineteenth century, and it came on in a rush*.'[5] Not always minor qualifications to the canonical version of globalization may be found in a literature that grows in volume, as well as either in geographic and historical scope and in technical sophistication[6]. However, it remains very much influential, and not without good reason.[7]

In an attempt to assess the differences between alternative views on the essence and timing of the historical process of globalization, De Vries (2010) distinguishes between "soft" and "hard" globalization. To this author: '*Evocations of a compressed and intensified world may be called 'soft globalization'*'[8]. De Vries' notion of "hard" globalization is basically identical to that of O'Rourke and Williamson. He also denies the possibility of its existence in the Early Modern Era: "*This was an age of soft globalization, not of hard globalization.*"[9]

"Hard" globalization –hereinafter simply globalization- is the subject of this paper. We present statistical and historical evidence in support of the idea that globalization, even if defined as the integration of international commodity markets, started in the 1700s and significantly progressed, albeit gradually and not without experiencing setbacks of varied intensity and duration, into the 1800s. Thus, the canonical period of globalization was preceded by a long-lasting previous phase of increasing intra- and intercontinental integration of grain markets. By the late eighteenth

2 O'Rourke and Williamson, 2002, p. 25
3 O'Rourke and Williamson, 2002, p. 26
4 O'Rourke and Williamson, 1999, p. 35
5 O'Rourke and Williamson, 2002, p. 109. In later works, these authors show an increasing interest in developments that took place in the Eighteenth Century. See O'Rourke and Williamson (2005) and O'Rourke et al. (2007).
6 See i.e. Ejrnaes and Persson (2000), Llopis and Jerez (2001), Jacks (2004, 2005, 2006), Dobado and Marrero (2005), Llopis and Sotoca (2005), Challú (2006), Bateman (2007), Shiue and Keller (2007), Özmucur, S. and Pamuk (2007), Federico and Persson (2007), Federico (2008), Studer (2008), Van Bochove (2008) and Rönnbäck (2009).
7 See e.g., Findlay and O'Rourke (2007), O'Rourke, Prados and Daudin (2008), Daudin, Morys and O'Rourke (2008).
8 De Vries, 2010, p. 711. Flynn and Giráldez (2004) offer a definition of globalization according to which it *"began when the Old World became directly connected with the Americas in 1571 via Manila."* Flynn and Giráldez, 2004, p. 82.
9 De Vries, 2010, p. 731.

century, the integration of grain markets between the US and Europe and within Europe had already reached high and unprecedented levels.

This new perspective is reached by means of expanding backwards the conventional time-span of the analysis as to include the first half of the eighteenth century and of widening the geography of markets considered by adding the US, and to a lesser extent Russia, to Europe in this story about an earlier and more gradual process of globalization than usually thought of. Other markets in the Americas (Argentina and Mexico) have also been studied but we do not find any evidence of their integration in the emerging international grain market of the 1700s.

Our research has been stimulated by Federico's study on the "*first European grain invasion*" and by that of Sharp on the "*long American grain invasion of Britain*"[10]. However, the latter author's analysis of intra-continental market integration starts in 1750 and finds that "*price dispersion remained roughly constant in the second half of the 18th century.*"[11] Sharp reckons that "*some degree of long run market integration was already present in the trade in wheat between the US and the UK from the eighteenth century.*"[12] Nonetheless, he disregards the effects of the growing US exports of grain and flour to continental Europe in that period.

Therefore, our results not only offer a wider perspective of the globalization process in terms of time and space but also, reinforcing those by Rönnbäck (2009), might contribute to make the distinction between "soft" and "hard" globalization less clear. This author after studying the convergence of prices of a number of commodities other than grain (sugar, tobacco, cacao, etc.) from mid sixteenth to late eighteenth centuries, concludes that "*the issue of an 'early globalisation' can not be dismissed as easily as has often been done so far.*"[13]

The specialized literature has generally disregarded the possibility that the canonical period of globalization could be viewed as the recovery of a previous trend initiated in the late Early Modern Era. Likely, that is probably due to the impact on the international integration of markets for goods and factors resulting from the nineteenth-century revolution in transport and communications. A certain artificial divide between those scholars dedicated to the pre-industrial period and those who are mostly concerned with developments associated to the first stages of the process of modern economic growth may have contributed to the absence of a very long-run perspective of the

10 See Federico (2008) and Sharp (2008a).
11 Federico, 2008, p. 50.
12 Sharp, 2008a, p. 16.
13 Rönnbäck, 2009, p. 96.

globalization process. Additionally, the disruption of the international economy founded by O'Rourke (2006) during the French Revolutionary and Napoleonic Wars, confirmed by the intra- and intercontinental disintegration of grain markets that we also observe, might have been misinterpreted. In our opinion, the intense and widespread disruption of the 1793-1815 period may be considered as such precisely because it interrupted a long-lasting trend towards closer national and international integration of markets in the West, being those of grain included in that dynamic. This idea is consistent with some works in which grain markets in some parts of Europe are shown as being well and/or increasingly integrated during the eighteenth century[14]. Moreover, the notion of the recovery at some point after 1815 of a pre-1793 long-lasting trend towards increasing market integration fits well with Jacks's claim that *"we can tentatively date the emergence of a truly international market for wheat from around 1835."*[15] This rapid emergence of an international market for wheat after an intense disruption of the international economy would be more difficult to explain otherwise. At the national level, in European countries -other than Britain, which according to Shiue and Keller (2007), might be considered an exception- significant increases in grain market integration have also been registered in the 1700s.[16]

In other words, it is our contention that if compared with the abnormally low levels of grain market integration of the exceptional late years of the Early Modern Era, the progress in the central decades of the nineteenth century seems causally disconnected from any previous historical precedent. However, when, as in this paper, the level and trend of the decades prior to the 1790s become the term of comparison, the picture looks different.

The skepticism about the possibility of globalization in the eighteenth century might also have been strengthened by an overestimation of the effects of mercantilism and warfare on market integration as far as grain is concerned. Certainly, as Findlay and O'Rourke (2007) reckon, restrictive mercantilists policies along with repeated and widespread international armed conflicts did not facilitated the integration of markets. However, pro-integration underlying forces (expansion of a "cereal economy" in the US and rapid population growth and increasing grain prices in Europe, in particular) seem to have been powerful enough as to compel

14 I.e. Persson (1999), Van Tielhof (2002), Jacks (2004), Bateman (2007), Özmucur and Pamuk (2007), Shiue and Keller (2007) and Van Bochove (2008).
15 Jacks, 2005, p. 399. To this author, "*much of the action in price convergence seems to have taken place well before mid-century*." (Ibidem).
16 See e.g., Chevet and Saint-Amour (1992), Llopis and Jerez (2001), Llopis and Sotoca (2005), Challú (2006) and Kahan (1988) for the cases of France, Spain, Mexico and Russia, respectively.

governments to adopt a series of ad hoc market friendly policies regarding grain (reductions in tariffs, liberalization of imports, suppression of medieval regulations on market functioning, etc.), if only because of the generalized political problem represented by feeding a growing number of subjects facing more and more expensive staples (Persson, 1999).[17] Economic agents (individuals and small-sized firms) seem to have responded positively to the new opportunities offered for doing profitable business in the market for grain, both domestically and internationally.

Additional eighteenth-century developments that favored market integration (improvements in transport and communications, reduction in other transaction costs, defeat of the piracy in the Mediterranean, etc.) may have been underestimated as well. On the other hand, while the effects of wars (Seven Years Wars, American Revolution, etc.) in terms of grain market integration are clearly perceptible, they did not always affect all grain markets intensely and/or for a long time. It is somewhat surprising to realize that, in the particular case of the grain trade and its consequences in terms of market integration, the effects of the wars shock frequently vanished more rapidly than usually assumed.

In summary, our picture of an early globalization in the eighteenth century is not one of anything close to a revolution but that of small incremental changes in multiple factors (policies, institutions and techniques) that gradually resulted in significant progress in intra- and intercontinental grain market integration. Geographical (easy access to the sea and availability of waterways in Europe and its "*proximity to America*"[18]) and historical (emergence of the US as important grain exporter) accidents are not irrelevant. Needless to say that our partial revision of the canonical version of globalization is influenced by the gradualist critique, initiated by Harley (1982), Lindert and Williamson (1982), Crafts (1985), to the traditional narrative of the British industrial revolution and by the scholarship offering a more optimistic view on economic growth during the Early Modern Era.[19]

Although this paper does not directly address the issue, in an attempt to put the early globalizing experience of the Western world in a wider context and stimulated by Shiue and Keller (2007) and Studer (2008), we have initiated a preliminary examination of eighteenth-

17 As pointed out by Persson (1999), "authoritarian liberalism", a combination of economic liberalism and political authoritarianism, was instrumental to the implementation, since the 1760's and not without setbacks, of reforms in the century-old grain market regulation of several European countries (France, the Habsburg monarchy, Scandinavia, Spain and Tuscany). The dismantlement of the traditional grain policies had started before in England.

18 The idea of the *"proximity to America"* as a factor favoring economic development in Europe (Findlay and O'Rourke, 2007, p. 361) also seems compatible with an early integration of grain markets across the Atlantic.

century intra-continental market integration in Asia.[20] Our tentative exploration does not find in the East anything similar to what is observed in the West. If confirmed by further analysis, this finding might be relevant in terms of the Great Divergence debate, since it would suggest that comparable levels of national market integration –*i.e.,* China and Western Europe, albeit not India, according to Studer (2008)- could be reached in different international contexts in terms of global policies, institutions and techniques, being the West far ahead from the East in this respect. This difference seems to confirm the importance attributed to foreign trade, in especial that between Europe and America, by Pomeranz (2001), Acemoglu et al. (2005) Findlay and O'Rourke (2007) and Galor and Munford (2008) to explain the rise of the West. In our view, predating the Industrial Revolution, the early phase of globalization that we find is causally related to and explained by Western economic advantages already existing in the first half of the eighteenth century. Thus, our research, if properly expanded, might also contribute to the long-lasting and intense inquire into the fundamentals of modern economic growth.[21]

The data used in the work consists of wheat prices series for a number of markets in Europe and the Americas, mostly referred to 1703-1815 period. In some cases the nineteenth century has been partially or totally included in the analysis. As a common unit of measure, we use prices in terms of grams of silver per liter of wheat.

An additional novelty of this paper is of methodological character. Our approach to the analysis of grain market integration is, to the best of our knowledge, unprecedented in economic history studies. We have performed statistical analyses for several time series of wheat prices to study the evolution of the underlying market integration process. We assume that changes in the dispersion of the unexpected shocks affecting the relative prices -approximated by the standard deviation of the innovations, hereafter SDI, of ARIMA models- can be interpreted in terms of market integration, when nominal prices follow the Law of One Price (LOP). Specifically, a reduction in the SDI suggests more rapid short term adjustment in the market and therefore increasing market integration. Formally, we consider that the LOP holds if: (i) nominal prices for the same commodity are of order one, I(1), and (ii) relative prices are stationary, I(0). These

19 See e.g., Persson (1988), De Vries (1994) and De Vries and Van Der Woude (1997).
20 An unpublished statistical and graphics appendix contains, among other items, these results, and is available from the authors on request.
21 The enormity of the relevant literature on the subject dissuades us from making any bibliographical reference.

conditions require that prices are cointegrated of order CI(1,1)[22], with cointegrating vector (1,-1), which implies a very strong relationship between prices. Regarding alternative methodologies applied in the specialized literature, this proves being a rather strict sufficient condition for the hypothesis of market integration to be accepted.[23]

In the following section we explain our theoretical and methodological approach to the analysis of market integration. The third section is dedicated to show the main empirical findings of our research. In Section 4 the principal economic implications of those findings and the historical evidence in support of our hypothesis are discussed. The paper ends with some final remarks.

2 Data, Model and Empirical Findings

2.1 Data

We consider ten series of yearly wheat prices in our empirical analysis: Amsterdam and Holland (H), Arévalo (inner Spain, A), London and Southern England (L), Gdansk (G), Milan (M), Strasbourg (S) and Vienna (V) in Europe; Buenos Aires (BA), Upper Bajío (Central Mexico, Mx), and Pennsylvania (P) in America. Albeit with some exceptions, the series cover the period 1703-1815 at least, with only a few missing observations. In some cases (H, L, P, V and S), time series also cover most of the canonical period of globalization. Geographical coverage allows studying the relationship between markets with different characteristics associated to the location (close, remote, interior or coastal markets) in America and Europe. More details on data are shown in Appendix 1.

In order to make prices more comparable, we use a common unit of measure for all markets. Thus, prices are expressed in grams of silver per liter of grain. When needed, the conversion from local units into grams of silver per liter has been made -see Appendix 1. Results obtained with prices in terms of silver are virtually identical to those resulting from using nominal prices. The reason is that silver prices in nominal terms did not significantly change either in Europe or America over the eighteenth century.[24]

22 x_t and y_t are said to be cointegrated of order CI(d,p) if x_t and y_t are both integrated of order d, but there exist a k such that $y_t = kx_t$ is integrated of order d-p.

23 See e.g., O'Rourke and Williamson (1999, 2002, 2004) and Federico (2008).

24 Nominal prices of silver in England and Holland were constant over the years 1703-1815 (0.46 and 9.6 grams of

Data (in logs) are depicted in Figures A.1 (America) and A.2 (Europe) -see Appendix 2. All graphs include the corresponding relative price (log differential) of all markets in the sample with London as the numéraire. Trends of wheat prices in Europe and Pennsylvania grew, especially from 1740 to 1815. The series that also cover most of the XIX century exhibit a brief fall at the end of the Napoleonic Wars and a gradual increasing trend since then. It appears that prices of wheat in Europe and Pennsylvania relative to London's could be represented as a constant plus a stationary stochastic perturbation. Different cases are Mexico and Buenos Aires, as prices in those markets do not show any increasing trend. As a matter of fact, some graphs in A.1 and A.2 show not only a possible common stochastic trend, but also covariation over time and coincident responses to far-reaching events (wars, revolutions, etc. see Table 3, 2). For instance, Europe and Pennsylvania exhibit signs of being closely interconnected within a strong relationship. Interestingly enough, the literature has so far, more or less explicitly, assumed that there might be a certain level of intra-continental integration while inter-continental integration would be a nineteenth-century phenomenon. Supporting findings by Sharp (2008a), new evidence demonstrates the existence of early grain market integration between Europe and North America.

In the following sub-section, we present the methodology employed to determine the level of market integration and its changes over time.

2.2 Methodology

We start our analysis by studying the non-stationarity of any (log) nominal wheat price included in the work.[25] For those series that are confirmed to be I(1), we test the non-stationarity of (log) relative prices. According to Forni (2004), by using this strategy -*i.e.*, by first analyzing the stationarity of nominal and then of relative prices- the cointegration relationship and the cointegrating vector (1,-1) are jointly tested, which is conceptually preferable and statistically

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silver per pence and guilder, respectively). This was nearly the case in most western markets considered, for devaluations were small and infrequent except in the cases of Strasbourg and Pennsylvania. The price of silver in Strasbourg remained constant from 1727 to 1789. After 1789 price fluctuates greatly owing to the intense monetary problems experienced by Revolutionary France. Price of silver in Pennsylvania remained almost constant over time except for the great devaluation occurred during the American Revolution. Therefore, our results concerning Europe and North America are robust to the change in the definition of the price (nominal or in silver) used. As to Hispanic America, monetary stability seems to predominate before the independence. The "real de a ocho" -a continental, and almost universal until the second decade of the nineteenth century, currency- was slightly devalued from 1727 to 1786 in three successive steps.

25 In the samples analyzed nominal price series need to be logarithmically transformed to avoid heteroskedasticity related to increasing mean, non-normality and non-linearity.

more efficient. The cointegration relationship between two (log) price series with cointegrating vector (1,-1) is closely related to the Law of One Price (LOP).[26] As a matter of fact, if $P_{it} = P_{jt}$, then the log relative price $R_{ijt} = \ln(P_{it} / P_{jt}) = 0$, which is a mathematical representation of the deterministic and dynamic notion of the LOP: in an efficient market, all identical goods must have only one price. Obviously, its stochastic counterpart allows R_{ijt} to suffer transitory variations, but a long run average constant in time. Note that this average could be different from zero since it responds to the existence of non-zero trading costs.

Therefore, we share with Persson (1999), Ejrnaes and Persson (2000) and Shiue and Keller (2007) that cointegration provides substantial evidence in favor of market integration[27], although in this paper we are more restrictive as we require a cointegrating vector (1,-1). That is, we require that the LOP holds. Nonetheless, we do not directly associate the LOP with the concept of market integration. In fact, we attempt at going somewhat further in the study of this notion. The second part of our empirical analysis comes from Engel and Rogers (1996), who argue in favor of using the dispersion of relative prices when studying market integration. However, our paper differs in that it uses a measure of residual dispersion of the univariate models of these (log) relative prices, instead of the variance of the relative prices themselves. Földváry and Van Leeuwen (2010) convincingly discuss the advantages of using these residuals instead of other commonly utilized statistical approaches –*e.g.*, coefficients of variation- for measuring market integration. In this respect, residual variance will reflect the share of shocks in total variance, *i.e*, the effect of unexpected events on price volatility. If markets are more integrated these unexpected events should have a reduced effect on relative prices. As a consequence, we will interpret a decreasing trend-like behavior in the residual dispersion as increasing market's ability to cope with the effect of shocks.

Let us consider that nominal log-wheat prices ($\ln P_t$) have the following properties: (i) a small number of influential impulse interventions in the series level, (ii) zero-mean, (iii) a second-order autoregressive, AR(2), structure with two conjugate imaginary roots, giving rise to damped oscillations with some period (in years), and (iv) a first-order moving average, MA(1), structure. The AR(2) represents a cyclic-like behavior where the period describes the time elapsed (in years)

26 See Persson (2008) for an explanation of the Law of One Price.
27 However, the economic interpretation of cointegration is not self evident –see Federico (2008). We share with him the idea that cointegration is not a sufficient condition of market integration in terms of the Law of One Price.

from peak to trough.

Generic univariate ARIMA model for P_t can be written as:

$$\ln P_t = \xi_t + N_t, \qquad (1-\varphi_1 B-\varphi_2 B)\nabla N_t = (1-\theta B)a_t, \quad a_t \sim \text{iidN}(0,\sigma_a^2); \tag{2}$$

where ξ_t represents a sum of intervention terms, each of the form $\omega_0 \xi_t^{I,t^*}$ for a parameter ω_0 at time t^* and ξ_t^{I,t^*} is 1 when $t = t^*$ or 0 otherwise. Moreover, ∇ is the difference operator such that $\nabla = (1-B)$, being B the backshift operator, *i.e.*, $B \ln P_t = \ln P_{t-1}$. If θ equals 1, the MA and the difference operator cancel out. In order to test the null hypothesis $\theta = 1$, the Generalized Likelihood Ratio (GLR) test by Davis *et al*. (1995) is used. Thus, model (2) allows $\ln P_t$ be I(0) or I(1).

As a logical consequence of applying logs to nominal prices, relative prices are equally transformed. As we explained above, we only use univariate analysis of log-relative prices to study pairwise cointegration relationships between markets. Consider now that $R_{ijt} = \ln(P_{it} / P_{jt})$ could have some interventions -as specified in (2)-, a mean and an AR(2) structure. Generic univariate model for R_{ijt} is expressed as:

$$R_{ijt} = \xi_t + \mu + N_t, \qquad (1-\varphi_1 B-\varphi_2 B)N_t = a_t, \quad a_t \sim \text{iidN}(0,\sigma_a^2). \tag{3}$$

When $\varphi_2 = 0$ or the AR(2) has real roots, we employ the test by Shin and Fuller (1998), hereafter SF, to contrast the stationarity of R_{ijt}.[28] However, when (3) presents imaginary roots SF is not justified. In such case an ARIMA(2,1,1) is estimated, where the null hypothesis of non-invertibility can be tested with GLR. If R_{ijt} is stationary, a cointegration relationship between $\ln P_{it}$ and $\ln P_{jt}$, with cointegrating vector $(1,-1)$, is then detected.

In those cases, we proceed to analyze how the residual dispersion obtained from modeling the (log) relative prices evolves over time. We will consider that a statistically significant reduction in residual dispersion indicates a reduction in the possibilities of arbitrage through a more rapid short term adjustment in the market and, therefore, increasing market integration. Two ways to study the evolution of the residual dispersion obtained from the estimated (log) relative price models are proposed. The first one consists in re-estimating the relative price ARMA models

in different subsamples and testing potential changes in their residuals variance. The second one is based on the visual analysis of the sample standard deviation calculated using rolling windows of a fixed span.

2.3 Empirical Findings

We begin by applying model (1) to our dataset. The results are presented in Table 1. Main findings are that the GLR test does not reject the null of non-invertibility for Mexico and Buenos Aires. Therefore, those series are I(0), while all others in the sample are confirmed to be I(1) and have an AR(2) structure with cycles of periods that go from 5.4 (Strasbourg) to 10.6 (Vienna) years. Table A.1 shows all the interventions, the extreme residuals at common years and their possible historical explanation, suggesting that contemporaneous relationships abound in this dataset. The number of coincidences also reveal how related the prices are. In most of the European series, intervention terms are defined for wars, *e.g.*, War of the Spanish succession, War of Jenkins' Ear or French Revolutionary and Napoleonic Wars. In Pennsylvania, the outliers coincide with the American Revolutionary War. In all cases, then, interventions are empirically and historically founded.

The second step of our methodology consists of analyzing the pairwise (log) relative prices. We use London as reference market in this analysis as it was considered the link between Europe and North-America. In theory, if the seven possible log-prices ratios with London are stationary, then any of the other log-price ratios, among the rest of the markets, are also stationary.[29] Results of the univariate analysis of the (log) relative prices, through the estimation of model (3), are reported in Table 2. The study has been carried out for different subsamples so that we can identify potential changes in the parameters. The subsamples have been chosen requiring, at least, 35 observations each. The estimated means ($\hat{\mu}$) are negative in all the cases and no significant differences between subsamples of the same series are observed, which indicates that, during the eighteenth century: (i) London exhibited the highest wheat prices and, (ii) no evidences of convergence in mean have been found. However, we do detect evidence of this type of convergence from the end of the Corn Laws (circa 1847) up to the 1860s, between London and Holland, Strasbourg, Vienna or Pennsylvania. This period of convergence in mean can be observed

28 We use Shin and Fuller (1998) instead of the more common ADF as it is more convenient for ARMA processes.
29 Theoretically, if two log-ratios with the same denominator are stationary, then the three series are stationary. Using the Pythagoras Rule one can easily understand and prove this conjecture. So it is unnecessary to study the stationarity of every pairwise relative price.

in Figures A.1 (plot A) and A.2 (plots B, D and F), and should be modeled so that the cointegration holds during the whole period (1700-1900). Nevertheless, although this question has economic and historical relevance, it is not the main goal of this paper and it is not utterly investigated here.[30]

[INSERT TABLE 1 ABOUT HERE]

The analysis reveals four main statistical arguments in favor of increasing market integration. First, SF's null hypothesis of non-stationarity is clearly rejected in any relative price, which implies a cointegration relationship -with cointegrated vector (1,-1)- between every nominal wheat price and London's. Second, Table 2 not only shows the existence of a non-stationary common factor in wheat nominal prices, but also common cycles that disappear when the relative prices are modeled. Arévalo is the only market whose nominal price does not present common cycles with the rest, probably because of its isolation from the sea and other waterways. Third, the first order autoregressive ($\hat{\varphi}_1$) is more persistent in the subsample 1703-1757 than in 1758-1792 (except in the case of Vienna), meaning that relative prices return faster to their constant long-term mean in the second subsample than in the first one. Fourth, residual dispersion is higher in the first half of the eighteenth than in the second one. In fact, Table 2 shows that the standard deviation of the residuals for wheat relative prices is always lower in the sample 1758-1792 than in 1703-1757. Note that, in this empirical regularity, wheat relative prices seem to converge to a residuals' standard deviation around eighteen per cent, which might be considered as the maximum possible degree of integration (with London) given the existing relevant conditions in terms of trade costs (transportation, communications, tariffs, etc.) before the French Revolutionary and Napoleonic Wars. In this respect, the last column in Table 2 presents the confidence interval at 90% for the ratio of the variances estimated in both subsamples, $a_1 : 1703-1757$ and $a_2 : 1758-1792$. When this confidence interval does not include the unity then $\sigma^2_{a_1}$ will be considered greater than $\sigma^2_{a_2}$ with 90% of confidence. Only G/L and P/L reject $\sigma^2_{a_1} > \sigma^2_{a_2}$ for this confidence level, probably because they started from the highest integration levels in the sample, close to the eighteenth-per cent threshold. To check the robustness of the results reported in Table 2, we carry out an

30 In the Unpublished Statistical and Graphics Appendix.

additional analysis with the same series in local currencies. The findings are very similar and the conclusions do not vary significantly.[31]

In attempt to place this early episode of Western globalization in a wider geographical and historical context, a preliminary analysis has been developed using some price series of rice for Asia (China, Korea and Japan). No evidence of intercontinental integration has been found so far, although, consistently with Shiue and Keller (2007) for the Chinese case, market integration at the national level (*i.e.*, Japan) is clearly perceptible.[32] If confirmed by further research, these differential results between East and West might have interesting implications for the debate on the Great Divergence.

[INSERT TABLE 2 ABOUT HERE]

Figure 1 depicts a measure of the integration degree between markets based on the standard deviation of the residuals obtained from fitting an ARMA model to the (log) relative prices. The graphs present the results mentioned above when it is evaluated in two subsamples (left plot) and when it is evaluated in four subsamples (right plot) with different reference markets. Subsamples have always been chosen so that there are enough observations to calculate the standard deviation (35 observations). Left plot of Figure 1 compares the residual dispersion in 1720-1754 and 1758-1792, using Pennsylvania and Arévalo as reference markets. The main conclusion is that the standard deviation is almost systematically lower in the second subsample even for these extreme denominators chosen: a city located in a different continent (Pennsylvania) or a market hundreds of miles away from the coast in inner Spain (Arévalo). L/P and H/P show an exceptional behavior, as there is no significant difference between their degrees of integration in the periods analyzed. An explanation to this fact could be that the integration between these markets, which had already achieved a high level in the first half of the eighteenth century, was more affected than the others by the American Revolutionary War. On the other hand, when the available data permit it, the right plot presents the residual standard deviation of every market within four subsamples: 1705-1740, 1758-1792, 1812-1847 and 1840-1875. The results illustrate: (i) an increasing integration during the second half of the eighteenth century, (ii) a stagnant integration in the next sixty years, and (iii) a speed-up of the integration that took place in the second half of the nineteenth century.

31 A complete analysis with local currencies is available in Unpublished Statistical and Graphics Appendix
32 Ibidem.

[INSERT FIGURE 1 ABOUT HERE]

Finally, Figure 2 shows the evolution over time of the dispersion of the residuals obtained from the relative prices using London as the numéraire. The series are calculated with rolling windows of span $t = 35$. Thus, at a specific period t each point is the standard deviation of that residual and the previous thirty-four. This allows us comparing the eighteenth century with the canonical period of globalization in terms of market integration. In fact, the residual standard deviation of H/L and P/L around 1896 could be considered an approximation to the maximum possible integration level before the twentieth century. Therefore, our approach indirectly yields an ad hoc metric of the process of market integration through the eighteenth and nineteenth centuries. Figure 2 shows a non-monotonic decreasing trend of the residual standard deviations -*i.e.* increasing market integration- during the eighteenth and the nineteenth century. This decreasing trend is cut by the French Revolutionary and Napoleonic Wars from, roughly, 1790-1800 (depending on the relative price). This maximum degree of integration reached was only recovered sixty years later, at the end of the Corn Laws, around 1850. Since then and up to 1896, residual dispersions converge quickly to a level of roughly seven per cent, reaching the maximum degree of integration of the period 1703-1896.

[INSERT FIGURE 2 ABOUT HERE]

3 Main economic implications and historical evidence

In the first half of the eighteenth century, several western markets had already reached a significant level of integration –see Figures 1 and 2. Thus, not only markets in the Baltic and the North Seas, but also in North America, Central Europe and the Mediterranean, show statistical signs of integration. Given the obstacles to market integration that presumably existed in the international economy, our results might be viewed are somehow surprisingly high and widespread, although they are limited to a minority among the many pairwise markets in our sample. As expected, confirming previous works by Van Tieholf (2002), Jacks (2004) and Van Bochove (2008), the Baltic and Holland are overrepresented in this initial group of early integrated markets, while other areas (e.g., particularly Arévalo) were, also predictably, much less integrated.

However, the integration of North America with Europe, not only with Britain, is statistically perceptible since the first half of the eighteenth century (i.e., Gdansk, Holland, London and Milan). This fact gives an intercontinental character to this early process of market integration and extends to the Continent the geographical influence of Sharp´s *"long American grain invasion of Britain"*.

During the central decades of the eighteenth century market integration generally increased within Europe and between Europe and North America, albeit not without setbacks of variable intensity and duration. More than half of the pairwise markets in the sample reached a SDI value below twenty per cent at some point in the second part of the eighteenth century. Only in a few pairs of markets an upward trend of the SDI values is registered. Arévalo, which, owing to geographic, economic and institutional factors (distance from the sea, poor communications, low agricultural productivity, comparative backwardness of Spain, etc.), may be taken as an extreme case, also participated in this common dynamic towards closer intra- and intercontinental market integration, albeit still maintaining high SDI values by any standard.

As to London, our reference market, its integration with the rest of markets in the sample increased in all cases. Nonetheless, an interesting pattern emerges. It may be described as a peculiar variety of β-convergence. Those markets less integrated with London initially (Arévalo, Milan and Vienna, especially) show a faster growth in integration, while those markets with a higher level of initial integration experienced a much slower dynamics (e.g., Pennsylvania and Gdansk). This is an indication of the wide geographical dimension of this early phase of globalization but also of its limits. Our measure of integration never reaches a value below fifteen per cent. In fact, a majority of markets seem to convergence to a threshold by late eighteenth century, with SDI values of roughly eighteen per cent. These values, which might be thought of in terms of the steady state associated market integration in the eighteenth century, are well above the minimum reached during the canonical period of globalization, whose steady state would be between five and ten in our metrics. Another illustration of this "bounded" process might be obtained by looking at the Pennsylvania grain market. Under the assumption of high substitutability between wheat and corn, the SDI value of the relative price of the two grains might be considered as the maximum level of integration possible in the 1700's, since it results from physically contiguous markets and lower transaction costs may be hypothesized. In fact, its SDI values over the century consistently are the lowest ones observed in our sample but still somewhat above those calculated for the Atlantic trade in wheat during the canonical period of globalization.

On the other hand, neither Mexico nor Argentina participated in the process that was taking place in Europe and North America. Thus, there was progress in globalization, not without limits, determined by the technical and economic conditions of grain trade and production in the second half of the eighteenth century.

Consistently with O'Rourke, all markets unequivocally experienced a substantial decrease in integration during the late eighteenth and early nineteenth centuries. The disintegration was high not only with respect to the preceding decade but also, in some instances -see Figure 2-, when compared to the first half of the eighteenth century. Our findings confirm Persson's intuition on the behavior of price dispersion in Europe during the French Revolutionary and the Napoleonic Wars[33]. They are also consistent with the sharp increase in European price dispersion shown by Federico (2008). The disruptive effects of military conflicts on market integration in the West were hardly new (e.g., Seven Years Wars and American Revolutionary War). On the other hand, although disintegration reached unprecedented intensity, duration and geographical scope during the French Revolutionary and the Napoleonic Wars, its effects in a number of markets were not significant until well into this period, or at least not especially intense. Therefore, the timing and the depth of the disintegration were not homogeneously distributed across our sample of markets. During the rest of the 1810's, 1820's and 1830's those markets for which we have information show that integration continued, albeit at levels below those that had been reached decades before.

Thus, the progress in globalization during the eighteenth century was followed, not without some exception, by substantial decline. This interruption of the process initiated in the 1700's very much resembles the one of the canonical period of globalization caused by the First World War and subsequent historical developments. This similarity reinforces our view of globalization as a gradual century-long lasting process. At the same time, the important setback in the late 1700's and early 1800's might have been an explanation of why the real progress of globalization in the eighteenth century has passed unnoticed. Most studies do not assess market integration over both two centuries since they mainly focus on the two last thirds or three quarters of the nineteenth century. Therefore the evolution of market integration, then, is somehow misleading since it starts at the abnormally high levels of disintegration resulting from the setback provoked by the French Revolutionary and Napoleonic Wars and their aftermath. A joint examination of the 1700's and 1800's proves to offer a more accurate perspective.

Starting from 1750, Federico (2008) analysis of the "*first European grain invasion*" avoids this bias. However, this author seems to downplay the progress in market integration across Europe and between North America and Europe that is perceptible –even in his work- during the second half of the eighteenth century (Federico, 2008, pp. 26-27). On the contrary, he claims that the integration of the European tallow candle market started in the eighteenth century (Federico, 2008, p. 32).

After the backlash, market integration resumed at some point in the second third of the nineteenth century. Favored by the transport revolution and changes in policy, the progress in market integration was especially rapid and widespread, as the canonical version of the globalization progress regards it. However, the duration and the intensity of the convergence in average prices –see previous section- across the Atlantic might have been overestimated in the conventional narrative of globalization (Persson, 2004; Federico, 2008).

From this interpretation some conclusions may be drawn: globalization started in the eighteenth century, long before the nineteenth-century transport and communication revolution and followed a dynamic that was gradual and non-monotonic rather than explosive and linear; a significant level of intra- and intercontinental market integration was reached in the West –albeit not in Argentina and Mexico- before the Industrial Revolution.

As to the first conclusion, we are well aware that the economic consequences in terms of mobility and prices of goods, services and factors of production in the early phase of the globalization process were of much lesser importance than in the canonical period. However, its real dimensions have been somewhat overlooked so far in the relevant literature. Besides, assessing why a phase of globalization was possible prior to any revolution in transport and communication offers interesting insights into the causes and consequences of modern economic growth.

The reinforcing interaction of several factors can explain such an important development –no matter how quantitatively limited these are compared to the canonical period- as the eighteenth-century start of globalization.

The emergence of the US and Russia as significant grain exporters to European countries took place earlier than usually recognized in the relevant literature. This important development was not overlooked by Braudel. He did not omit to mention the exports of wheat from Ukraine to Turkey,

33 Persson, 1999, p. 113.

France, Spain and Portugal (Braudel, 1992, pp. 108-109). Neither did he forget to point out the early presence of North-American wheat and flour in both Atlantic and Mediterranean Europe. From 1739 US grain and flour was unloaded in Marseilles.

As to the US, abundant evidence suggests that the cereal economy of the Thirteen Colonies might be well somewhat underestimated. Davies (1962) offers an interesting picture of the importance reached by the American cereals' exports to Britain by 1770-1774. Non-negligible volumes had already been imported when the Corn Law of 1774 inaugurated an era of "free trade" in grain between Britain and the US until 1815 (Sharp, 2008a). Rice imports almost equaled those of grain[34]. All rice and one eighth of the corn came from the US. While corn imports satisfied the increasing domestic demand, rice was almost entirely re-exported. Re-exports of rice were far from insignificant, as its growth was very fast –a six-fold increase between 1722-1724 and 1770-1774- and its value roughly a third of that of tobacco. Northwestern Europe was the main market, although re-exports to Southern Europe, small in magnitude as they were, had been growing rapidly as well. The Thirteen Colonies displaced other sources of rice's supply (i.e., Italy) and retained a near monopoly on imports over the 1700s (Coclains, 1993). An export-oriented industry experienced an early and rapid growth in Georgia and, especially, South Carolina made rice rank third among colonial exports by 1770 (Nash, 1992, p. 679). Shipments from this colony to Southern Europe started in the 1730s and accounted for thirteen to twenty-six per cent of total exports between 1717 an 1772 (Nash, 1992, p. 692)[35]. British imports in 1761-1770 almost equaled those of 1831-1840, representing more than a third of the figure of 1841-1850 (Coclains, 1993). South Carolina-Georgia region lost the Portuguese market to Brazil in the 1790's and shares of the European market to Italy, being (partially) crowded out from Great Britain by Asian exports by early nineteenth century (Coclains, 1993).

By the early 1770's it was not just only American rice that was crossing the Atlantic. According to Flavell (2010), wealthy rice planters were also visiting London (which she deems to be "*America's capital town*" by then) for "*business and pleasure*"[36].

There seems to be an interesting story of eighteenth-century market integration that involved

34 Rice was far from being irrelevant in the Western international economy of the eighteenth century, having diverse final and human uses (Coclains, 1993).

35 Quantities of rice exported from South Carolina became significant: eighteenth per cent of the grain shipments via the Sound plus the English exports of bread grains in the 1760´s. (Nash, 1992, p.689).

36 Henry Laurens "had travelled first-class, in one of the packet ships established by Britain to improve imperial communications". (Flavell, 2010, p. 11).

rice since more than a century before the period studied by Latham and Neal (1983) and Latham (1986).

We cannot hereby elaborate on the expansion of grain production and exports in eighteenth-century America, in spite of its intrinsic interest. By 1768-1772 significant quantities of grains were exported from the Middle Colonies to continental Europe, exceeding those that had Britain and Ireland as destination (Findlay and O'Rourke, 2007, pp. 234-235 based on McCusker and Menard)[37]. The importance of the Southern European market for the wheat from the Middle Colonies has been pointed out by Mancall et al. (2008). Exports of wheat and flour from the mid-Atlantic region increased in a half between 1768–1772 and 1790–1792 (Hunter, 2005). The figures offered by Findlay and O´Rourke (2007) reveal the importance attained by exports of cereals to the Atlantic and the Mediterranean in the economy of colonial British America as early as in 1768-1772. Assuming that most sugar and rum imported into Britain was produced in the Caribbean, cereals turn to be the main export, ahead of tobacco. In the late 1780's wheat and flour exports exceeded those of tobacco (Matson, 2006). Continental Europe was also the main market for grain and rice exports from the Upper South and the Lower South, respectively. American grain production and exports were responsive to the conditions in the Atlantic economy (North America, the West Indies and Europe) since the 1740's (Matson, 2006).

The most compelling argument supporting the notion of an early intercontinental integration of the market for grain has been made by Sharp (2008a). This author shows convincing historical and statistical evidence on the "long American grain invasion of Britain" that started by mid eighteenth century. This early "invasion" resulted in some degree of market integration for wheat in the Atlantic Economy. Exogenous shocks (trade policy, wars and politics) continuously interfered in the already ongoing progress of market integration between the US and Britain since long before the canonical period of globalization. Intercontinental exports of cereals may have not been very significant quantitatively. In spite of it, this author unequivocally concludes that *"some degree of long run market integration was already present in the trade in wheat between the US and the UK from the eighteenth century."*[38] Thus, Sharp's findings are consistent with ours. However, our hypothesis of an early beginning of globalization somewhat differs from his notion

37 In fact, grains exports to the Continent widely exceeded those going to Great Britain and Ireland. Continental Europe turns out to be as important a market as the West Indies.
38 Sharp, 2008a, p. 16.

of "proto-globalization".[39] We find that intercontinental market integration was a wider eighteenth–century phenomenon since it was not limited to the US and Britain[40].

As a result of diverse circumstances (territorial conquests, forest cleaning and transformation of meadows and pastures), the plow land area more than doubled between 1696 and 1796 in Russia (Kahan, 1985, p. 46). A relatively "late comer" to the expansion of world trade in early modern times, and one of the world granaries in the nineteenth centuries, Russia emerged as a new actor in the international grain market in the 1700's. As in other European countries, the State made a significant contribution to domestic market integration (purchases of grain for the armed forces, liberalization of grain trade in the 1760's, building of ports, canals and roads)[41]. New areas were cultivated along the Volga[42]. Outlets to the Black Sea, after two successful campaigns against the Turkish Empire in 1768-1774 and 1787-1792, constituted a landmark in the long history of Russia's integration in the international market for grain (Kahan, 1985). By 1791-1801 exports of wheat through the Black Sea ports had grown enormously and reached a significant level, since they exceeded that of the shipments through the Sound. The dominance of the Black Sea in Russian exports of wheat during the canonical period of globalization became by then established[43].

The share of grains in Russian exports grew from 2.9 per cent in 1710 to 16.9 per cent in 1769 and to 6.9 per cent in 1793 (Kahan, 1985, p. 168). As a result from this rapid growth –a fortyfold increase in annual current values from 1701-1761 to 1796-1805- grain came to represent one-fifth of total exports and ranked first among them in 1802-1805 (Mironov, 1992). The level of exports reached by early nineteenth century remained constant the following four decades. Russian exports of grains, facilitated by the foundation of Saint Petersburg in 1703 (Unger, 1959), became

39 Sharp, 2008b.

40 It is probably not just anecdotal that the first war waged abroad by the US –Barbary War of 1801-1805- seems to some extent connected with the protection of the American trade in grain with the Iberian Peninsula and the Mediterranean. Fighting piracy in this sea, as urged by Jefferson in 1785, was one of the goals of the Naval Act of 1794 and the subsequent construction of a powerful six-frigate fleet. Some of them participated in the first Barbary War. In 1790, Jefferson estimated that one sixth of American exports of wheat and flour and *"some rice, found their best markets in the Mediterranean ports"* (Jefferson, 1907, vol. 3, pp. 94-95).

41 A detailed description of the processes of agrarian expansion and market integration in eighteenth-century Russia in Kahan (1985)

42 Migration of Germans –among them, the Mennonites (McNeill, 1992)- to the banks of the Don and the Volga in the second half of the eighteenth century made a significant contribution to the expansion of agriculture in the southern Russian Empire.

43 It turns out that consequences of warfare –e.g., Russo-Turkish conflicts of the second half of the eighteenth century- not always seem to have been negative for international market integration (e.g., the expansion of the US throughout the West or the conquer of the pampas in Argentina, both at the expense of the aboriginals peoples).

important internationally[44], moving upwards in response to a bad harvest in Western Europe (Nash, 1992).

Spain, a net importer of grain, constitutes a good example of the case we are trying to make. Geographic, institutional and policy obstacles had traditionally conspired against market integration. Free trade on grain was approved in 1765, following a partial liberalization of imports adopted in 1756 and 1757. During the American Revolution, wheat and flour exports found a niche within the Spanish Monarchy, commonly assumed to be the epitome of mercantilism. Cuba was allowed to trade with the US and became an important outlet for American flour (Cusick, 2000; Hunter 2005). Some shipments had already been arriving onto the island on an irregular basis since the 1760's (Johnson, 2002). In 1797, as a consequence of British Navy's efficiency at blockading the Atlantic maritime routes, the Spanish government authorized the "commerce of neutrals" with the Hispanic territories in America. US exports of wheat flour peaked in the late 1810's; not reaching similar levels until circa 1870 (Salvucci and Salvucci, 2000).

Even more interestingly, American exports of wheat and flour were given access to the Peninsula and the Canary islands long before the boom of 1812-1814 (Hunter, 2005). The main Spanish port, Cadiz, located in the confluence of the Atlantic and the Mediterranean had been receiving significant quantities of wheat and flour from Northern Europe, Italy and Western Mediterranean, Eastern Mediterranean and Black Sea, North America and Atlantic Africa-Barbary reached Cadiz at least from 1768 to 1806 (Martínez Ruíz, 2005)[45]. Other coastal towns were also dependant on imports to satisfy their increasing demand of grains in response to their growing population and economic specialization. By late eighteenth century, Cataluña imported almost forty million metric tons of wheat annually (Martinez Ruiz, 2005, p. 47). Along with Barcelona, other important Mediterranean towns –i.e., Alicante and Valencia- also relied on imports for satisfying their local demands of wheat and flour (Alberola, 2001).[46] More instances of the presence in the Spanish shores of grain imported through long-distance trade during this period

44 According to Kahan (1985), 39.5 and 6.5 per cent of total shipments of rye and wheat through the Sound, respectively, in 1738-1741; 23.2, 9.7 and 15.3 per cent of total shipments of rye, wheat and other grains, respectively, in 1768-1772 (Kahan, 1985).

45 Non-negligible imports of wheat from the Baltic arrived in Cadiz, through the intermediation of Dutch merchants and carriers, during the late seventeenth and early eighteenth centuries (Crespo, 2007). In some cases, wheat came from as far as the northern Russian port town of Archangel (Crespo, 2001). In 1777, almost ten per cent of Russian exports of wheat via Saint Petersburg had Spain as final destination (Guimerá, 1998). The Scandinavian found a niche in shipping wheat from Russia and other Baltic ports to the Mediterranean [Johansen (1992)]. Dutch vessels were also very active as carriers of Russian re-exports to Portugal and the Mediterranean.

46 American wheat started to reach Alicante in 1777 (Alberola, 2001, p. 251).

might be reported (Basque Provinces, Mallorca, Malaga, etc.).

Martin Corrales's (1989, 1990, 1995, 2007) extensive work on the trade between the Spanish Mediterranean towns –Cadiz included- and the Levant and Northern Africa offers substantial evidence regarding the importance reached by grain imports from those destinations by late eighteenth and early nineteenth centuries. Although not easily determined, he states it is possible that significant quantities of the wheat that arrived to Eastern and Southern ports were originally Russian. This author also mentions a factor that surely contributed to the closer integration of Spain into the Mediterranean wheat market: decreasing piracy. The Spanish Navy increased its effectiveness at suppressing Muslim piracy on Spanish coastal provinces and vessels since mid eighteenth century. Between 1767 and 1791 Treaties of Peace, Friendship, and Commerce between the Hispanic Monarchy and Morocco, the Ottoman Empire, Tripoli, Alger and Tunisia were signed (Martin Corrales, 2007, p. 510).

As in other European countries, domestic market integration increased in Spain during the second half of the eighteenth century (Llopis and Jerez, 2001; Llopis and Sotoca, 2005). A similar process is observed after the 1780's by Challú (2006) in Mexico. In contrast to the metropolis, the colony did not integrate in the international market for grains, in spite of the flour exports to the Caribbean via Veracruz. In fact, late eighteenth-century Spanish absolutism, albeit not always consistent, may be viewed, as far as grain imports are concern, as less protectionist than its liberal successor, especially in 1820-1869. As it is well known, grain protectionism also increased in Britain after 1815.

It is, then, far from surprising that our empirical results show a rapid advance of the integration between Arévalo –an important grain market, located hundreds of miles away from the coast in inner Spain, from which wheat for the capital town was dispatched- and Pennsylvania[47].

Furthermore, other interesting developments were taking place within the Atlantic that involved the American territories of the Hispanic Monarchy.[48] The most surprising is the trade in grain and flour between the British colonies in North America and the Canary Islands during the

47 A detailed study on the early and consistent significance over the eighteenth century of the Iberian Peninsula for the US grain and flour exports in Lydon (2008).

48 During most of the eighteenth century, Cuba's demand for wheat and flour was satisfied via imports from Spain and Mexico, while the rice consumed in the island's elite and occasionally by the military garrison seems to have come, at least in part, from the Peninsula (Parcero, 2005). American and French flour was re-exported from the Peninsula to Havana and Caracas (Moreno, 1992). Flour was exported from Mexico to other Hispanic American territories (Ortiz de la Tabla, 1978). Exports of wheat from Chile to Peru were common during the colonial period and predated those made to California and Australia in the canonical period of globalization.

second half of the eighteenth century (Hernández González, 1995-1996). After the independence of the US, a decrease in the Spanish tariffs on flour triggered the re-exports of North American flour from the Canary Islands to Cuba (Hernández González, 1995-1996). The flour industry that had been established in Northern-central Spain during the second half of the eighteenth century aiming at exploiting the competitive advantage created by two public works (Canal of Castile and Royal Road from Santander to Reinosa) for serving the Hispanic American market disappeared by early nineteenth century owing to the US competiveness. By then American exports of flour had reached the South Atlantic. They started to arrive in Brazil after the liberalization of foreign trade in 1808, being in 1822 only second to those sent to Cuba, which in turn had already surpassed other destinations in the Caribbean.[49] American exports had neither minor nor ephemeral economic consequences.[50]

The early presence of wheat in Chile was also noticed by Braudel (1992, p. 109). Exports of wheat from Chile to Peru were common during the colonial period and predated those made to California, Australia and the Pacific (Bolivia, Ecuador and Polynesia) in the mid of the 1900's. According to Caceres (2010), by late eighteenth and early nineteenth century, those exports averaged 10,000 metric tons per year.[51] This figure is comparable to those to California in the Chilean wheat export boom caused by the Golden Rush. It also is clearly higher than that of exports to Australia and the Pacific in the 1840's and the 1850's. After being interrupted in the decades following the independence, wheat exports to Peru resumed in the 1840's. While they peaked in some years at levels that were three to four times higher than in the late Bourbon period, the average during the second half of the nineteenth century did not even double it.

Thus, the presence in the international market of the main grain exporters (the US and Russia) during the canonical period of globalization had actually already started in the 1700s. It was favored by pro-market changes, albeit with setbacks, in the grain policy of the European states in response to the failure of the medieval regulations when confronted with an increasing population (Persson, 1999). Grain seems to have been subject to an ad hoc consideration by governments within the context of mercantilism if only because of the strength of the political represented by feeding their subjects. Albeit not always consistent their policies, favoring free national and

49 A high differential in prices and a better quality domestic production.

50 They displaced commercial production of wheat in Rio Grande do Sul and contributed to the reorientation of agricultural production in this province. American flour constituted the most important Brazilian import from the US during most of the nineteenth century.

international trade in grain -either conditional and/or temporary or not- contributed to the unprecedented level of grain market integration reached in Europe long before the Free-trade Era. In short, it is doubtful that mercantilist principles ruled the grain markets in Europe since the 1760's. As opposed to navigation, manufactures and colonial goods, rather the contrary seems to be true. There may have been some order in the mercantilist jungle after all.

Some of the obstacles to globalization in the Early Modern Era found by De Vries (2010), O'Rourke and Williamson (2002 and 2004) and Findlay and O'Rourke (2007) might not apply to grain trade in the West. In contrast to the European trade with Asia, national and international commerce in grain was not monopolized by a few privileged companies (VOC, EIC, etc.). For the Dutch case, Van Tielhof (2002) is clear in this respect[52]. In others, less competitive markets might be operating. In any case, all available information suggests that market structure underlying grain transactions across North America and Europe was much more competitive than the one reigning on overseas trade[53]. This significant difference influenced market power and mark-ups and, hence, transaction costs. Thus, it may be seen that institutions and policies matter for market integration.

Moreover, the volume of the grain trade within the West was significantly bigger than the Asian-European trade. Between 1700 and 1759, the yearly average volume of English and Baltic exports of grain doubled that of the tonnage, ballast included, of the vessels involved in the commerce between Asia and Europe[54]. In the 1790's grain trade through the Sound exceeded the former in forty per cent[55] . The yearly average of grain arrivals to Amsterdam during the 1700's was 10 per cent higher than that of the Asian-European trade[56]. By late eighteenth century, total cereals exports, including flour, by the US alone surpassed the Asian-European trade in a ratio of 1.5 to 1[57]. Although estimating the total volume of grain traded in European continent is a difficult

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51 See: www.economia.unam.mx/cladhe/registro/ponencias/453_abstract.doc. Visited on 09/30/2010.

52 *"Most of the Dutch trade ad shipping, including that to the Baltic, was characterized by free enterprise: many individuals were striving after profit in competition with each other. The most important exception to the rule was the trade to the West and East Indies."* Van Tielhof, 2002, p. 117.

53 An interesting example from a different geographical and institutional context is offered by the Mexican port-town of Veracruz. According to Widmer (d.n.a.), in the wheat flour trade with La Habana *"some 70 merchant companies were involved. During the first decade of the nineteenth century, the degree of concentration was relative low: the 15 main exporters do not even account for half of the shipments"* (Widmer, d.n.a., p. 111) [our translation from Spanish]. Less competitive was the institutional setting behind the comparatively small trade with Campeche: an agreement between the municipality and an individual firm provided 50% of the shipments. In any case, differences with the big European chartered companies involved in overseas trade were significant.

54 Estimated with data from Van Tielhof (De Vries (2010, p. 716) and Von Tielhof (2002, p. 53).

55 Estimated with data from Van Tielhof (De Vries (2010, p. 716) and Von Tielhof (2002, p. 61).

56 Estimated with data from De Vries and Van Der Woude (1997, p. 417) and De Vries (2010, p. 716).

57 Estimated with data from Shepherd and Walton (1972, p. 194) and De Vries (2010, p. 716).

endeavor, it seems safe enough to claim that it was several -and probably many- times bigger than overseas trade. Thus, the objection to the existence of globalization before the nineteenth century based on quantitative (per capita or absolute) irrelevance ought to be reconsidered, at least partially, as far as grain is concerned.

In the 1700s, in spite of mercantilism and almost constant warfare between Western powers, foreign trade increased substantially. It is true that repeated wars of unprecedented scale between the Western powers in an almost worldwide theater (Europe, the Americas and Asia) conspired against international market integration during most of the eighteenth century. In this respect, it is interesting to note that the effects of the Jenkins Ear War, the War of Austrian Succession and the American Revolution, not to mention the French Revolutionary Wars, are clearly perceptible in our quantitative results –see Appendix 2, Table A.1. Certainly, it is observed frequently that those effects of war affect all or most markets in our sample over a shorter or longer period. This finding is consistent with O'Rourke (2006) and Findlay and O'Rourke (2007). The idea is in tune with the high costs of war and military expansion in terms of trade estimated by Glick and Taylor (2010) and Acemoglu and Yared (2010) for 1870-1997 and 1985-2005, respectively. Nonetheless, it is also perceptible that not always intense effects persist all along the duration of the conflicts in all, or most, markets. Moreover, our results show –i.e., Figure 2- that integration continued rising during part of the 1793-1815 period between some markets. Coincidently, only a few interventions of residuals have been necessary in those years and they concentrate in just a few markets, or a few years. Thus, warfare matters but, as for mercantilist policies, excessive generalizations ought to be avoided.

Indeed, neutrality proved very beneficial for the shipping and trading companies of Denmark-Norway, even after the 1790´s (Andersen and Voth, 1997). By increasing its tonnage and its market share, the Swedish merchant fleet also took advantage from neutrality, in particular in the Mediterranean (Johansen, 1992; Müller, 2006). The tonnage of the Western -the Netherlands excepted- merchant fleet grew significantly –roughly a threefold increase- between 1670 and 1780, especially in the cases of North America, Scandinavia, France and Britain (Maddison, 2003). The series of Dutch volume of trade constructed by Van Zanden and Van Tielhof (2009) shows, in the second half of the eighteenth century, a resumption of growth after the long quasi-stagnation of 1650-1750. The value added of the Dutch shipping industry by these authors experienced rapid growth during the same period. The dramatic fall caused by the Fourth Anglo-Dutch war was

followed by a strong recovery.

Foreign trade experienced significant growth in most American and European countries –e.g., Britain, France, Russia,[58] Spain[59] and its territories in America and the US, among others. The reconstruction by Cuenca (2004) of the British and French foreign trade of the late eighteenth and early nineteenth centuries shows a detailed, and somewhat surprising, picture. Total trade of the two countries grew by almost fifty per cent –roughly 1.3 per cent annually- between 1787-1789 and 1816-1820 despite their nearly permanent state of war during the period. At the end of the Napoleonic Wars, Britain had almost doubled its trade while that of France had decreased in more than a third. In other words, it was not just a zero sum game.

Trade of the US with the two countries grew even faster, with its annual growth rate close to four per cent. In 1787-1789, the US was a significant market for British domestic exports (Findlay and O'Rourke, 2007). According to estimates by Cuenca (2004), they turned out to be a more important trade partner in the late 1810's. US exports to Britain increased by 5 per cent annually between 1787-1789 and 1816-1820, while the growth of British domestic exports into the US was 4.2 per cent. Although much smaller in size, trade with France also grew at a rapid pace -3 per cent annually- in these turbulent years. Therefore, it seems that neither independence nor conflicts in Europe –maritime blockades and other interferences in trade included- or the Anglo-American war of 1812-1815 prevented commercial relations across the North Atlantic from flourishing. Cuenca (2004) argues that vessels from neutral countries gained an increased share of British cargoes in the Anglo-American trade since the British merchant fleet was deeply involved in the war effort. A sort of substitution effect between belligerents and neutrals operated in the Atlantic and the Mediterranean seas. Thus, it well might be that Müller is right when claiming that warfare had *"less negative impact on the functioning of the eighteenth-century trading system than some historians believe."*[60] Nevertheless, our empirical results, confirming those of O'Rourke (2006), show that, in terms of intra- and intercontinental integration of grain markets, the negative impact did exist between 1792 and 1815. Less impact is quite different from no impact.

58 Russian foreign trade in real terms increased around fifteen fold over the eighteenth century [Kahan (1985)].
59 The third global geo-strategic player in the turbulent eighteenth century was Spain. As such, it participated, forcibly or otherwise, in most of the conflicts that took place in the various theaters of war (Americas, Asia and Europe). The new series of Spanish private imports from Hispanic America in 1747-1820 elaborated by Cuenca (2008) shows that, at its peak in 1791, just before the 1792-1815 years, they had been growing –bullion excluded- at a surprisingly high annual rate: almost six per cent in constant prices, in spite of dramatic setbacks in 1761, steep fall in c. 1776-1782 and inter-annual fluctuations all through the period.
60 Müller, 2006, p. 43.

Thus, the potential for globalization in the eighteenth century seems to have been not fully exploited instead of, as it is claimed by O'Rourke (2006), being *"constantly frustrated by mercantilist policies and warfare."*[61]

Transport revolution does not seem to have been a necessary condition for the wave of globalization that swept through the second half of the twentieth and probably neither for that of the canonical period, for that matter.[62] Hummels (2007) does not find any clear downward trend in the prices of ocean shipping during the second era of globalization. Changes in communications and the Internet revolution appear to have been more important in fostering international integration. Mohamed and Williamson (2003) shares Hummels's view on the issue. Persson argues that the fall in transport costs from New York to UK ports during the second half of the nineteenth century was *"neither sharp nor dramatic."*[63] Jacks and Pendakur (2008) do not attribute a primary role to the maritime transport revolution in the explanation of the trade boom of the late 1800's. Thus, globalization could occur without a transport revolution in the eighteenth century.

In any case, Bogart (2005a, 2005b, 2009) shows that transport in England had experienced substantial improvements since long before the arrival of the railways. Similarly in their non-revolutionary essence, if not necessarily in degree, improvements in roads, canals and ports took place in other European countries (i.e., France, Russia and Spain). Besides, maritime transport, if only because of higher regularity and predictability, did not remain stagnant in terms of its contribution to market integration. Our intuition is that freights fell, albeit in an undetermined, and most likely small, if compared with the nineteenth century, proportion. Some indirect indication of the reduction in the CIF price of grain reaching European ports may be found in Manera (1999), since maritime insurance rates in Mallorca decreased over the eighteenth century.

On the other hand, Van Tielhof (2002, pp. 156-166) convincingly shows substantial improvements in the postal system which resulted in a faster, cheaper and more regular

61 O'Rourke, 2006, p. 124.
62 Hummels (2007) does not find any clear downward trend in the prices of ocean shipping during the second era of globalization. Changes in communications and the Internet revolution appear to have been more important in fostering international integration. Mohamed and Williamson, although claiming 'that Freight rates did fall globally´ (Mohamed and Williamson, 2003, p. 28) between 1869-1913, also reckons, based on Hummels' work, that 'commodity-deflated real freight rates hardly fall at all' over the half century following 1950 (Mohamed and Williamson, ibidem). Jacks and Pendakur *"find little systematic evidence suggesting that the maritime transport revolution was a primary driver of the late nineteenth century global trade boom"*. (Jacks and Pendakur, 2008, p.5).
63 Persson, 2004, p. 125.

transmission of commercial information between Amsterdam and Baltic markets. As an externality of these improvements, *"the privileged position of Amsterdam as a centre of information"* was damaged.[64] Increasing efficiency in the Prussian postal service is also pointed by Van Tielholf (2002). Van Bochove (2008) concludes that *"substantial improvements in the quality and speed of information"* caused the narrowing connection of Northern-European wheat markets to each other over the 1700s.[65] More or less progress in postal services across the West may be safely assumed in the early phase of globalization. More generally, the importance of the improvements in information transmission during the second quarter of the nineteenth century, some decades before the diffusion of the electric telegraph, for the growth of trade and market integration has also been argued by Kaukiainen (2001).[66]

Chevet and Saint-Amour (1992) emphasize the role of information in the integration of French regional markets before any significant amelioration in transport networks. A similar claim is made for eighteenth-century Spain by Llopis and Sotoca (2005). Roehner (1994) offers an interesting explanation of the processes of regional, national and international integration of markets in which he distinguishes between transport of wheat and transmission of information. Being the later an integral part of the integration of markets, he suggests the idea of arbitrage as resulting in an "*effet de contagion de proche en proche.*"[67] Therefore, the progress in functional interdependence between markets did not need the wheat to be transported over long distances. Market integration, then, is not just only about transporting grain physically between markets but also, and importantly, about transmitting information between them. Information seems to have been more efficiently transmitted during the eighteen century. Thus, volumes of grain, in spite of being comparatively significant by any relevant standard of the period, did not need to be as huge as many scholars seem to assume more or less explicitly.

Transaction costs other than transport and communication seems to have experienced decreases as well.[68] Van Tielhof (2002) shows substantial reductions in transaction costs (taxation, storage and measuring costs included) associated to the grain trade in Amsterdam from 1730

64 Van Tielhof, 2002, p. 164.
65 Van Bochove, 2008, p. 55.
66 This author, quoting Steele, also reckons that some progress in the communication over the North Atlantic had already been made as early as in the late seventeenth and early eighteenth centuries thanks to the growing number of ships crossing the ocean and the emergence of novel service business (post and newspapers).
67 Roehner, 1994, p. 356.
68 Van Tielhof (2002) shows substantial reductions in transaction costs (taxation, storage and measuring costs included) associated to the grain trade in Amsterdam from 1730 onwards.

onwards. As far as tariffs were concerned, this was also the case in all European countries that somewhat opened their national markets to foreign concurrence. However, the policy on grain imports was not always consistent (Persson, 1999). In spite of it, widespread trade liberalization of the 1800s had, as far as grain is concerned, in the 1700s. In fact, some countries –e. g. the UK (Corn Laws) and Spain (prohibition of imports)- adopted a more protectionist grain policy in the first half of the nineteenth century than in the second half of the eighteenth century.

Even in the case of the trade on exotic overseas commodities, conventional wisdom might be in need of reconsideration –i.e., Rönnbäck (2009). Interestingly enough, in his defense of an "early globalization" of colonial goods, this author observes that the efficiency and openness of markets as well as handling and wastage costs matter for market integration.[69] That the world coffee market had reached a high degree of integration by the second half of the eighteenth century is claimed by Topik (2003). His explanation points in a similar direction.[70] Furthermore, O'Rourke and Williamson (2009) may be interpreted as recognizing the increasing integration of European markets for species in the Early Modern Era after the Vasco de Gama's voyages.

In brief, many small, incremental –albeit not revolutionary- changes in almost every relevant variable conducting to closer intra- and intercontinental market integration may be found in the eighteenth century.

4 Final remarks

If we accept O'Rourke and Williamson's definition of globalization as international commodity markets integration, our findings, then, seem to allow us to conclude that the beginning of globalization is perceptible several decades prior to the canonical period. From this perspective, our work may be considered a partial revision of the standard version of globalization since it emphasizes an earlier origin, a non-explosive initial development, a longer duration and a non-monotonic evolution over almost two centuries (central decades of the 1700s to 1913).

In other words, the undeniable globalization boom in the mid nineteenth century was preceded by a "mini-boom" of more limited economic consequences in the second half of the eighteenth century. From a very long-run perspective, our picture is one of globalization as a less explosive

69 Thus, some inter-continental convergence in prices of coffee, tea, cloves and pepper during the early modern era might result from pro-convergence factors of this type –e.g., deregulation of monopolies, reduction in handling and wastages costs.

70 *"Improved warehouse capacity, port facilities, bulk freight, and predictable freight lines reduced the intermediation costs."* Topik, 2003, p. 29.

phenomenon as it had a first phase from the 1750's to the 1790's, or beyond in some cases, that converted it into a more gradual process than usually recognized in the specialized literature. Besides, the post-1914 globalization backlash might turn to be not strictly unique as it would have had a historical precedent in the enormous disruption of international trade caused by the Revolutionary and Napoleonic wars.

Logical extensions of this work include:

1) Further exploitations of the results from the time series analysis performed so far. On the one hand, at the empirical level, it would be interesting to study and compare the convergence in mean detected for the relative price with London as the numéraire from the end of the Corn Laws up to the 1860s. Do some relative prices converge faster than others? Which ones and why? Do they converge to the same value? On the other hand, some new perspectives on the causes and consequences might emerge from the assessment of the common cycles observed in the series.

2) Wider explorations of the factors behind the mid-eighteenth-century "mini-boom" of globalization at the national and international levels (transaction costs, speed of information diffusion, policies towards grain markets, etc.). It might be fruitful to estimate a model of market integration in order to determine the relative importance of the variables that explain its progress during the early phase of globalization.

3) Estimating the welfare gains for the average European consumer from the early rise in intra- and intercontinental market integration in the West –similarly to Hersh and Voth (2009) with respect to colonial goods-. This estimation might be complemented with that of the losses caused by the disintegration of the process in late eighteenth and early nineteenth centuries.

4) Exploring the extent of market integration in the East. Our preliminary statistical examination of Asian markets (China, Japan and Korea) shows results that confirm those obtained by Shiue and Keller (2007). Some national markets were well integrated. However, this is not always the case, as has been shown by Studer (2008) for India. Besides, no statistical signs of intra-continental integration of rice markets have been found yet. If confirmed by further research the contrast between East and West in this respect might have interesting implications for the Great Divergence debate.

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Table 1. Estimated univariate models of wheat prices series in first log differences.

Sample	Variable (Mnemonic)	$(1-\phi_1 B-\phi_2 B^2)$ $\hat{\phi}_1$ (s.e.)	$\hat{\phi}_2$ (s.e.)	Period[1] years (s.e.)	$(1-\theta B)$ $\hat{\theta}$ (s.e.)	GLR[2] $H_0:\theta=1$	$\hat{\sigma}_a$ (%)
Panel A:	**Nominal wheat prices in Europe**						
1703-1913	London (L)	.62 (.09)	-.29 (.07)	6.6 (.7)	.77 (.08)	30.0	18.6
	Holland (H)	.80 (.09)	-.27 (.07)	9.1 (1.3)	.82 (.07)	14.1	17.6
1703-1875	Strasbourg (S)	.74 (.13)	-.44 (.08)	6.4 (.70)	.70 (.15)	29.5	16.9
	Vienna (V)	.70 (.09)	-.18 (.08)	10.6 (5.9)	.88 (.05)	18.6	22.1
1703-1815	Arévalo (A)	.75 (.10)	-.22 (.09)	9.8 (4.2)	.90 (.05)	8.3	31.5
	Milan (M)	.61 (.18)	-.55 (.08)	5.5 (.60)	.26 (.22)	24.1	13.1
	Gdansk (G)	.66 (.17)	-.39 (.09)	6.2 (1.1)	.60 (.18)	10.8	15.4
Panel B:	**Nominal wheat prices in America**						
1720-1896	Pennsylvania (P)	.66 (.10)	-.38 (.07)	6.3 (.5)	.72 (.09)	8.3	18.9
1703-1804	Mexico (Mx)	.39 (.10)	-	-	.99 (.08)	0.9*	31.9
1719-1800	Buenos Aires (BA)	-	-	-	.97 (.05)	0.3*	13.5

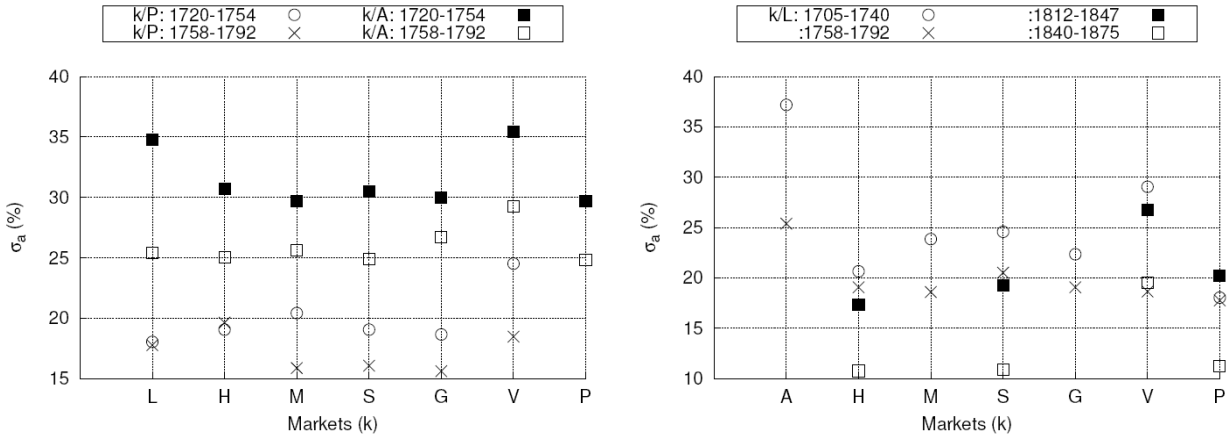
Notes: (1) Period of the cycle related to the second order autoregressive, calculated as $2\pi/\arccos(\phi_1/2\sqrt{-\phi_2})$.
(2) Generalized Likelihood Ratio (GLR) test of Davis, Chen and Dunsmuir (1995).
Cut-off values at 10% and 5% levels are 1.0 and 1.9, respectively.
* Does not reject the GLR null hypothesis at 5% level.

Table 2. Estimated univariate models for relative prices (logs) with London as the numéraire.

Sample	Ratio	$(1-\phi_1 B-\phi_2 B^2)$ $\hat{\phi}_1$ (s.e.)	$\hat{\phi}_2$ (s.e.)	SF[(1)] $H_0:\phi_1=1$	$\hat{\mu}$ (%)	$\hat{\sigma}_a$ (%)	$\sigma^2_{a1}/\sigma^2_{a2}$ 90% conf. interval[(2)]
Panel A:	**Relative wheat prices in Europe**						
1703-1815		.71 (.09)	-.24 (.09)	-	-.42 (.06)	34.6	
1703-1757	A/L[(3)]	.67 (.13)	-.29 (.09)	-	-.45 (.08)	36.6	[1.2,3.3]
1758-1792		.62 (.17)	-.36 (.17)	-	-.35 (.06)	25.9	
		.68 (.07)	-	17.3	-.23 (.07)	22.8	
	M/L	.65 (.10)	-	7.8	-.15 (.09)	23.4	[1.1,2.9]
		.40 (.16)	-	9.2	-.22 (.05)	17.5	
		.59 (.07)	-	23.3	-.51 (.05)	23.6	
	G/L	.31 (.14)	-	19.5	-.41 (.04)	20.5	[0.8,2.1]
		.28 (.17)	-	11.5	-.49 (.04)	18.1	
1703-1875		.66 (.06)	-	17.3	-.41 (.05)	21.6	
1703-1757	S/L	.67 (.10)	-	6.8	-.35 (.10)	26.5	[1.1,3.1]
1758-1792		.41 (.15)	-	3.2	-.42 (.05)	19.2	
		.55 (.07)	-	24.0	-.72 (.05)	25.0	
	V/L	.55 (.11)	-	10.9	-.75 (.08)	28.9	[1.5,4.1]
		.70 (.14)	-	1.9	-.60 (.10)	18.3	
1703-1896		.57 (.06)	-	22.9	-.28 (.04)	19.2	
1703-1757	H/L	.35 (.13)	-	18.5	-.18 (.05)	24.8	[1.1,3.1]
1758-1792		.11 (.17)	-	17.7	-.17 (.03)	18.1	
Panel B:	**Relative wheat prices in America**						
1720-1896		.53 (.17)	-	44.8	-.42 (.06)	18.4	
1720-1757	P/L	.51 (.14)	-	7.1	-.53 (.06)	18.9	[0.7,1.9]
1758-1792		.35 (.15)	-	11.2	-.41 (.04)	17.5	

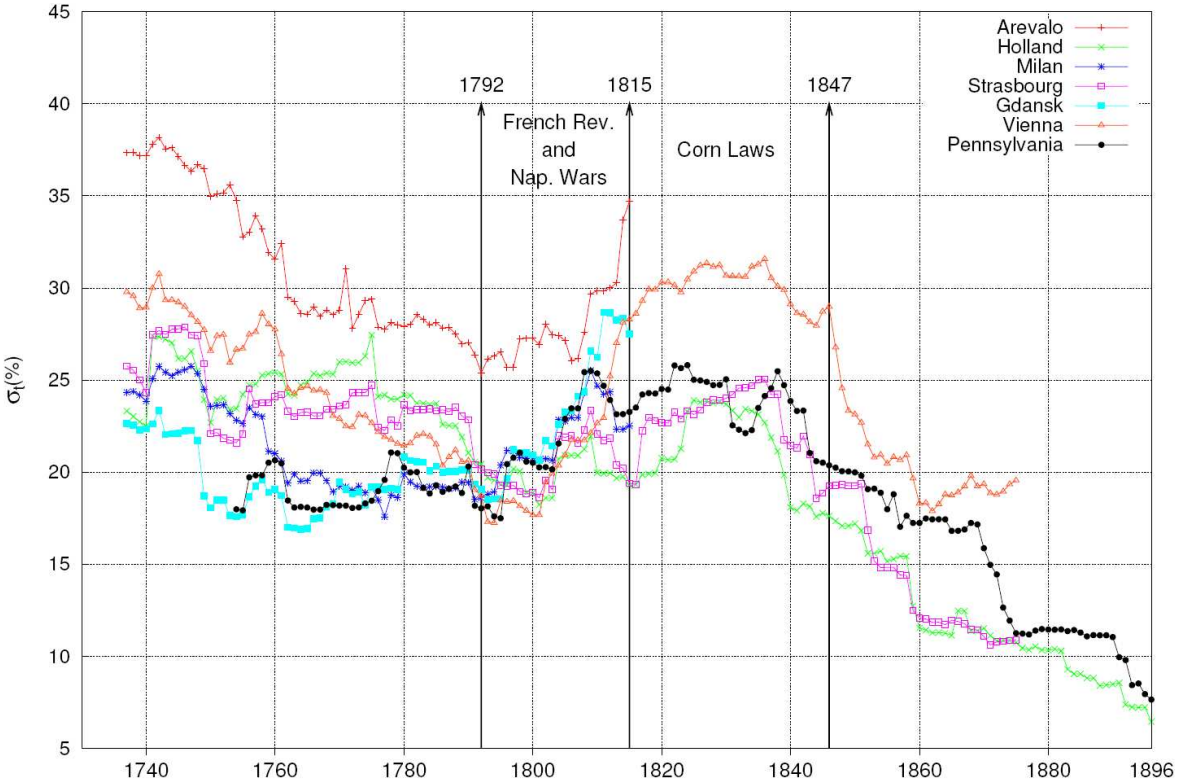
Notes: (1) Shin and Fuller (1998) statistic (SF). It tests whether an AR(1) operator is non-stationary.
(2) $\hat{\sigma}^2_{a1}$ and $\hat{\sigma}^2_{a2}$ are, respectively, the residual variances estimated in the period 1703-1757 and 1758-1792.
(3) A/L presents an AR(2) with imaginary roots and the unit root SF test is not justified. In this case, we estimate an ARIMA(2,1,1) and we test the null hypothesis of noninvertibility with GLR whose critical values are 1.0 (10%) and 1.9 (5%). GLR value for A/L (period 1703-1815) is 0.0, thus H_0 cannot be rejected.

Figure 1. Integration between selected pairwise markets, eighteenth and nineteenth centuries



Left plot: Standard deviation of the residuals calculated in the subsample specified and obtained from the (stationary) relative prices with Pennsylvania (P) and Arévalo (A) as reference markets. Right plot: Standard deviation of the residuals from the relative prices with London (L) as reference market.

Figure 2. Market Integration with London as the numéraire, eighteenth and nineteenth centuries.



The series are the (log) relative price residual standard deviation calculated using rolling windows of $t = 35$ span.

Appendix 1.

Sources of data and methods of conversion from local units into grams of silver per liter are:

Amsterdam and Holland, 1703-1896: Wheat prices in grams of silver per liter from series elaborated by Robert C. Allen:
(http://www.nuff.ox.ac.uk/users/allen/studer/amsterdam.xls). From 1703 to 1819 and from 1867-1896 prices are from Utrecht/Groningen and from Amsterdam in 1820-1866. Missing observations are 1771, 1802-1803, 1822-1823 and 1826-1827. In these and all cases, missing observations have been estimated through state-space algorithms. See note 26.

Arévalo, 1703-1815: Wheat prices in reales de vellón per fanega from Llopis and Jerez (2005). Conversions of Spanish units into grams of silver per liter: 1 fanega = 55.5 liters; reales de vellón converted into grams of silver at rates of exchange from Hamilton (1988). From 1801 onwards, the exchange rate vellón/silver in 1801-1815 is assumed to be that of 1800.

Buenos Aires, 1719-1800: Wheat prices are assumed to be originally expressed in reales de vellón per fanega. Conversions of Spanish units into grams of silver per liter: 1 fanega = 55.5 liters; reales de vellón converted into grams of silver at rates of exchange from Hamilton (1988). Otherwise they would be the highest wheat prices on earth, which difficult to accept. In any case, cointegration is not affected by the level of price. Missing observations are 1724, 1726, 1729 and 1731.

Gdansk, 1703-1815: Wheat prices in grams of silver per liter from series elaborated by Robert C. Allen (http://www.nuff.ox.ac.uk/users/allen/studer/gdansk.xls.

London and Sothern England, 1703-1896: Wheat prices in grams of silver per liter from series elaborated by Robert C. Allen:
http://www.nuff.ox.ac.uk/users/allen/studer/london.xls

Milan, 1703-1815: Wheat prices in grams of silver per liter from series elaborated by Robert C. Allen (http://www.nuff.ox.ac.uk/users/allen/studer/Northern%20Italy.xls).
Missing observations are 1805-1807.

Pennsylvania, 1720-1896: Wheat prices in grams of silver per kilo from the GPIHG (http://gpih.ucdavis.edu/files/Penn_spliced_1720-1896.xls). The kilo/liter ratio used is 0.772 (http://gpih.ucdavis.edu/files/Weight_vs_volume.xls).

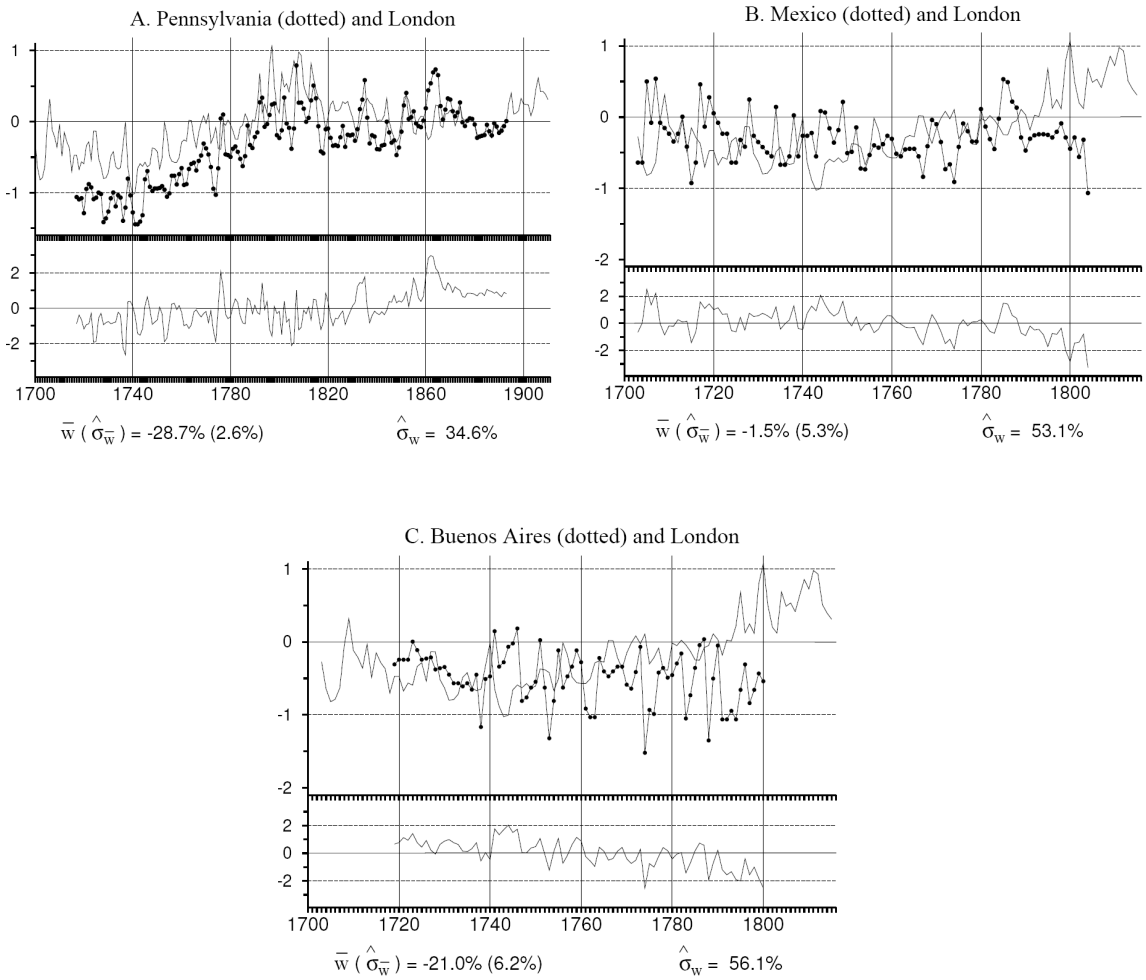
Strasbourg, 1703-1875: Wheat prices in grams of silver per liter from series elaborated by Robert C. Allen (http://www.nuff.ox.ac.uk/users/Allen/studer/strasbourg.xls). Missing observations are 1794-1795.

Vienna, 1703-1875: Wheat prices in grams of silver per liter from series elaborated by Robert C. Allen (http://www.nuff.ox.ac.uk/users/allen/studer/vienna.xls).

Upper Bajío, 1703-1804: Wheat prices in silver reales per carga from Garner (1993). Conversion of colonial units in grams of silver per liter: 1 carga = 149.578 kilos (Florescano, 1986). Content in silver grams of the real taken from Burzio (1956-1958). The kilo/liter ratio used is 0.772. (http://gpih.ucdavis.edu/files/Weight_vs_volume.xls). Missing observations are 1791-1795.

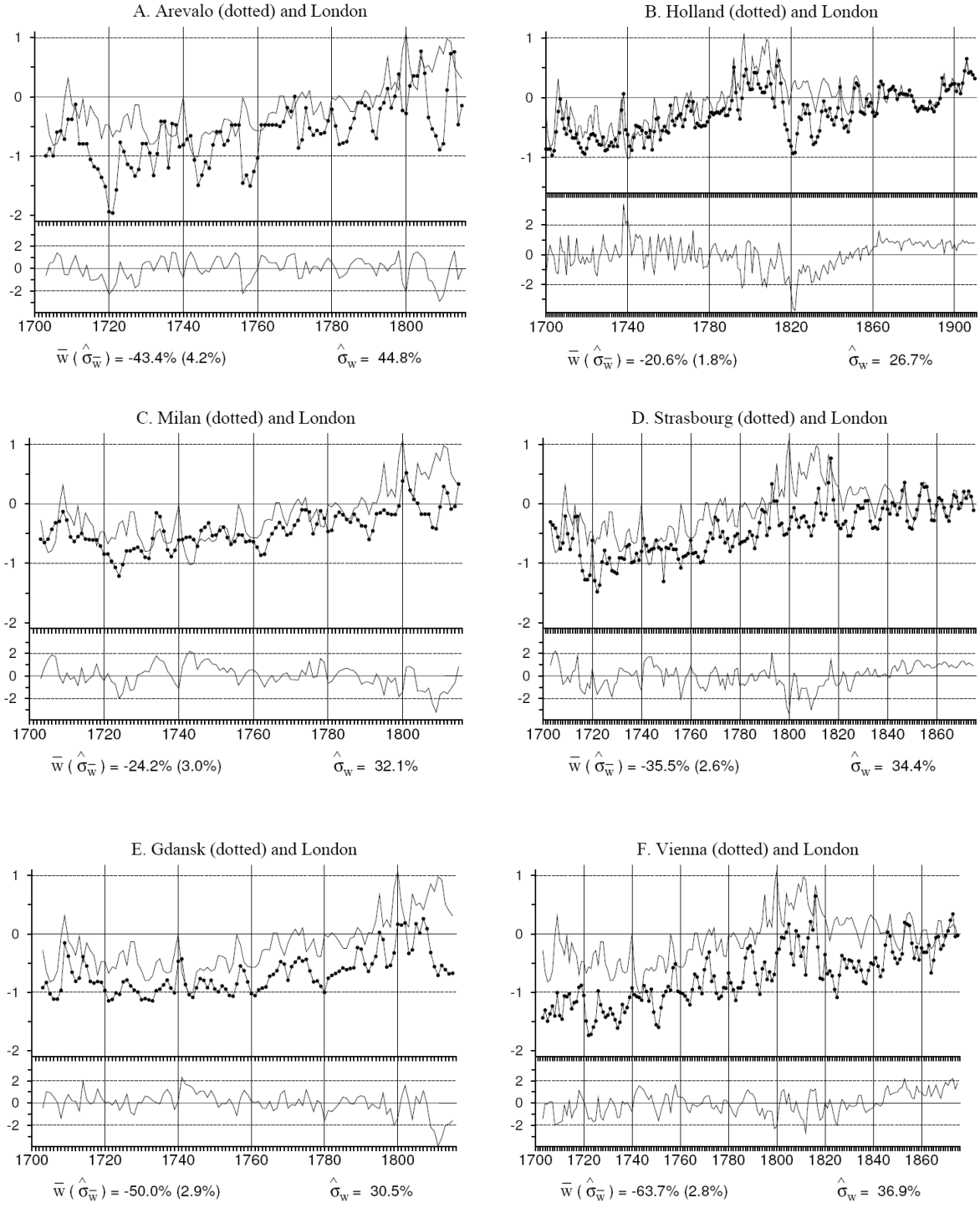
Appendix 2.

Figure A.1 Price of wheat (logs) in the Americas and London and standardized relative pairwise price (plotted below)



$\overline{w}$ and $\hat{\sigma}_w$ are, respectively, the sample mean and standard deviation of the relative price.

Figure A.2. Wheat price (logs) in the European Continent and London and standardized relative pairwise (plotted below).



$\bar{w}$ and $\hat{\sigma}_w$ are, respectively, the sample mean and standard deviation of the relative price.

Table A.1. Common univariate residual extreme values and possible historical explanation, 1703-1815.

Year	Yearly Price Data								Relative Price Data							Comments:
	L	A	H	M	S	G	V	P	A/L	H/L	M/L	S/L	G/L	V/L	P/L	
1708	++		+						-	-	-		-	–		War of the Spanish Succession
1709	++	+	++	+	++	I+64	+			-			I+24	-		“
1710			+	-	-	I+29	-						I+31			“
1714	–		+			++			+	++	+	++	++	+		“
1715	+	-	-		–	-	-					–				
1718	-	-			-		+							++		
1720		–			I+53	-			–			I+51				
1724				-	+			+			–					
1727	+				+		-		–						–	
1731	-				+			–							-	
1733		+		++							+					War of the Polish Succession,
1734		+		++	+	+	–				+					
1737		++		-				+	++							
1739	+		+		-										I-67	War of Jenkins’ Ear,
1740	+		++		+	I+48	+	+							I-88	War of the Austrian Succession
1741	–		++		+	I+43		+	+	++	++	++	I+47	+	+	“
1742	-		–					-		+						“
1746				++							+					“
1748		+		+				++							+	“
1749				-	I-56	+	-					I-49				
1756	++	–	+		-	+			I-87	-	-	–		-	–	Seven Years’ War
1757						+	++									“
1762								+								“
1764			++	+				-		+						
1770		+	-		++	-	+	+								
1771		–	+			+	+		–							
1775	-		+				-	-		++						
1776			–	–	-	-		–		-	-				-	American Revolutionary War
1777				++		-		-								“
1778	-										++					“
1779				-		-		I+50							I+80	“
1780	+					-	+	I+54			–		–		I+52	“
1789					+	++										
1791		-		++	-		-	-								
1793		+			I+64		-					I+77				French Revolutionary War
1794	+				I+37		+					I+28				“
1795	++	+	I+44	+	I+42	++		++			-	I-17				“
1796	-						-				+				++	
1797	+	+	-			-		-					–			
1799	I+55	-	+						I-100	I-52	I-63	I-66	I-57	I-66	I-41	Napoleonic Wars
1800	I+65		+	++		++	+		I-102	I-54	I-59	I-84	I-45	I-62	I-52	“
1802	-			-	+	+	+	–								“
1804	++	+		-		+	+			–	–	–	–		–	
1805			+	–		+	+	+							++	
1807						++										
1808	+	-					++	–							–	
1809	+	-		-	-	–		+	–	–			–	+		
1810				++		-	-	I+65				–			I+80	
1811	+	+		+	+	-							–			
1812		+	+		+		–							–		
1813	-		-		-	-	++							++		

I+ There is a positive influential impulse intervention term at this date in this series (I- for negative) with the estimated increment (decrement) in percentage rate (%) , ++ stand for positive residuals with absolute value greater than two standard deviations and + between one and two standard deviations respectively (–, - for negative values). This table provides a benchmark for coincidences in extreme values that might reveal how prices are related. Some extreme values that are not common are not reported.