World and National Wheat Market Integration in the 19th Century: A Comovement Analysis*

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Abstract

This paper proposes to borrow from the literature on international business cycles and use its tools for market integration research. Applying comovement analysis to 19th century European and American wheat prices shows that the US experience after 1870 was maybe not that revolutionary to world wheat trade than the established convergence literature à la O'Rourke and Williamson (1999) suggests. It seems to be fair instead to speak of a major producer accessing the world's biggest market for wheat – Western Europe, including the UK. The results also call for reconsidering on how national and international markets evolved alongside as the timing turns out to be diverse across European nations in the 1800s. The biggest push to global wheat market integration happened before 1860, according to the results obtained here, before the railroad could have had substantial effects. In the last quarter of the 19th century world wheat market integration further accelerated, but at a slower pace than before 1860.

Preliminary!!! Don't cite!

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1 Introduction

Although market integration is one of the subjects in 19th century economic history that has drawn much attention, there is still room for improvement in terms of analytical tools. As more prices become available, demand for dynamic methods that can accommodate large cross-sections of price data increases. The origin of market integration – local, national or international – becomes a matter of interest as data increases in the cross-section.[1]

This paper draws from the literature on international business cycles and uses its tools for market integration research. Bayesian dynamic factor models are especially promising, since they measure comovement of many time series and go beyond bivariate comparisons.[2] Their complexity therefore grows only proportionally in the cross-section and along the time axis, but not exponentially as that of bivariate models including almost all cointegration frameworks. The dynamic setup allows for quantifying the share of price fluctuations due to world price movements, changes in national market conditions and local shocks.

Applying comovement analysis to 19th century European and American wheat prices shows that the U.S. experience after 1870 was perhaps not particularly revolutionary to world wheat trade in contrast to what the established convergence literature à la O'Rourke and Williamson (1999) suggests. It seems to be fair instead to speak of a major producer accessing the world's biggest market for wheat – Western Europe, including the U.K. The results also call for reconsidering the relation of national and international market development as their respective timing turns out to be diverse.

The largest boost toward global wheat market integration occurred before 1860, according to the results obtained here, before the railroad or the steamship could have had substantial effects. In the last quarter of the 19th century world wheat market integration accelerated further, but at a slower pace than before 1860.

The next section motivates comovement analysis taking into account historical and technical considerations. Section 2 provides a discussion of the relevant methodological literature. An intuitive introduction into the method followed by a formal description can be found in Section 4. Section 5 describes the data, while Section 6 explains the findings. The last section concludes. The appendix contains details about the estimation and discusses some data issues.

2 Motivation

The main focus of market integration research in the past three decades or so was on transatlantic market integration after 1870 (Harley 1980, O'Rourke 1997). The main argument stated that markets on both sides of the Atlantic merged because of lower transport costs, which resulted in declining price differences.

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[1] GAUSS code for the model used here is available from Chris Otrok's website at `http://people.virginia.edu/~cmo3h/research/wfac3b.prg`. The code with the necessary modifications is available from the author upon request.

[2] The dynamic factor is referred to as common component in this paper.

In the past few years scholars have begun to gather data from more markets spanning longer periods and applied improved econometric tools, mainly based on cointegration or price dispersion (Jacks 2005, Federico and Persson 2007, Persson 1999, Sharp 2008). The methodological arms race was aimed at accommodating the increasing amounts of data in a meaningful way and resolving the question as to how market integration should actually be measured.[3] However, the curse of dimensionality has not yet been overcome, at least in the case when dynamic relations are to be accounted for. Most methods rely on bivariate comparisons cause the amount of parameters to increase exponentially in the number of markets. The complexity of the method proposed here grows linear in data size and allows for studying a large number of markets over a long period incorporating dynamic relationships between prices.

Federico (2008) proposes to use the coefficient of variation as a measurement tool for market integration. While this method can handle many markets, it does not incorporate dynamic relationships. The obvious patterns of covariance in commodity prices are not exploited. Comovement analysis uses these patterns to estimate an unobserved common component that is used as a benchmark against which each single price is compared. This corresponds directly with Federico's (2008) critique of bivariate price comparisons. He calls for comparing prices against a hypothetical world price. Interestingly, this is exactly in the spirit of Veblen (1893) who discussed wheat prices after the American Civil War in the very first issue of the *Journal of Political Economy.* Thus, there appears to be a long tradition of analyzing local wheat prices on the basis of a latent world price. With this paper I aim to abandon the purely technical need to use bivariate comparisons and contribute to reviving a more intuitive approach of analyzing market prices across time and space. As methods based on the coefficient of variation go to a certain extent in that direction, they cannot track each market's development over time, which is a natural feature of comovement analysis.

Ejrnaes, Persson, and Rich (2007) use a multivariate error correction model that explicitly incorporates dynamic relationships. However, it is restricted in the cross-sectional dimension as its complexity grows exponentially with the the number of time series. Since it is based on cointegration, this and related classes of models rely on assumptions about the asymptotic properties of unit root tests. The model I propose uses Bayesian econometrics enabling my results to hold even if the sample is not representative for the whole population or the unit root properties of the data are not guaranteed (Uhlig 1994).

There has been a recent revival of an older discussion about the reason for decreasing price gaps in the Atlantic trade between Knick Harley (1988) and Douglass North (1958, 1968) : North repeatedly rejected the advantage of steam power and metal hulls in decreasing freight rates, and claimed that organizational improvements played a more important role in lowering transport costs and spurring change in international market integration in the first half the 1800s. According to recent studies important steps toward integration have indeed occurred before railroad, intercontinental steam ships and the telegraph could have had substantial effects. Wars and trade policy are instead suggested as important driving forces of market

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[3] Federico (2008) discusses the most popular methods so far.

integration (Persson 1999, Federico and Persson 2007, Jacks 2005).

Brautaset and Grafe (2005) present another argument that is based on constant transport technology. They propose scale economies in market efficiency as an explanation for market integration. That is, costs per unit go down as volumes of trade go up, holding technology constant. Some of my results favor this explanation as will be shown in this paper.

However, this debate only centers on the supply side of the market for trade services. What about the demand side? In the absence of transport cost changes, trade may still increase and price gaps decrease if the relationship between supply and demand changes. Sharp (2008) claims that the main reason for declining price gaps between the U.K. and the U.S. was the increase of American wheat supply. This issue needs to be discussed at the national level as well. Kopsidis (1998) argues that industrialization creates urban demand for agricultural goods, and leads to regionally integrated markets holding agricultural and transport productivity constant. This theory may explain national differences in the timing of the relative development of national and international market integration. The conventional view – using transport costs as the main argument – is that national markets integrate first, since relatively short distances imply low transport costs, and then international trade links are created as technology reduces the cost of distance. However, this order could be reversed. In developing economies some cities may already be linked quite well to international wheat trade due to, for example, a strategic geographical location, while land-locked rural areas are separated from national and international wheat trade. As industrialization sets in, urban demand increases and nationwide specialization begins, fostering national markets on the basis of international integration.

The feature distinguishing this study from others is that it truly differentiates between national and international integration. It can focus on single markets while keeping an eye on the aggregate development. Section 6 therefore delivers a number of new results about national integration in an international context.

3 Related Literature

Various uses of the common component approach in market integration research can be found. Qin, Cagas, Ducanes, Magtibay-Ramos, and Quising (2006) used a dynamic factor in a vector error correction model (VEC) as an aggregate of all "foreign" prices and compare it to an observed "home" price. By doing so, they augmented the VEC model to the multivariate case. My model is simpler. It conceptualizes the common component or factor as a manifestation of the comovement of prices in different markets and therefore as a manifestation of the law of one price.

Common factors can also be used in panel cointegration frameworks to increase the power of multivariate unit root tests, which goes back to Bai and Ng (2004) and Pesaran (2007). Applying this method in a recent study on German regional prices levels, Dreger and Kosfeld (2007) found a persistent lack of price convergence among German regions in the period from 1995 to 2004.

Principal component analysis has been used by Sánchez-Albornoz (1974) in a truly pioneering study. He analyzed annual Spanish wheat and barley prices between

1856 and 1889 and focused on the causal effects of wheat trade between regions. He identified regions along geographical and agricultural borders, but could not model the dynamic relationships contained in the data. Thus, in later studies he began to use univariate time series analysis and abandoned the common component approach.

Moreover, there is a strand in the international finance literature similar to what I am pursuing. Bekaert and Harvey (1995) proposed a time-varying measure for integration of national markets into the world market for capital assets. The set of country price returns in their model is explained jointly by a world benchmark portfolio and idiosyncratic country risk. The varying degree to which each of the two factors explained the returns was interpreted as a measure of world capital market integration, which is comparable to the latent factor of all prices in my paper.

Technically, this study is closest to Kose, Otrok, and Whiteman (2003a), although their research interest is not directly related to mine. They estimated the common component of output, consumption and investment between 1960 and 2001 for the G7 countries, and identified a world component and national components. I work with practically the same model but my focus is on price data and market integration.

The relation between international business cycle transmission and world market integration is obvious. Both describe different strata of globalization. While I measure market integration as it is manifested in the price comovement of a traded and crucial commodity, business cycles represent integrated markets subject to common output variations.[4]

Thus, it is appropriate to cite a recent paper that applies dynamic factor models to identify long run business cycle comovement between four Latin American economies starting in the last quarter of the 19th century, i.e., Argentina, Brazil, Chile and Mexico (Aiolfi, Catao, and Timmermann 2005). It finds strong exogenous shocks on the cyclical activities of Argentina, Chile and Mexico. Brazil was obviously better insulated from external influences. It remains a field of future research if this result is reflected in the behavior of traded goods in these countries.

A large body of literature utilises mixed sets of time series, i.e., prices and volumes, where either the common component is interpreted as the business cycle, or nominal and real common components are identified (Stock and Watson 1998). An application of a single component model to historical time series is described in Sarferaz and Uebele (2007).

One further application to price series is Reis and Watson (2006). They interpret the common component of a consumer basket of prices as the part of price fluctuations whereas relative prices stay the same (Bryan and Cecchetti 1993). They use it to analyze the degree of money neutrality and find that prices were not neutral in the U.S. after 1960.

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[4] The theoretical literature is not entirely conclusive about the correlation of trade flows and output variations, and I do not attempt to contribute to this question.

4 The Model

4.1 Intuition

Comovement measures synchronous price movements in large cross-sections. It has a certain similarity to correlation, the main difference being that correlation is defined over pairs. Another important difference is that comovement measures linear dependence not only in a given period but across time. It represents the whole spectral matrix of leading and lagging correlations (Kose, Otrok, and Whiteman 2003a, p. 1218).

While correlation can be understood as a simple bivariate counterpart of comovement, convergence captures a different aspect of relative prices. Take for example Harley's (1980) classic paper about convergence among U.K. and U.S. wheat prices in the second half of the 19th century, which begins with a graph showing a shrinking price gap between Chicago wheat and the British Gazette price (Figure 1). Harley, as well as other scholars succeeding him, refers to this closing gap when defining market integration (O'Rourke and Williamson 1999). However, Figure 1's second striking element – which Harley does not discuss – is the degree of correlation between the two prices. This element is another important feature and thus used as the main argument in this paper.

Figure 1: Price convergence between Chicago and Britain (Harley, 1980).

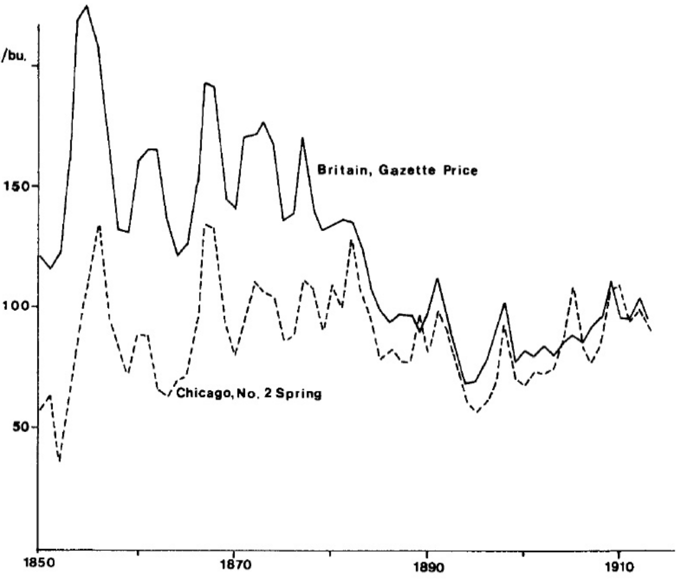

FIG. 1. Wheat prices: Chicago and Britain, 1850–1913.

This bivariate comparison can be carried out for more than two markets by comparing all single series with a benchmark series that represents maximum comovement of all observed series. Consider a simple steady state example. Imagine splitting up each single price p_i into a part c that is the same in all markets and a part u_i that is the deviation from c:

$$p_i = c + u_i \tag{1}$$

The common part c could be any rational number, but optimally it should be the one that minimizes the sum of the deviations u_i. For the sake of the argument, the mean over all prices p_i could be chosen, and the absolute deviations u_i could be expressed in percentage of p_i to show how much the common price element explains in each market i. An example is given in Table 1.

Table 1: Numerical example of common component.

Price	Common Component	Deviation	Absolute Percentage Deviation
p_i	c	u_i	$\lvert u_i \rvert / p_i$
3.41	3.00	0.41	12%
2.67	3.00	-0.33	12%
2.95	3.00	-0.05	2%
2.29	3.00	-0.71	31%
3.00	3.00	0.00	0%
5.08	3.00	2.08	31%
3.45	3.00	0.45	13%
1.85	3.00	-1.16	63%

In the left Column of Table 1 the observed prices are given. An arbitrarily chosen common component is given in Column 2 and the respective deviations in Column 3. Column 4 contains a normalized measure of how well the common component explains single prices in Column 1. The lower the percentage number, the more the common component explains single prices.

This is an example in the steady state, but what if we include dynamics? How would the common component change if the prices in Column 1 changed? These questions are answered in the following formal discussion. It starts with a dynamic extension of Equation 1.

4.2 Single Common Component

Given the relation between N prices and their common component in time t, consider what happens if all prices changed in the same direction and to the same degree. In this case their variation should be only due to the common part c but not the remaining part u_i, $i = 1, \ldots N$. If some prices changed to a different degree or in different direction from the others, the common part will explain only a fraction of the price variation and the rest will be due to the specific component $u_{i,t}$. Thus the dynamic formulation of Equation 1 for each $p_{i,t}$ is

$$p_{i,t} = a_i + \lambda_i c_t + u_{i,t} \tag{2}$$

Here c_t represents the common component, which is the same for all markets and therefore not indexed by i. There is a constant a_i and a weight λ_i that links the common price component to the i-th variable. $u_{i,t}$, the idiosyncratic or specific component, accounts for local, market specific influences, e.g. local crop failures or temporary demand fluctuations.

However, the idiosyncratic parts may experience their individual dynamic processes, i.e., they may be serially correlated, which is expressed as an AR(p)-process:

$$u_{i,t} = \theta_{i,1} u_{i,t-1} + \ldots + \theta_{i,p} u_{i,t-p} + \chi_{i,t} \tag{3}$$

Equation 2 resembles a linear regression, only that we do not observe the regressor c_t. We can instead describe c_t's dynamics by an AR(q)-process and treat it (together with Equation 3) as the transition equation in a state space model:

$$c_t = \varphi_1 c_{t-1} + \ldots + \varphi_q c_{t-q} + \nu_t \tag{4}$$

These three equations describe the basic setup. However, since many, not only one, common components are strived for, Section 4.4 extends the model to the case with K common components. In Section 4.5 I will show how the model parameters and the common component can be estimated. The error term assumptions will be discussed next.

4.3 Error Term Assumptions

The local market shocks $u_{i,t}$ are assumed to be normal and uncorrelated in the cross-section:

$$E\left[u_{i,t} u_{j,t-s}\right] = \sigma^2_{u_i} \; \forall \, i = j \; \wedge s = 0, \; 0 \; otherwise.$$

The error term $\chi_{i,t}$ in the local market shock's process is likewise normal, and serially and cross-sectionally uncorrelated:

$$E\left[\chi_{i,t} \chi_{j,t-s}\right] = \sigma^2_{\chi_i} \; \forall \, i = j \; \wedge s = 0, \; 0 \; otherwise.$$

The common component's error term ν_t is normal with

$$E\left[\nu_t \nu_{t-s}\right] = \sigma^2_{\nu_t} \; for \; s = 0, \; 0 \; otherwise.$$

The error of the common component ν_t is uncorrelated with the error of the local component $\chi_{i,t}$:

$$E\left[\chi_{i,t} \nu_{t-s}\right] = 0 \; \forall \; i, s.$$

4.4 Multiple Common Components

So far I have explained the estimation of only one common price component. If this represents comovement of all prices in the sample this can be referred to as the world component. Each local price series is thus explained by its comovement with the world price and local shocks. However, additional shocks may arise from the national level. Those shocks may be different from global shocks, for example if there are strong border effects that do not allow the transmission of national demand shocks to other countries. In the framework proposed here it is possible to estimate both global and national common components in one model and assess their relative explanatory power. Essentially, the world component explains the variance in all price series and therefore its corresponding weights are all nonzero, while the national components explain only the variance of some price series identified by nationality. For example, the national component of Spain is identified by setting all weights that belong to cities outside Spain to zero. Identifying national components *ex ante* is opposed to obtaining multiple orthogonal common components endogenously and identifying them *ex post*. It implies that the national common components do not need to be orthogonal to each other. What is orthogonal, however, is each national component relative to the world component.

In this setup, Equation 2 can be formulated as:

$$P_t = \Lambda C_t + U_t, \tag{5}$$

where P_t is an $N \times 1$ vector of N price series, C_t is a $(K+1) \times 1$ vector of common components (the number of a column of ones plus common components), Λ is a $N \times (K+1)$ matrix of weights and U_t is a $N \times 1$ vector of idiosyncratic components. In the case of an international and several national common components, there is one international common component, and $R < N$ national components, with R being the number of countries in the model. For example, in the case of $N = 10$ markets and $R = 2$ countries, each being represented by half of the sample, $K = 1 + R = 3$. The $10 \times (K+1)$ matrix Λ_t contains a column of constants, one column of N elements for the world component and then R columns of weights for each country, which are only nonzero for the observations for the respective country.

Equation 5 for this case could then be formulated as:

$$P_t = A + \lambda^w c_t^w + \lambda^1 c_t^1 + \lambda^2 c_t^2 + U_t, \tag{6}$$

where P_t consists of 10 price observations in period t, $A = [a_1, a_2, \ldots, a_{10}]'$ is a vector of constants, $\lambda^w = [\lambda_1^w, \lambda_2^w, \ldots, \lambda_{10}^w]'$ is a vector of weights that are nonzero for all i, c_t^w is the value of the world price component in t, $\lambda^1 = [\lambda_1^1, \lambda_2^1, \ldots, \lambda_{10}^1]'$ is the national component for country 1, where only those λ_i^1 are nonzero that correspond to cities of country 1. All other λ_i^1 are set to zero. Accordingly, the elements contained in λ^2 are only nonzero if corresponding to cities in country 2. U_t is a 10×1 vector and contains price elements not explained by either the world component or the respective national component.

The transposed matrix of weights Λ' then looks like:

$$\begin{array}{l} \\ \mathit{world\,component} \\ \mathit{national\,component}\,1 \\ \mathit{national\,component}\,2 \end{array}
\begin{bmatrix} a_1 & a_2 & a_3 & a_4 & a_5 & a_6 & a_7 & a_8 & a_9 & a_{10} \\ \lambda_1^w & \lambda_2^w & \lambda_3^w & \lambda_4^w & \lambda_5^w & \lambda_6^w & \lambda_7^w & \lambda_8^w & \lambda_9^w & \lambda_{10}^w \\ \lambda_1^1 & \lambda_2^1 & \lambda_3^1 & \lambda_4^1 & \lambda_5^1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \lambda_6^2 & \lambda_7^2 & \lambda_8^2 & \lambda_9^2 & \lambda_{10}^2 \end{bmatrix} = \Lambda'$$

Accordingly, a single price observation $p_{i,t}$ is composed of the following elements:

$$p_{i,t} = a_i + \lambda_i^w c_t^w + \lambda_i^1 c_t^1 + \lambda_i^2 c_t^2 + u_{i,t}, \tag{7}$$

where one of the national weights is zero.

I follow Kose, Otrok, and Whiteman (2003a) in estimating the multiple common components. They apply a sequence of single common component models. c_t^1 and c_t^2 are estimated for the variance unexplained by c_t^w. The rest of the model is the same as in the single component model above, only that there are $K = 1 + R$ common component AR-processes now:

$$c_t^k = \varphi_1^k c_{t-1}^k + \ldots + \varphi_q^k c_{t-q}^k + \nu_t^k, \tag{8}$$

where $k \in \{w, 1, \ldots, R\}$ and

$$E\left[\nu_t^k \nu_{t-s}^j\right] = \sigma_{\nu^k}^2 \; \forall \; k = j \; \wedge \; s = 0; \; 0 \; \forall \; k, s.$$

4.5 Estimation

The classical estimation of a state space system is standard in multivariate time series econometrics (Hamilton 1994, Stock and Watson 1989, Geweke 1977). However, I follow the Bayesian way of estimation, in part because the dimensionality is much less of a problem as I can use Gibbs sampling that reduces the curse of dimensionality. Another reason is that it is a convenient way to deal with uncertainty about the unit root properties of the variables (Uhlig 1994).

The single component model is described in detail in Otrok and Whiteman (1998). In the next subsection I relate mostly to Kose, Otrok, and Whiteman (2003a), which features the estimation of K common orthogonal components.

Kose, Otrok, and Whiteman (2003a, p. 1220f) explain why Bayesian estimation is convenient for this class of models. The challenging aspect of the estimation is that both a linear regression with serially correlated errors and the AR-coefficients of c_t have to be determined simultaneously. This is done in classical statistics by utilizing the linearity of the model in the observables. A Kalman filter-smoother procedure leads to the unobserved parameters' likelihood function. It is Gaussian and can be estimated by maximum likelihood (Stock and Watson 1998). However, if the the model becomes large in the cross-section it is difficult to estimate, since dimensionality increases exponentially (Kose, Otrok, and Whiteman 2003a, p. 1220f).

Bayesian methods allow for estimating the common component c_t and the other parameters $(\phi, \theta_i, \sigma_u, etc.)$ of the model separately. In Bayesian statistics the unknowns are treated as random variables, as opposed to in classical statistics where they are treated as constants. Treating the model parameters and the common component as random implies determining their probability distribution. Unfortunately, for the model above, the joint distribution of the parameters and the common price component is nonstandard. This problem can be solved by decomposing the joint distribution of the parameters and the common component into conditional distributions. One is the distribution of the parameters conditional on c_t, and the other is the distribution of c_t conditional on the model parameters. These conditional distributions have standard forms and are therefore computable. Moreover, the optimization problem for the variable specific parameters is done separately for each observable $p_{i,t}$ and does not increase exponentially with the number of variables N, since the covariance matrix of the $u_{i,t}$ is diagonal, i.e., all cross-sectional correlation is contained in the common components (Kose, Otrok, and Whiteman 2003a, p. 1220) and not in $u_{i,t}$.

The sampling, i.e., making random draws from posterior distributions derived from the model, is done by a Markov chain Monte Carlo (MCMC) procedure.[5] Upon iterating on sampling, the Markov property of the marginal distributions, which is to converge to an asymptotic distribution, is utilized.

To begin, a vector of arbitrary starting values is chosen for the common component. The distribution of the parameters conditional on that value is then determined and a vector of values for the parameters is sampled, which finishes the first iteration. In the second iteration, a new value for the common component is drawn conditional on the draw for the parameters from the previous iteration. Then, new values for the parameters are sampled conditional on the new common component draw. The procedure is repeated until convergence is achieved. It can be shown that the conditional posterior distributions converge to the true desired marginal posterior distributions as the number of iteration steps goes to infinity (Geman and Geman 1984) Here the number of draws is 24,000 of which I use 20,000 for inference, and discard the first 4000. The latter is done in case the starting value was chosen inferiorly. As a convergence check, I repeat the procedure several times with different starting values and compare the respective results. The AR-order for the world common components is chosen as $q = 8$, which reflects business cycle frequency with annual data. For the variable specific processes, $p = 3$ is chosen following Kose, Otrok, and Whiteman (2003a). I have estimated several variations of this setup and found that the results are robust to the choice of the AR-orders.

Two approaches are proposed in the literature for sampling the common component conditional on the parameter draw. One is Otrok and Whiteman (1998) and the other Kim and Nelson (1999). I have followed the former, having compared the outcomes of both methods. The results are basically the same. In the appendix I formally describe the sequence of draws.

4.6 Identification

The identification issues here have been discussed extensively in Otrok and Whiteman (1998). The principal problem is that the weights λ_i and the latent variable c_t are determined jointly in Equation 2 and the following two cases are observationally equivalent: $\lambda_i c_t$ and $(-\lambda_i)(-c_t)$. This problem can be solved by pinning down one (and only one, since this in turn pins down c_t) λ_i to be positive. In the example chosen above identification is achieved through setting λ_1^w greater than zero, as well as λ_1^1 and λ_6^2, the first national factor loadings in rows 3 and 4, respectively (Kose, Otrok, and Whiteman 2003a, p. 1219). Here I choose the weight corresponding to the price of wheat in London to be positive; i.e., to be positively correlated with the world price, which does not seem to be a very strong restriction. The cities whose prices are assumed to be positively correlated with their respective national common

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[5] "Monte Carlo," because artificial data are generated, and "Markov chain", because the distribution conditions only on the last iteration and not on the whole history.

component are Paris for France, Berlin for Germany, Stockholm for Sweden, Vienna for Austria-Hungary, Brussels for Belgium, New York for the U.S., Oslo for Norway, and Santander for Spain.

A similar problem arises if for example c_t is measured in centimeters and λ_i in inches – or vice versa. The scale of the common component is undetermined, which is due to the fact that the variance of the common components' error term ν_t is not identified. Following, among others, Sargent and Sims (1977) it is set to one, but it could be set to any other constant likewise.

4.7 Priors

The priors I use are the same as those in Kose, Otrok, and Whiteman (2003a, p. 1221). Five prior distributions must be chosen. The first two are the distributions of the AR-parameters for the common component (Equation 8) and the local shocks (Equation 3). Next is the prior distribution of the factor loadings λ followed by the prior distributions of the variances of the local shocks' and the common components' error terms, $\sigma^2_{\nu^k}$. The latter is the easiest, since for identification purposes explained above it must be set to a constant and thus has no distribution (Section 4.6).

The variance of the local shock's error term has an inverted gamma prior distribution:

$$\sigma_{\chi}^{prior} \sim \mathcal{IG}\left(6, 0.001\right)$$

which implies a fairly loose prior. Thus I do not claim to have important prior knowledge about the idiosyncratic error variance and leave the setting of its value mostly to the data.

The AR-parameters of both the common component and the local shocks have normally distributed prior distributions with zero mean, implying the assumption that they are not serially correlated. The more distant the lag is, the more certain this assumption becomes, and thus the variance around zero decreases exponentially:

$$\varphi^{prior} \sim \mathcal{N}(0_{q\times 1}, \Sigma)$$

where

$$\Sigma = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & \frac{1}{2} & \vdots & \vdots \\ \vdots & \cdots & \ddots & 0 \\ 0 & \cdots & 0 & \frac{1}{x} \end{bmatrix},$$

with $x = p$ or q.

4.8 Presentation of Results

This section explains how the results from the estimation are presented. It especially describes how the variance decomposition is carried out.

In order to capture changes of market integration I choose subperiods. It means that the model is estimated separately for subsequent time periods. In each subperiod, a new world price component and new national price components are derived from the data. Section 6 starts with showing the importance of working in subperiods.

I have experimented with different subperiods, and finally decided to choose periods of about 25 years starting from 1806 in order to divide 19th century into even quarters:

1. 1806-1829
2. 1830-1855
3. 1856-1880
4. 1881-1907

This choice is supported by major historical events over these 102 years. The first quarter captures a period of disintegrated world markets, as a result of the Napoleonic Wars and British import tariffs of those years. The next period up to the mid-1850s possibly exhibits increasing market integration as steam ship technology, the railroad and organizational improvements started to proliferate, fewer wars occurred on the European continent, and liberal trade politics became more widespread. The following quarter should continue that development although it includes the American Civil War, which is likely to have had a severe impact on world wheat trade. In the same subperiod, tariffs were reduced due to the treaties induced by Cobden-Chevalier, which however seemed to have little effect on wheat trade (Lampe 2007). The last subperiod starting in 1880 is likely to exhibit a strong drive toward Atlantic market integration according to O'Rourke and Williamson (1999). On the other hand, some countries increased tariffs that had been lowered or abolished earlier in the century.

In order to assess the relative explanatory power of the components for each price series I follow Kose, Otrok, and Whiteman (2003a) who employ variance decomposition for each price series i of the form

$$var(p_i) = (\lambda_i^w)^2 var(c^w) + (\lambda_i^1)^2 var(c^1) + (\lambda_i^2)^2 var(c^2) + var(u_i) \tag{9}$$

resulting in the fraction of volatility explained by the world component:

$$\frac{(\lambda_i^w)^2 var(c^w)}{var(p_i)}. \tag{10}$$

Since sampling from conditional distributions yields sampling error, the orthogonality of the common components is not automatically given, although they are uncorrelated. Thus, at each step of the Markov chain the national components are orthogonalized relative to the world component. Numerically, this does not change the results in any relevant way, but ensures that the volatility shares add up to 1 (Kose, Otrok, and Whiteman 2003a, p. 1226). In order to give valuable insights into the relative explanatory power of each component, I present arithmetic averages of the volatility shares.[6]

5 Data

The data set is taken from Jacks (2005), Jörberg (1972, Sweden), and Jacobs and Richter (1935, Germany).[7] I do not use all series, because some start too late or end too early. For several reasons, I work with annual data here: first, it increases data coverage, second, the problem of seasonality does not arise, and third, it is interesting for economic historians if the proposed method is applicable even to low frequency data. The data set with which I work contains 60 annual wheat price series ranging from 1806 to 1907. The Norwegian and the Spanish series as well as the observations for Cincinnati only start in 1830.[8] In the results section, I discuss how I included them in the estimation. Wheat prices are observed in the following markets:

- Austria-Hungary (4): Vienna, Lwow, Krakow, Ljubljana (Krakow did not belong to the Hapsburg monarchy for the whole period)
- Germany (4): Königsberg/Kaliningrad, Hamburg, Berlin, Munich
- Belgium (3): Ghent, Bruges, Brussels
- U.K. (12): London, Manchester, Liverpool, Exeter, Carmarthen, Dover, Gloucester, Worcester, Cambridge, Norwich, Leeds, Newcastle
- France (11): Bayeux, Saint-Brieuc, Toulouse, Bordeaux, Chateauroux, Mende, Barleduc, Arras, Pau, Lyon, Paris
- U.S. (4): New York, Alexandria, Philadelphia, Cincinnati
- Sweden (11): Stockholm, Uppsala, Södermanland, Östergötland, Kalmar, Halland, Skaraborg, Örebro, Västmanland, Gästrikland, Hälsingland
- Spain (9): Cordoba, Gerona, Granada, Lerida, Oviedo, Segovia, Zaragoza, Santander, Burgos
- Norway (2): Bergen, Christiania/Oslo

Figure 2 shows the geographical extent of the European markets in the sample. Figure 3 presents the same for the U.S. markets.

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[6] I carried out the same for the standard errors of the decomposed variances, which can be found in the appendix. This was not done at every step of the Markov chain, but still provides a good view of the average accuracy of results of the variance decomposition.

[7] All series are annual or seasonal variations have been controlled for in another appropriate way (Jörberg 1972).

[8] Earlier prices for Cincinnati exist, and have been used to form wholesale price indexes for the Ohio delta 1816-1860 (Berry 1935). Future research will complete the data set using the sources given there.

Although scattered data exists for Italy, Odessa and more German cities, the coverage is not sufficient. There are 19th century wheat prices from many German cities, but only up to the 1860s (Fremdling and Hohorst 1979). Italian data is plentiful, too, but it either starts in the 1860s or ends in 1899. The reason why there is sometimes better data coverage for the first half of the 1900 may be that administrations tried to control prices to preserve domestic peace, but progressing political and economic liberalization led the states to abandon those attempts after the middle of the 19th century.[9]

For the empirical model employed here it is not necessary to convert the coins and weights and volumes as long as they remain constant over time. Unit differences only represent permanently different means that do not affect comovement. The means of all data series are therefore normalized to 0. Similarly, the variance of each series is normalized to 1.

The price data provided by Jacks (2005) is converted to American dollars per 100kg. I ensure that all prices are expressed in gold dollars but not in greenbacks. There are large relative price variations during the 1860s, which make such an exercise advisable. I used gold denominated benchmark price series from independent sources to compare them with the original prices. I also directly look at the relevant exchange rates found in the Global Financial Database. The appendix documents this in detail. I find that Spanish, Austria-Hungarian, and English prices are converted to gold dollars, while the others are provided in greenbacks. As a consequence, instead of recalculating all currency conversions, I continue to work with Jacks' data, deflating the series given in greenbacks such that all series are denominated in gold dollars per 100kg.

Although overall inflation in the 19th century was small, I take out long run trends from the data by applying a Hodrick-Prescott filter with the Ravn-Uhlig lambda of 6.25.[10]

6 Results

6.1 Evidence for Structural Change

In order to give an impression of the changing comovement in the 19th century Figure 4 plots a world price component spanning 102 year from 1806 to 1907 against subperiod world price components, each spanning about 25 years.[11] The standard deviation of all series price components is normalized to 0.1, which is the average standard deviation of English wheat prices in the 19th century. The fluctuations are percentage deviations around a smooth trend as discussed in the data section. The vertical lines divide subperiods.

We can clearly observe the price peak in 1847, which was induced by bad harvests throughout Europe in 1846 (Berger and Spoerer 2001). The common component

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[9] I thank Michael Kopsidis for this remark.

[10] Alternative filters like Baxter-King and Christiano-Fitzgerald yield very similar results (Baxter and King 1999, Christiano and Fitzgerald 2003).

[11] Kose, Otrok, and Whiteman (2003b) estimate a similar model for subperiods in order to capture structural breaks in world business cycle comovement.

Figure 2: European markets.

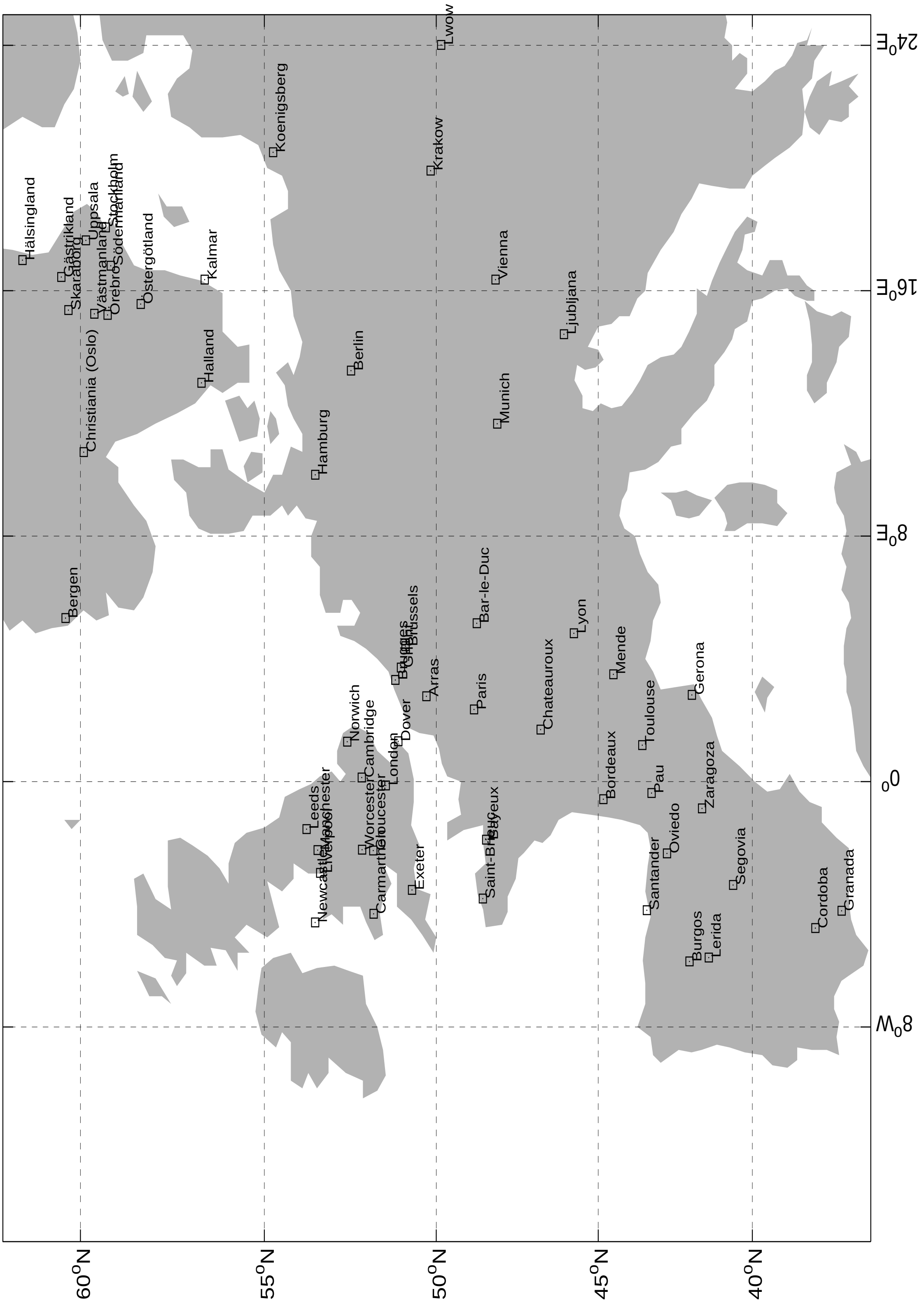
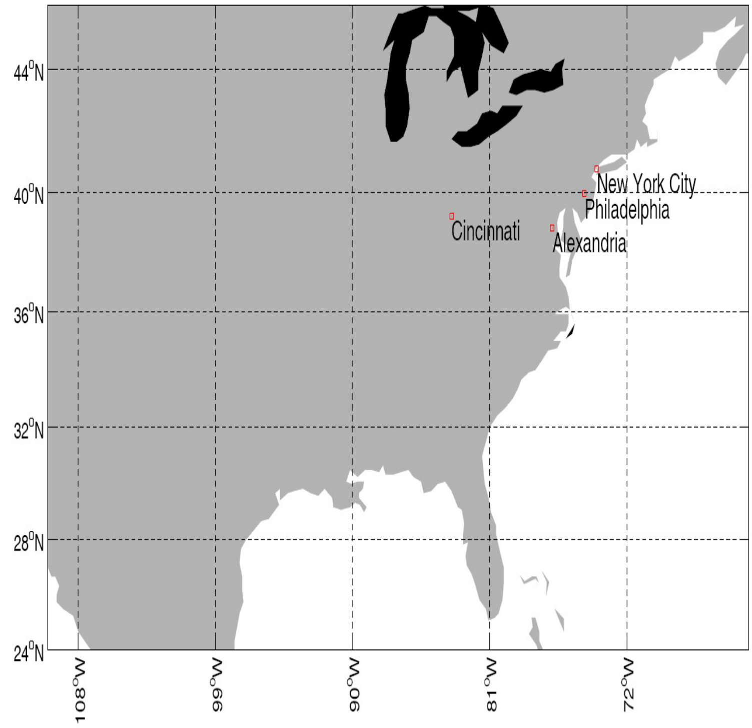


Figure 3: American markets.



confirms also the notion that wheat did not strongly take part in a worldwide "speculative" inflation of 1870-73 Veblen (1893, p. 20).

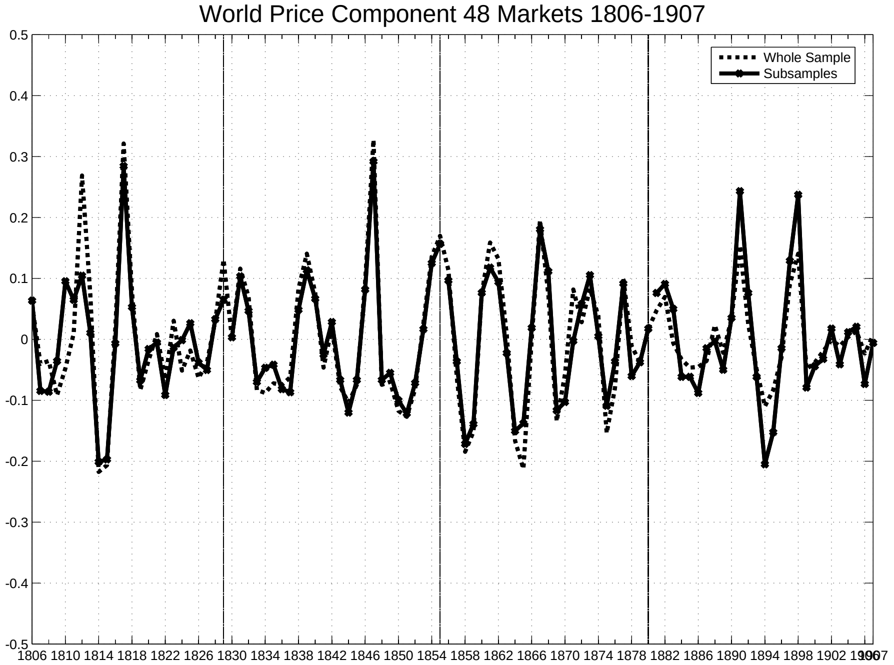
If structural change did not matter, estimating the model for the whole period or breaking it up would make no difference to the common price component. What Figure 4 demonstrates instead is that, in three out of four periods, the subsample world price (solid line) is different from the world price estimated from the full sample (dotted line). Before 1830 the subperiod world component does not exhibit the strong peak around 1812 as the full sample component does. Conversely, the M-shaped price deviations centered on 1895 are much stronger when taking only information after 1880 into account. In the 1850s and 1860s, the restricted sample world price fluctuates less than its full sample counterpart.

Apart from misspecification of the common component, taking the period as a whole prohibits the relative weights λ_i to change over time. They represent each market's sensitivity to world price fluctuations. Without breaking the sample up, it would be impossible to capture changes in the degree of how much single markets take part in world wheat trade.

6.1.1 Antebellum International Market Integration

The trend obtained for worldwide comovement is shown in Figure 5 as a cross country average. It reveals the integrating forces of world trade in the 19th century. Globalization according to Figure 5 manifested itself in a strong increase between the first and the second quarter of the 19th century: the world component explains on average only 34% price variance between 1806 and 1829, but 58% between 1830

Figure 4: World price component during 19th century. Whole sample estimate vs subsample estimates.



and 1855. This first shift to integrated markets is followed by a second, albeit smaller one, as the flatter shape of the upper curve in Figure 5 shows. At the same time national market integration, representing solely national comovement, steadily declined in the 1800s, first quickly, then at a slower pace. These two developments add up to decreasing market separation; i.e., on average 19% of price variance was subject to local shocks before 1830, compared to only 8% after 1880 (not shown).

These results emphasize the role of market integration in the first half of the 19th century, as opposed to the “First Wave of Globalization” story famously put forward by O’Rourke (1997), among others. Recently there has been greater recognition of the former point, the post-Napoleonic improvement of world commodity market integration. Jacks (2005) finds decreasing transport costs for wheat before 1860 and Federico (2008) reports declining price dispersion in European wheat prices from the early 1800s on. Kaukiainen (2001) proposes decreasing information costs on why markets could come to function so much better without the widespread use of steam technology and the telegraph. He finds that business letters to and from London traveled on average twice as fast in the middle of the 19th century than at the beginning. Factual transport cost in sail shipping decreased impressively, as Brautaset and Grafe (2005) find. They argue that economies of scale can explain these cost reductions in shipping.

6.2 Broad Trends

The country averages are presented in Figures 6-7. Figure 6 contains averages for the major countries such as the U.K., the U.S., France, Austria-Hungary and Germany, while Figure 7 features Norway, Sweden, Belgium and Spain.[12] The upper panel shows world market integration, the middle national market integration and the lower one market separation in the sense that it shows the share of price variance, which is explained by neither national nor international comovement. The results are presented in such a fashion that it is possible to get a complete picture of a country's market integration process throughout the 19th century.

In the U.K. for example, the upper part of Figure 6 shows that it continuously integrated into the world market. At the same time the middle panel shows that conditional on world market integration the importance of national specific shocks decreased continuously. The lower panel shows a very low value of separation. Thus already in the beginning of the 19th century, U.K. markets were either nationally or internationally integrated with local shocks having almost no influence on local prices at all.

Three new perspectives on 19th century wheat market integration can be deduced from these results. First, European market integration before 1860 has been neglected in the literature relative to transatlantic market integration. The European market is not the consequence of a return to protectionism under Bismarck & Co in the 1880s but a result of weakening market forces after the end of the Napoleonic Wars. Second, the American Civil War represents a phase of transatlantic market disintegration; therefore postbellum market integration is a candidate for a postwar reconstruction phenomenon. This puts the "Grain Invasion" into perspective. The third result relates to the relative development of national and international integration, which was different across countries.

6.2.1 U.S. Accession to European Integration Levels

These results imply that the story to be highlighted in 19th century international wheat market integration is maybe not so much one of America and Europe merging into a common transatlantic market due to reduced transport costs, but rather that of an already integrated European market that opened up to another major supplier. One could also argue that it is likely that the strong increase in comovement between American markets with the world price could have occurred one or two decades earlier but was impeded by the Civil War (see Sharp (2008) for a similar argument). The level of integration of the U.S. markets at the end of the century, however, is comparable to that of France's as the top panel of Figure 6 shows. While the U.K.'s markets are integrated best in the last quarter of the 19th century, major German cities come second, well above the U.S. markets. If the U.S. markets are placed between France and Germany, two protectionist countries in terms of market integration, then a changed perspective relative to the traditional story of protectionist and free market nations after 1880 seems to be justifiable (see O'Rourke and Williamson (1999) for the established view).

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[12] The full set of results can be found in the appendix.

6.2.2 Late National Market Integration and Urban Demand for Wheat

The third set of results stems from the ability of the model to truly differentiate between national and international integration. They evolve differently across nations in the 19th century as the middle panel in Figure 6 shows. While toward the end of the 19th century we observe decreasing sensitivity to national shocks in the U.K., the U.S. and Germany, in France and especially in Austria-Hungary national shocks explain more than they do in the preceding subperiod (Figure 7). A related pattern can be observed in Spain, where national shocks' explanatory power decreases but remains on a very high level. On average wheat prices in Spain are explained 50% by national shocks, and about 35% by local shocks (Figure 14).

While protectionism seems to be the first possible explanation for increasing shares of the national component after 1880, another important factor may have been differences in the timing of industrialization across the nations discussed here. Kopsidis (1998, 2002) argues that integration of agricultural markets may have been spurred by industrialization. The creation of urban demand for agricultural goods led to regional specialization, which made it profitable for farmers to produce for the market and ship their goods to the cities. Even in the absence of technological progress unit transport costs may fall during this process due to economies of scale in market efficiency.

6.3 Country Results

The **U.K.** is certainly the country of which the highest world market integration and lowest separation of markets can be expected. Easy access to most U.K. cities by waterways and early commercialization are some of the often cited reasons for why industrialization first developed in England. Shiue and Keller (2007) for example find that at the beginning of the 1800s the U.K. was much better integrated than Western Europe on average. One still has to bear in mind that the first few decades witnessed the Napoleonic Wars and the Corn Laws that had an insulating effect on the U.K. wheat markets (Sharp 2006). Thus, one may find some limited world market integration and very low local market separation before 1830. Figure 8 shows exactly this. Note that there were some differences in the degree to which markets were globally integrated. 76% of wheat prices in Exeter were already determined by the world market, while prices in all other cities stayed below 60%.[13] In the aftermath, all cities converged to the same path of world market integration with shrinking nationally specific price components. Together with Belgium the U.K. emerged clearly as the most integrated wheat market during the second half of the 19th century.

In comparison, **France's** markets experienced a rather marginal development with considerable local heterogeneity. While early in the 1800s cities such as Paris, Lyon and Arras were better integrated into the world market than most U.K. cities, after the 1850s there was rather an anti-global tendency in those cities (Figure 9, upper panel). The French average for world integration did not decrease, however,

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[13] In the case of the U.K., France, Spain and Sweden, I did not plot all results to keep the graphs straightforward. All results can be found in the appendix.

because Toulouse, Mende and Pau followed a path of increasing integration. France ended the early 1900s as an intermediately globally integrated country with the largest national specific component in the sample (Figure 6).

The figures showing market integration in **Belgium** speak very much for themselves (Figure 10). All three markets behave almost identically. The largest part of price variation is subject to worldwide shocks (upper panel). The only peculiarity is the swing with a short setback to national specific price variation during the third quarter of the 19th century (upper and middle panel). It is striking that the Belgian markets in the sample were always fully insured against locally specific price shocks, reflected in the extremely low level of separation of all three markets over all periods (lower panel).

The disaggregated view allows for detailed insights into the development of **German** market integration. The upper panel of Figure 11 describes the astonishingly strong international integration of the German wheat markets. A global focus arose in the second quarter of the 19th century, too early to be fully explained by railroad or telegraph. It seems plausible to cite the German tariff union as the main driver of market integration. But this would imply strong explanatory power of the national component after 1830, and an increase relative to the first quarter (middle panel). Unfortunately, the small set of markets presented here is not suitable to confirm or refute this hypothesis, because Hamburg never became part of the tariff union, while Königsberg and Berlin have never been divided by tariff boarders. However, it is still interesting to find an already well integrated national market *before* the tariff union ever existed. Similar results were also found by Fremdling and Hohorst (1979) and Shiue (2005).[14] The evidence rather fits into a picture of increasing Baltic and North Sea trade that included the major Prussian and former Hanseatic cities. The introduction of the railroad was not without effect, though. It became important where waterways were missing: Munich, not connected to the Rhine-Weser-Elbe water network, has not been well integrated into the North-German market, as can be seen in the lower panel. Its separation from the North-German market was attenuated probably with the help of the railroad in last quarter of the 19th century.

The **United States** is the only major nation that developed no strong connections with the world market before 1880. Although the U.S. already supplied about half of the U.K.'s wheat imports in the 1850s (Sharp 2006), they were apparently not well integrated in the world market. What matured earlier, however, was a national market. Between the first and the third quarter of the 19th century comovement between the three East Coast cities New York, Philadelphia and Alexandria increased to such an extent that 60-70% of the variance of their prices was explained by the national component (middle panel in Figure 12).

The reason why comovement was strong but distinct from the world business cycle in the third quarter must be the Civil War in the 1860s, accompanied by harvest failures in the U.K. and Europe (Fite 1906, p. 264). Agricultural production in the American Midwest during the first Civil War years soared dramatically due to the increase in acreage and harvest luck. At the same time, the river connections to the South were partially closed and the relatively new railroad to Chicago could not meet demand. Thus, transport costs peaked at the beginning of the war, creating

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[14] See Dumke (1991) for details on the German tariff union.

a price wedge between the coast and the interior (Fite 1906, p. 270). This may explain the strong separation of the wheat market in Cincinnati from the East Coast markets as shown in the lower panel of Figure 12 panel and the corresponding decline of Cincinnati's national integration during the third quarter of the 19th century.[15] After the Civil War, internal and external trade flourished: all four markets integrated into the world market to a very high degree (72%).

The case of **Austria-Hungary** seems to be a good example in different evolving patterns of prices in cities within one nation. Before mid-century the eastern markets of Lwow and Krakow were separated from both national and international markets, while Ljubljana and Vienna were better connected to the international market. This seems plausible as they were closer to the rest of the European markets (see the map in Section 5). With progressing industrialization, the Hungarian part of the monarchy became the major grain supplier of the Austrian cities, and the national market increasingly integrated. Consequently, the degree to which the now-industrialized urban centers integrated into international market declined, as is shown in Figure 13 (see also Komlos (1979)). To sum up, market separation decreases (Figure 7, lower panel).

The **Spanish** national market was comparatively underdeveloped, as can be seen in Figure 14.[16] It is especially striking that there was no clear direction of development at all. Cordoba and Oviedo, for example, experienced international disintegration and then a thrust to more international comovement in the last quarter before World War I, while Lerida's path of development was the opposite. Overall, Spanish speed of world integration is the lowest in my sample for most of the observation period. Jacks (2005, p. 397) reports similar results from a TAR model. Pena and Albornoz (1984, p. 371) find underdeveloped intraregional wheat markets despite the import prohibition instituted in 1820. According to them, the situation was alleviated only in the 1880s when the railway network was improved. Some of their results can be found here, but still I rather find a secular decline than an improvement in efficiency. Herranz-Loncán (2007) finds both technological and institutional reasons for the relatively large regional divergence in economic development in Spain, confirming the overall low level of market development as I find. Barquín Gil (1997) does claim the existence of efficient commodity markets before 1850, but his sample is restricted to only one southern Spanish city, as Rosés (2003, 1000) criticizes.

When observing the average level of separation of the **Swedish** markets (lower panel in Figure 15), one could be tempted to group them into the same category as Spain's. However, there are differences in both development over time and the degree of similarity between the markets.

While the Spanish markets do not show any clear trend, there is an obvious tendency in Sweden toward more market integration, which becomes visible in the

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[15] Fishlow (1964) points out that Cincinnati was not a "leading Southern forwarder" (p. 358) and that the share of flour flowing east- and northwards increased from 3 to 90% between 1850 and 1860. But Cincinnati may have been dependent on sending its produce to the North by train or to the South by river – its location between the two fighting parties made its business vulnerable to war interruptions.

[16] Not all results are plotted in order to keep the plot straightforward. The remaining results are reported in the appendix.

top panel of Figure 15.[17] Moreover, only a small number of markets such as Uppsala and Hälsingland do not join into world market integration as much as most other Swedish cities. The high level of national market integration in the first quarter of the observation period is remarkable. Considering the Austria-Hungarian national wheat market for example, most cities' price comovements are comparable to Vienna's and Ljubljana's, while none are so asynchronous as Lwow's or Krakow's. In contrast to Spain, almost all Swedish cities are better integrated between 1806 and 1829 than any Spanish market in the following 26 years. The level of national specific shocks falls continuously in almost all Swedish cities, where the period of fastest fall is between the second and the third quarter of the 19th century. This seems rather late compared to other European nations such as Germany, Austria-Hungary and Belgium.

Commenting on **Norway**, the results in Figure 16 seem to be counterintuitive. The results show a *decreasing* integration into the world market accompanied by an *increasing* weight of the national component and a U-shaped separation of the markets. The local price component stays always well below 25%. However, I doubt if the model should be set up along national boundaries in the case of Norway. First, only two markets are included as the Norwegian sample, which are separated by mountains, and a train connection was not finished before 1909. In fact, there is no reason whatsoever to assume that Bergen and Oslo, then Christiania, should be part of the same market: until 1905, Norway was not yet an independent nation, and administration functions were to a large part based in Stockholm. Culturally, especially linguistically, the dialect spoken in Bergen was probably related to Oslo dialect no more closely than to what was spoken in Stockholm.[18] Perhaps it would be safer to group Bergen with German or English markets, and Oslo with the Swedish, which remains to be part of future refinements of this project. The oddness of my results is reflected in Jacks (2005, p. 390, 396), who finds high speeds of international and intranational price adjustment before 1850, which abruptly decrease thereafter.

Overall, the picture drawn here is one showing a stronger wave of globalization in the first half of the century than in the second. The Napoleonic Wars may have suppressed possible trade relations that soon blossomed as the war was over (Federico (2008) follows this track). When dating the start of globalization, certainly we should look somewhere before 1850 similar to O'Rourke and Williamson (2002). The slowdown of the speed of globalization in the second half of the century should be emphasized. Railroad, telegraph and steamship were not the only forces of world and national wheat market integration. A better explanation should include the impact of wars (or better their absence), gradual technological improvements and the market creating forces of regional specialization in connection with economies of scale in market efficiency.

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[17] Some markets have not been plotted, but the results can be found in the appendix.

[18] Even today there are two kinds of high Norwegian, and many Norwegians speak their local dialect.

7 Conclusion

In this paper, I evaluate comovement among wheat prices in different localities to investigate 19th century market integration. Each price is divided into a world, a national, and a local component in four independent subperiods representing stages of market development. The explanatory power of the common components is used to assess changing degrees of market integration over time.

I explain that there was a tendency toward closer integration over the 19th century, but stronger in the first half than in the second. A high degree of international wheat market integration was reached before the telegraph, steamship and railroads could reach their full cost saving potential.

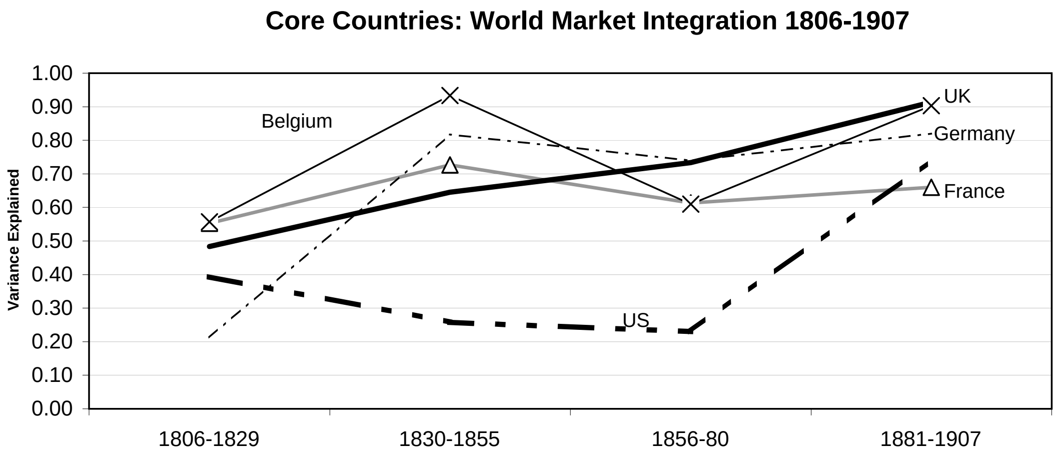
The 1860s was a decade of slower or no improvements of market integration, even when I control for exchange rate fluctuations caused by the decoupling of the paper dollar from gold. The American Civil War was the most likely reason, as it hampered intra-U.S. and Atlantic trade, while the Cobden-Chevalier network had no impact on wheat trade.

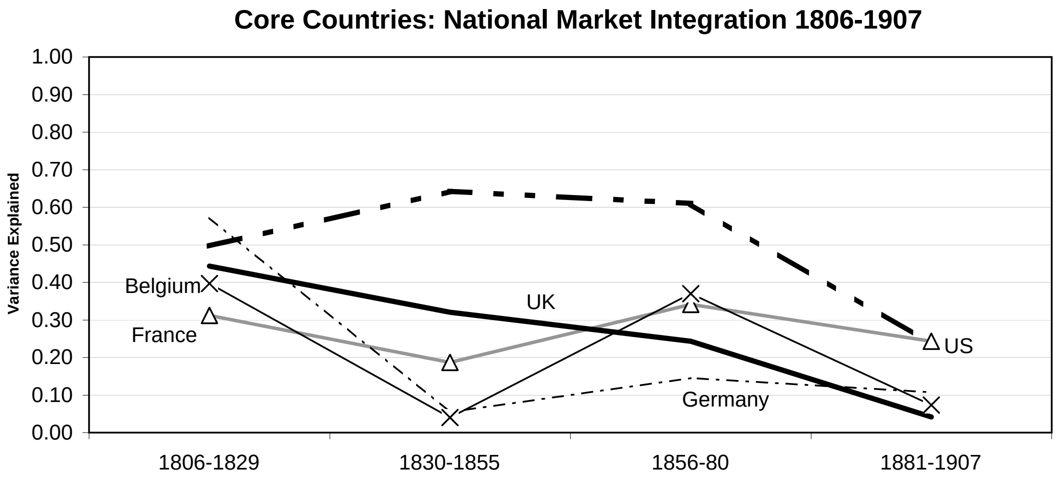
The U.S. markets were only fully integrated into the world market after the Civil War. Even then, they did not set the tone, but rather played one of many fiddles.

The North-German markets became integrated before 1830, while Munich was separated until after the German Reich was founded and railroad connections were established.

The introduction of comovement into the market integration literature has the advantage of forming a benchmark against which each market price can be assessed. Thus, it is not dependent on a battery of bilateral comparisons. Large amounts of price data can be processed and transformed into an intuitive measure of integration. The possibility for looking at each market individually is maybe the strongest argument for this method. Zooming into local circumstances while keeping an eye on the aggregate picture can be accomplished easily. Therefore, this method appears to be a useful means to throw light on questions of market integration in other regions and periods.

Figure 5: Development of world and national market integration, 1806-1907. Averages over cities' variances explained by world and national price component.


Core Countries: World Market Integration 1806-1907


Core Countries: National Market Integration 1806-1907

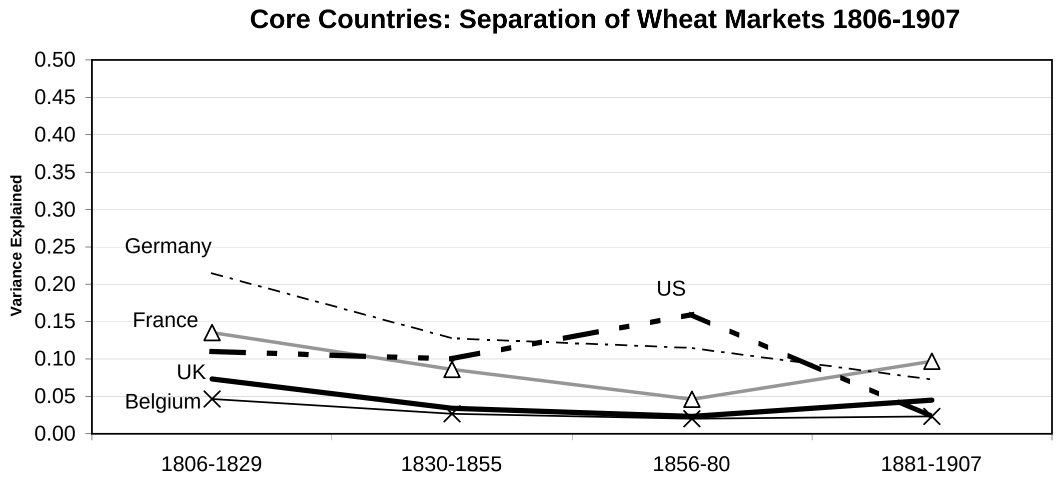

Core Countries: Separation of Wheat Markets 1806-1907

Figure 6: Development of world, national and local component, core countries, 1806-1907. Country averages.

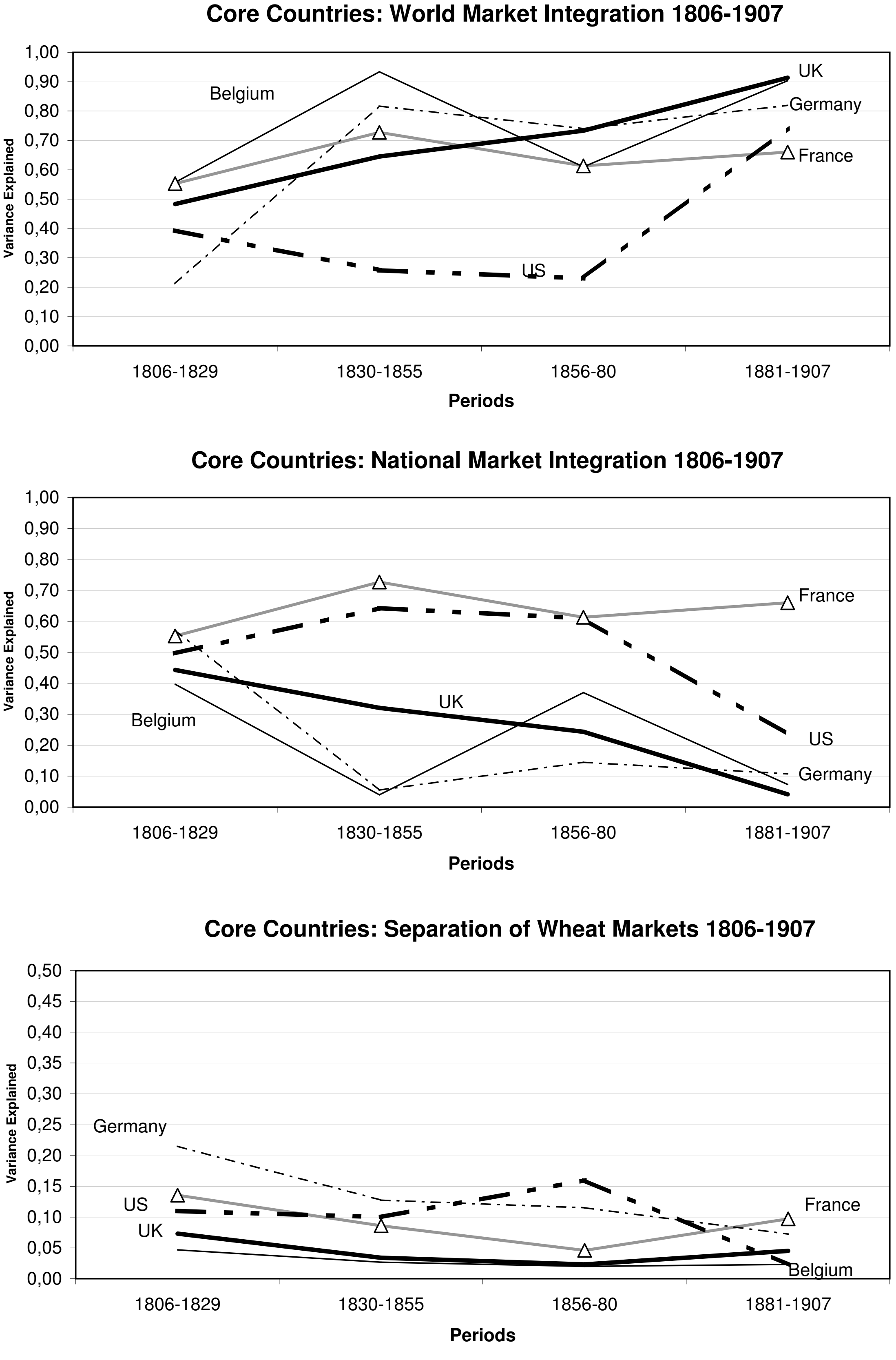
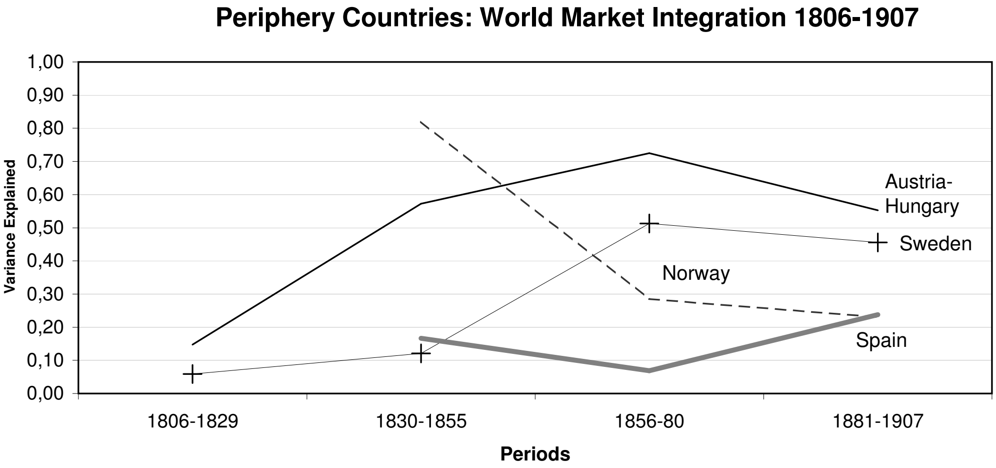
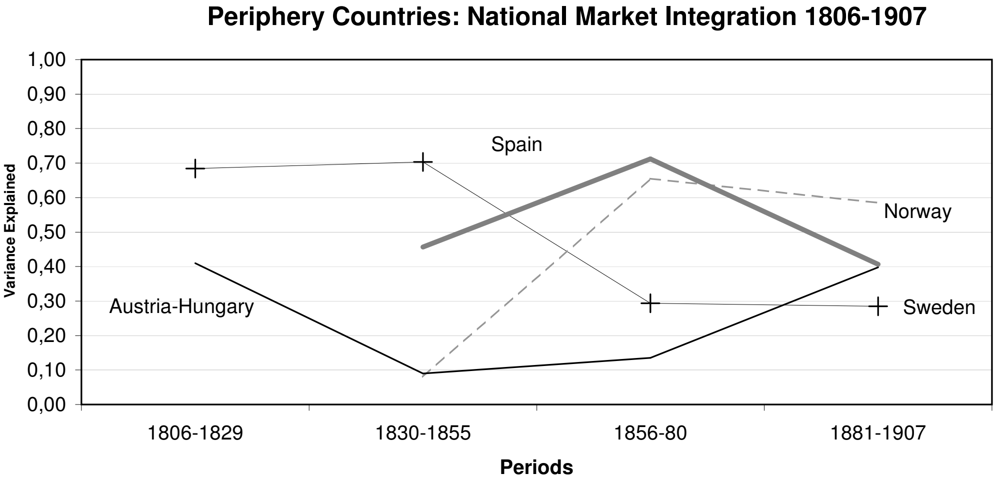


Figure 7: Development of world, national and local component, periphery countries, 1806-1907. Country averages.





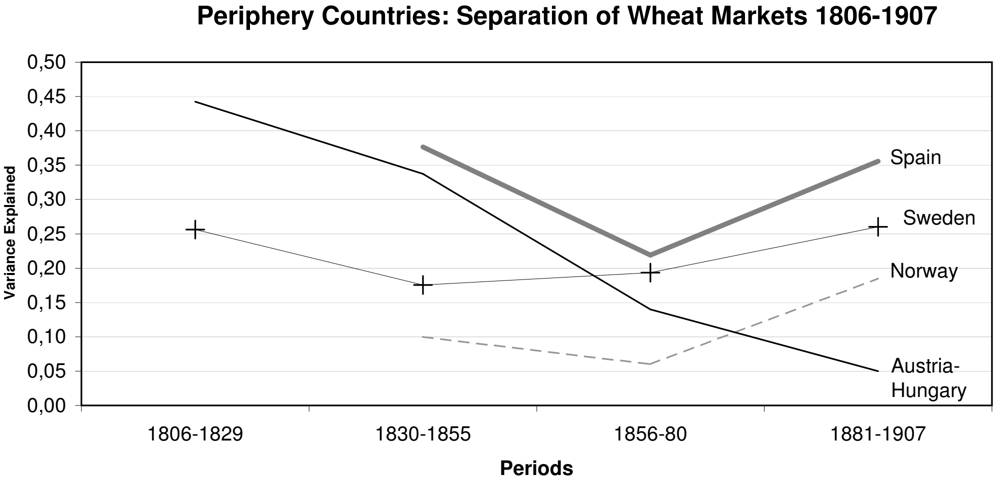


Figure 8: Development of world, national and local component in England, 1806-1907.

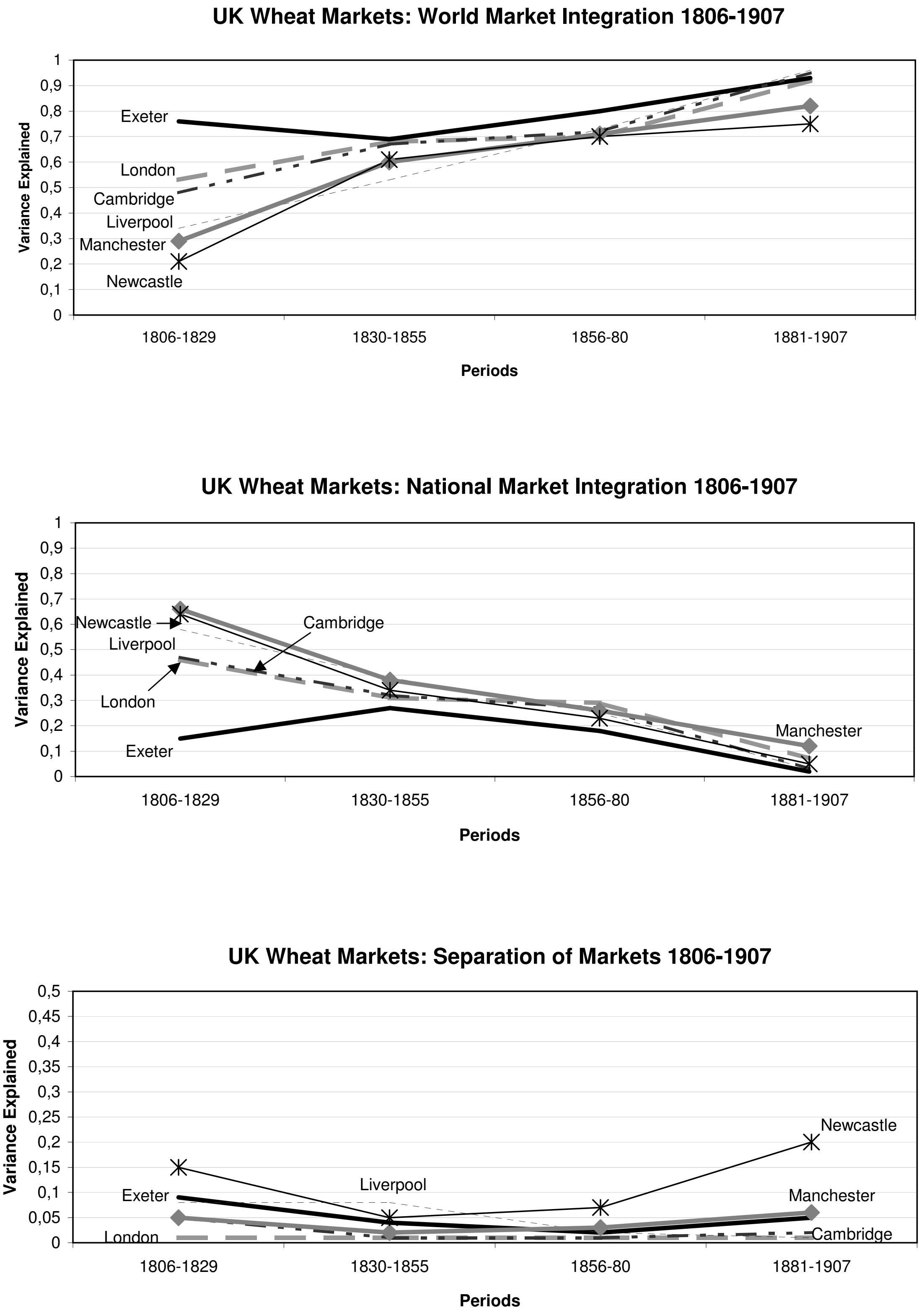
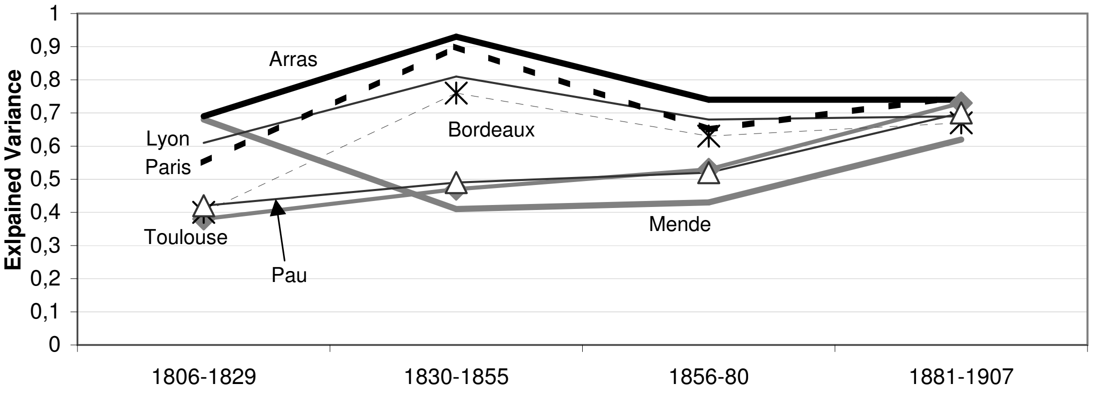
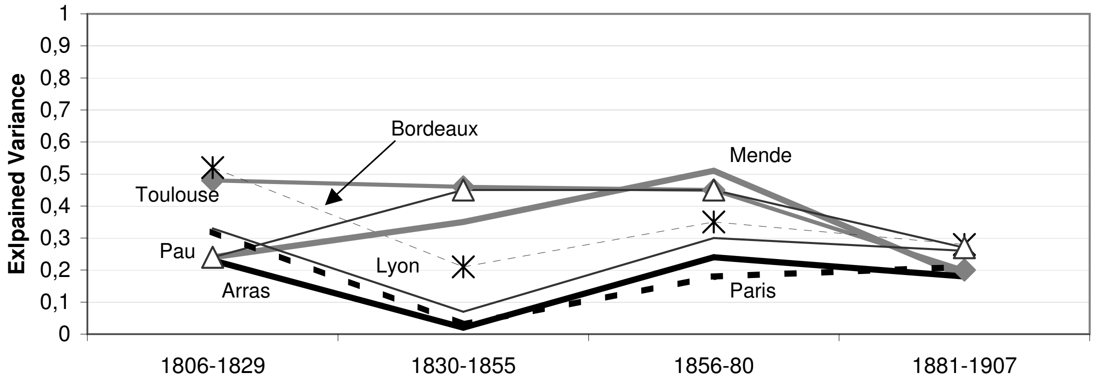


Figure 9: Development of world, national and local component in France, 1806-1907.

French Wheat Markets: World Market Integration 1806-1907



French Wheat Markets: National Market Integration 1806-1907



French Wheat Markets: Separation of Markets 1806-1907

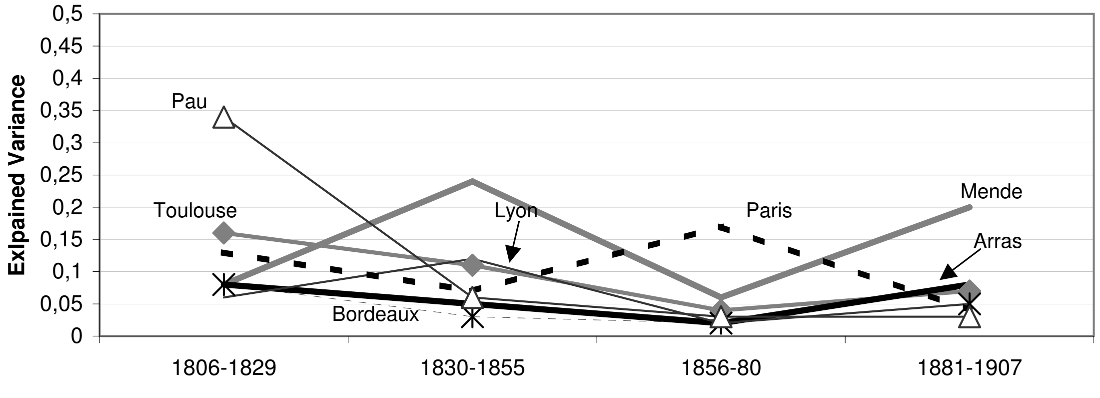
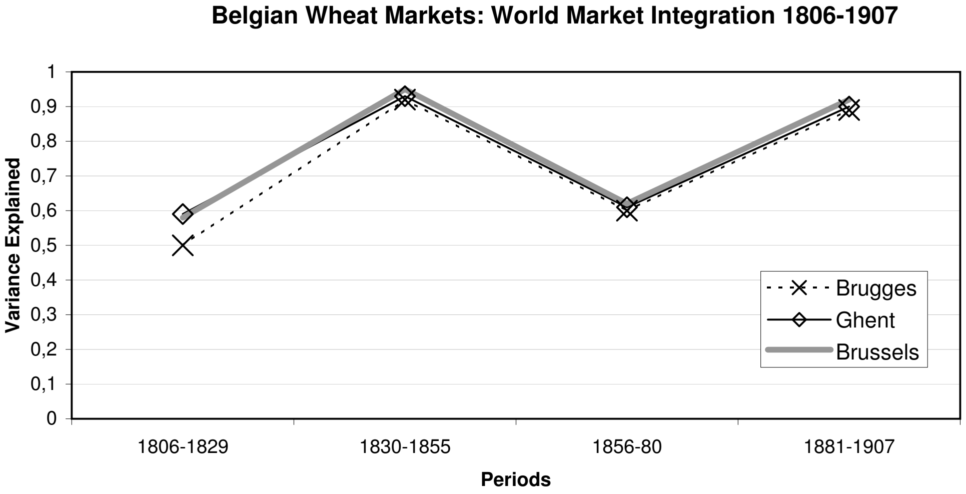
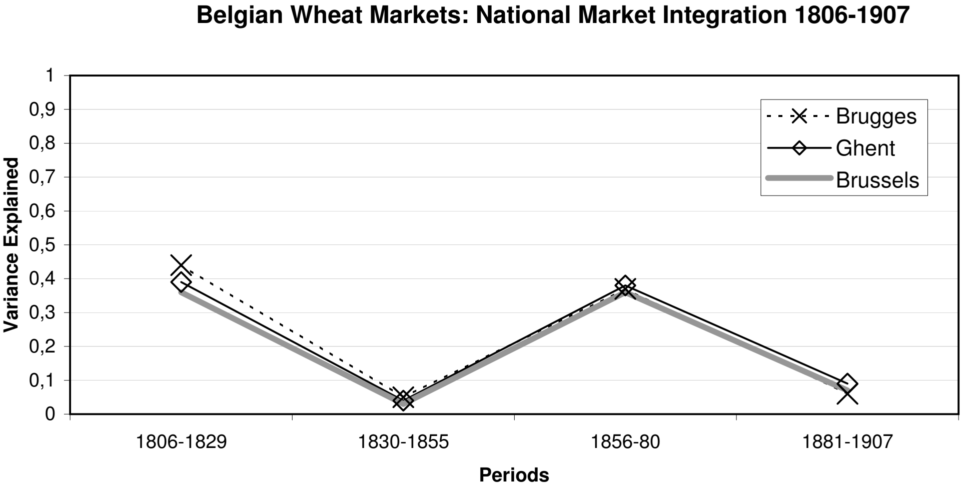


Figure 10: Development of world, national and local component in Belgium, 1806-1907.





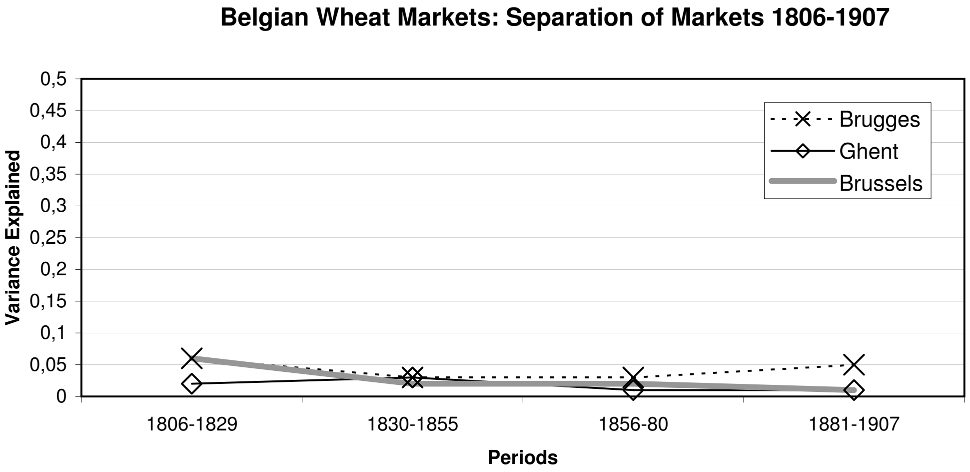


Figure 11: Development of world, national and local component in Germany, 1806-1907.

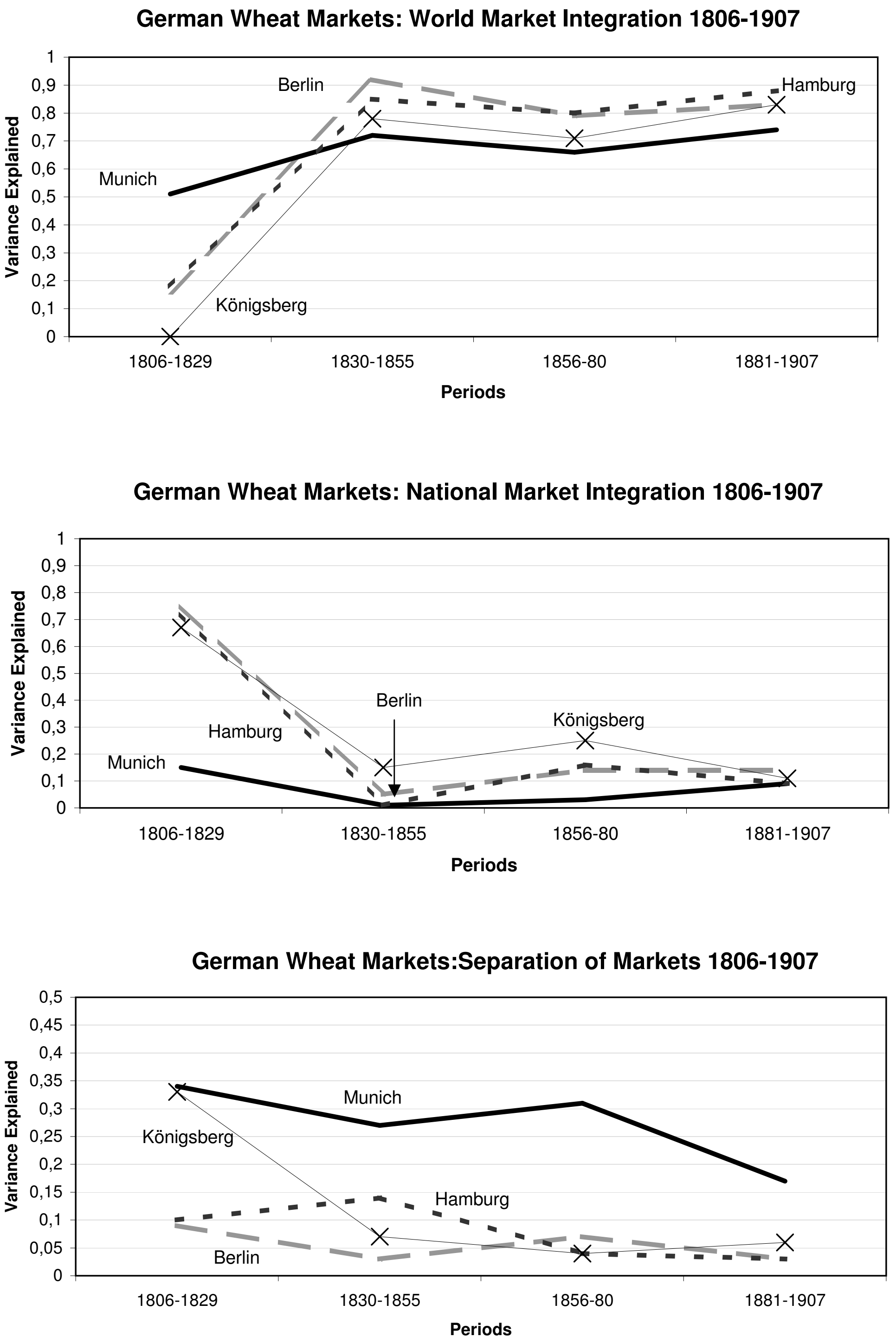
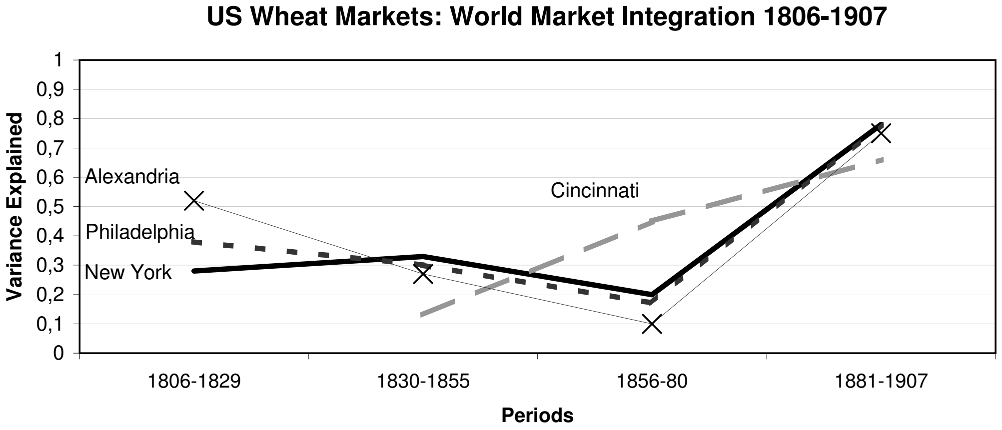
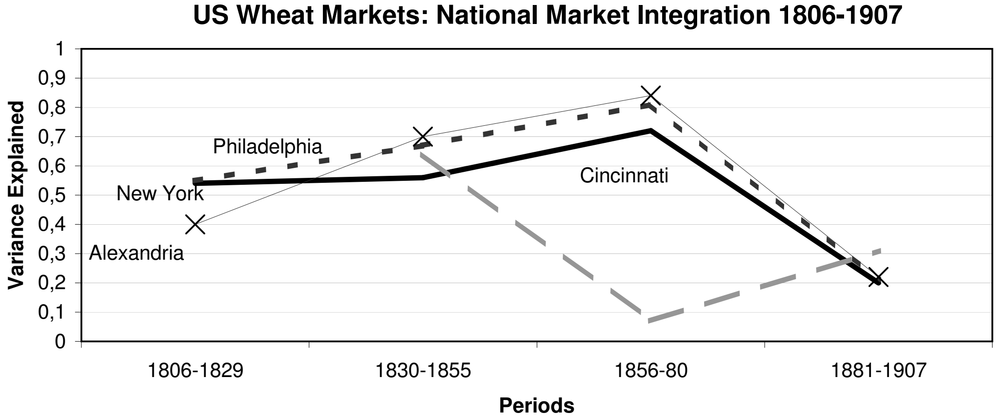


Figure 12: Development of world, national and local component in the U.S., 1806-1907.


US Wheat Markets: World Market Integration 1806-1907


US Wheat Markets: National Market Integration 1806-1907

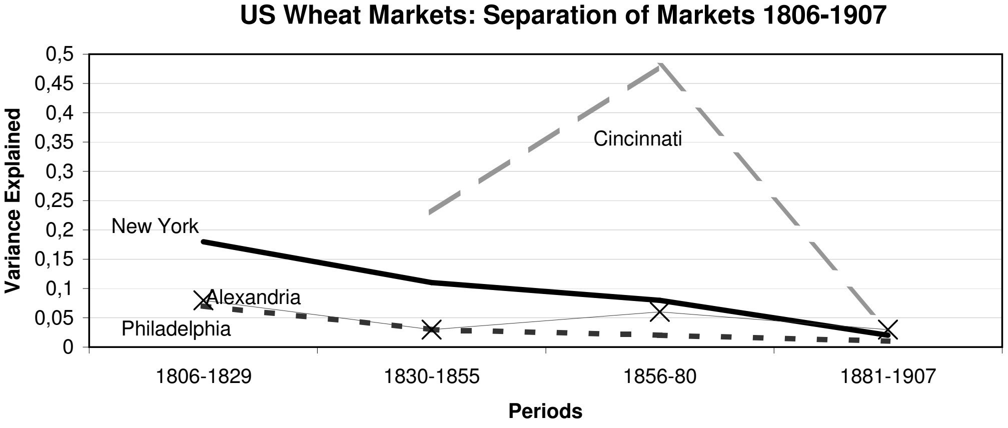
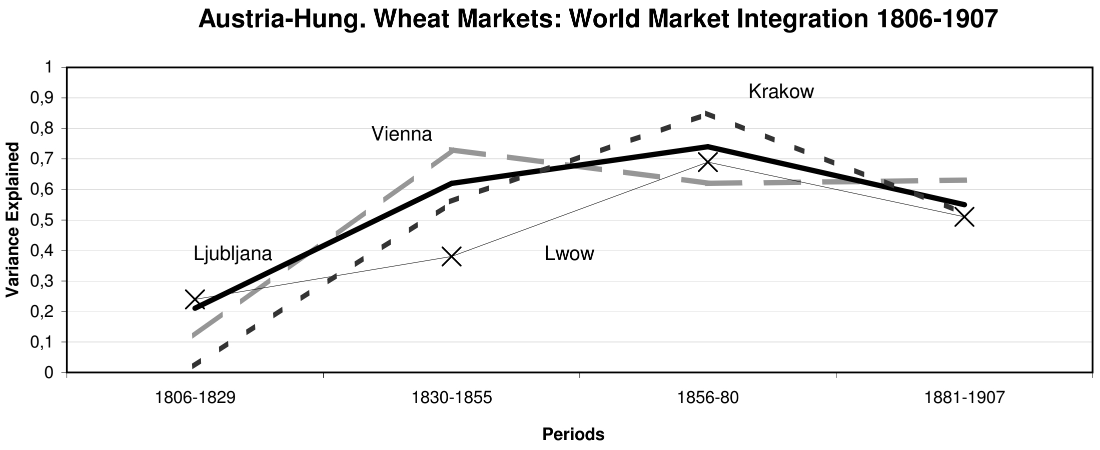
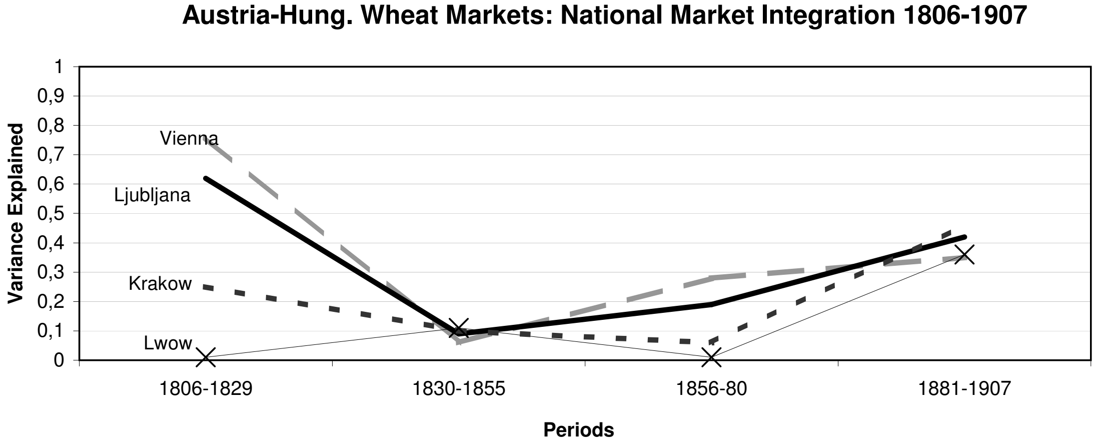

US Wheat Markets: Separation of Markets 1806-1907

Figure 13: Development of world, national and local component in Austria-Hungary, 1806-1907.





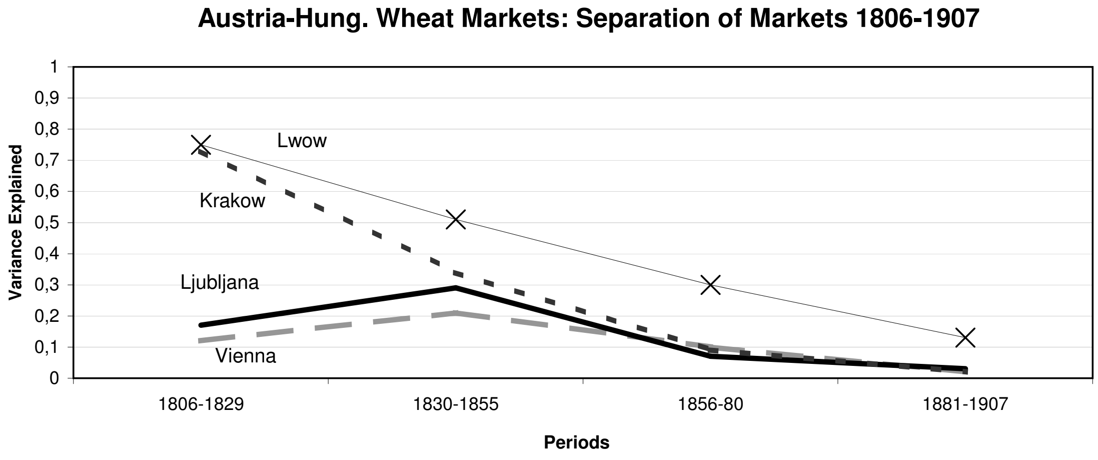
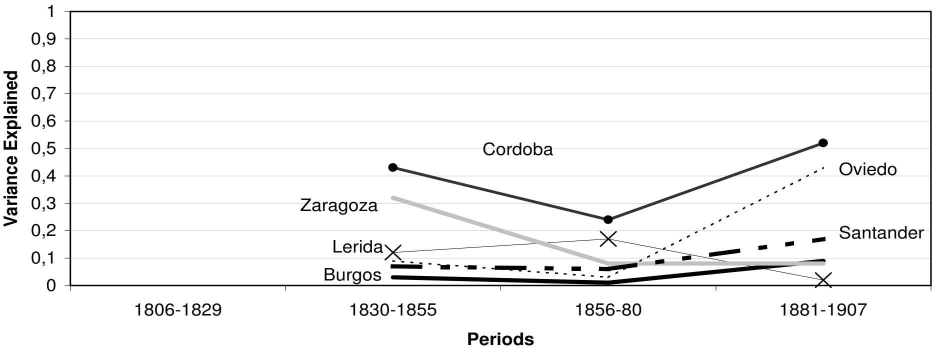
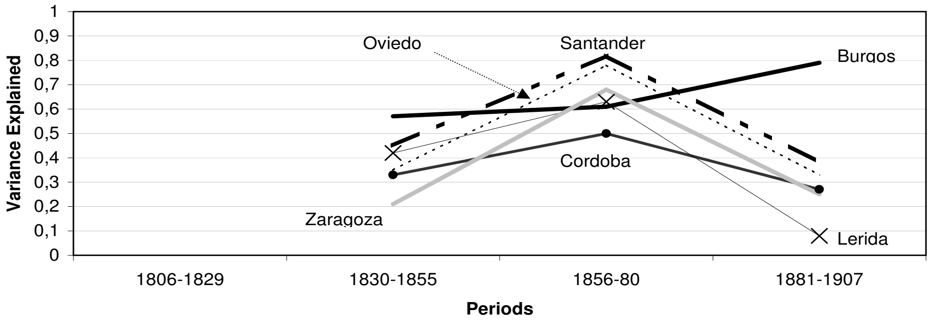


Figure 14: Development of world, national and local component in Spain, 1806-1907.

Spanish Wheat Markets: World Market Integration 1806-1907



Spanish Wheat Markets: National Market Integration 1806-1907



Spanish Wheat Markets: Separation of Markets 1806-1907

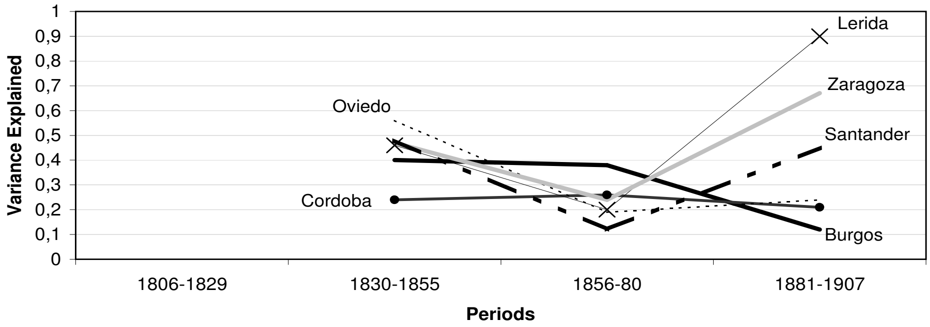


Figure 15: Development of world, national and local component in Sweden, 1806-1907.

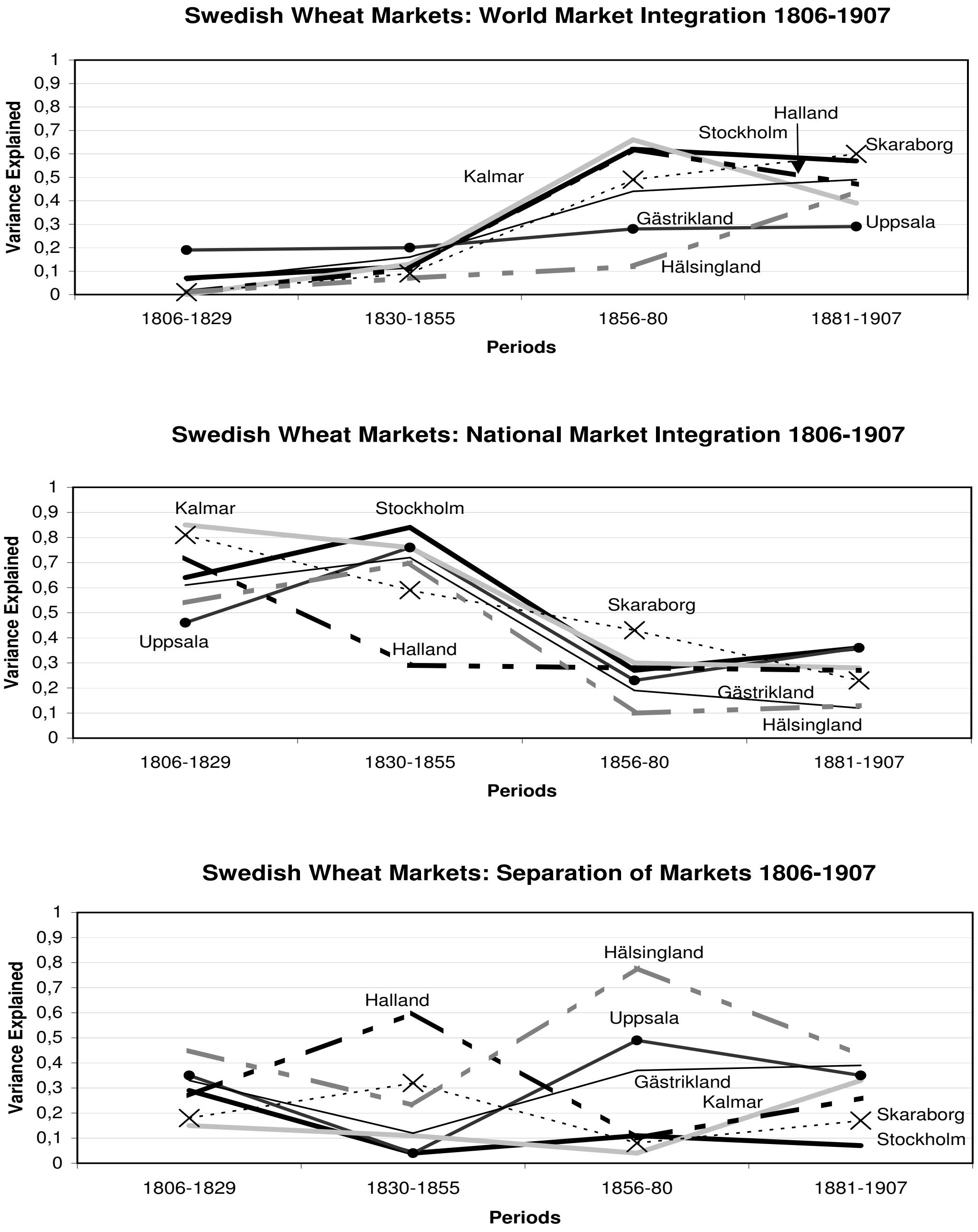
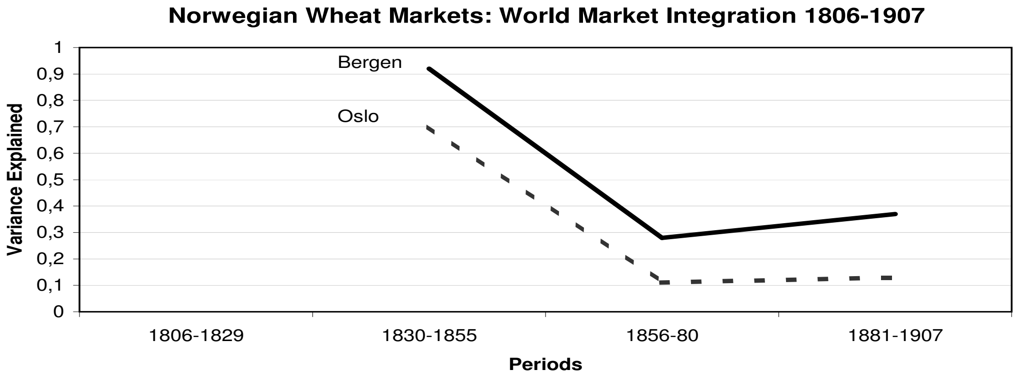
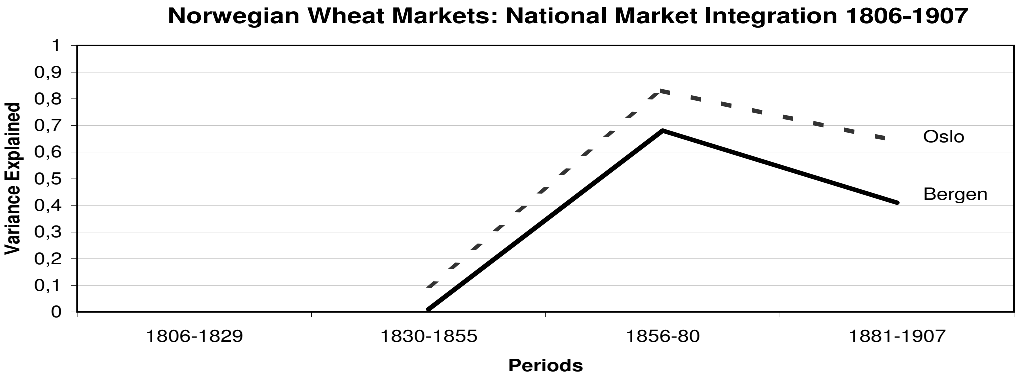


Figure 16: Development of world, national and local component in Norway, 1806-1907.





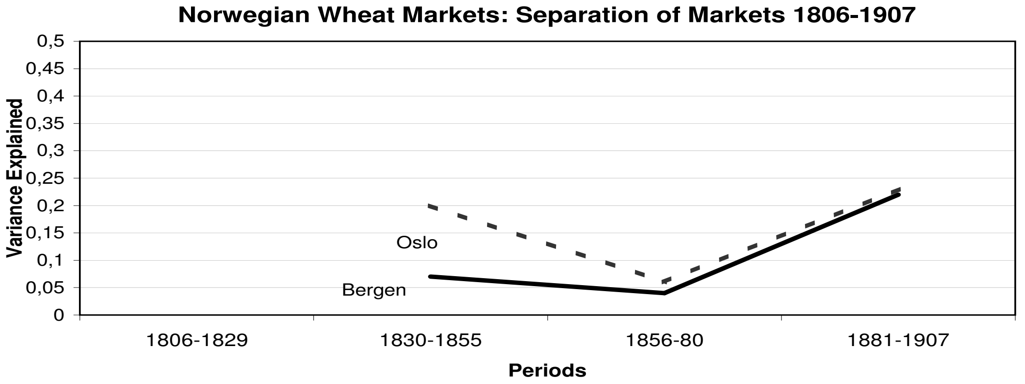


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Table 2: Medians of Explained Variances. World, National and Local Components of Wheat Prices, 60 Markets, 1830-1907.

					60 Markets, 1830-1907					
	%		1830-1855			1856-1880			1881-1907	
		World	National	Local	World	National	Lcoal	World	National	Local
1	Vienna	0.73	0.06	0.21	0.62	0.28	0.1	0.63	0.35	0.02
2	Lwow	0.38	0.11	0.51	0.69	0.01	0.3	0.51	0.36	0.13
3	Ljubljana	0.62	0.09	0.29	0.74	0.19	0.07	0.55	0.42	0.03
4	Krakow	0.56	0.1	0.34	0.85	0.06	0.09	0.52	0.46	0.02
5	Brugges	0.92	0.05	0.03	0.6	0.37	0.03	0.89	0.06	0.05
6	Ghent	0.93	0.04	0.03	0.61	0.38	0.01	0.9	0.09	0.01
7	Brussels	0.95	0.03	0.02	0.62	0.36	0.02	0.92	0.07	0.01
8	Bayeux	0.76	0.13	0.11	0.75	0.21	0.04	0.64	0.29	0.07
9	Saint-Brieuc	0.84	0.11	0.05	0.71	0.25	0.04	0.34	0.36	0.3
10	Toulouse	0.47	0.46	0.07	0.53	0.45	0.02	0.73	0.2	0.07
11	Bordeaux	0.76	0.21	0.03	0.63	0.35	0.02	0.67	0.28	0.05
12	Chateauroux	0.78	0.15	0.07	0.59	0.38	0.03	0.7	0.27	0.03
13	Mende	0.41	0.35	0.24	0.43	0.51	0.06	0.62	0.18	0.2
14	Barleduc	0.88	0.02	0.1	0.65	0.3	0.05	0.66	0.22	0.12
15	Arras	0.93	0.02	0.05	0.74	0.24	0.02	0.74	0.18	0.08
16	Pau	0.49	0.45	0.06	0.52	0.45	0.03	0.7	0.27	0.03
17	Lyon	0.81	0.07	0.12	0.68	0.3	0.02	0.69	0.26	0.05
18	Paris	0.9	0.03	0.07	0.65	0.18	0.17	0.75	0.21	0.04
19	Berlin	0.92	0.05	0.03	0.79	0.14	0.07	0.83	0.14	0.03
20	Konigsberg	0.78	0.15	0.07	0.71	0.25	0.04	0.83	0.11	0.06
21	Muenchen	0.72	0.01	0.27	0.66	0.03	0.31	0.74	0.09	0.17
22	Hamburg	0.85	0.01	0.14	0.8	0.16	0.04	0.88	0.09	0.03
23	London	0.68	0.31	0.01	0.7	0.29	0.01	0.92	0.07	0.01
24	Dover	0.7	0.28	0.02	0.75	0.23	0.02	0.9	0.06	0.04
25	Exeter	0.69	0.27	0.04	0.8	0.18	0.02	0.93	0.02	0.05
26	Gloucester	0.63	0.35	0.02	0.79	0.19	0.02	0.98	0.01	0.01
27	Worcester	0.62	0.35	0.03	0.75	0.23	0.02	0.97	0.02	0.01
28	Cambridge	0.67	0.32	0.01	0.72	0.27	0.01	0.95	0.03	0.02
29	Norwich	0.71	0.29	0	0.74	0.25	0.01	0.94	0.02	0.04
30	Leeds	0.64	0.35	0.01	0.72	0.26	0.02	0.92	0.05	0.03
31	Liverpool	0.53	0.39	0.08	0.73	0.25	0.02	0.96	0.03	0.01
32	Manchester	0.6	0.38	0.02	0.71	0.26	0.03	0.82	0.12	0.06
33	Newcastle	0.61	0.34	0.05	0.7	0.23	0.07	0.75	0.05	0.2
34	Carmarthen	0.66	0.22	0.12	0.69	0.28	0.03	0.92	0.02	0.06
35	New York City	0.33	0.56	0.11	0.2	0.72	0.08	0.78	0.2	0.02
36	Philadelphia	0.3	0.67	0.03	0.17	0.81	0.02	0.78	0.21	0.01
37	Cincinnatti	0.13	0.64	0.23	0.45	0.07	0.48	0.66	0.31	0.03
38	Alexandria	0.27	0.7	0.03	0.1	0.84	0.06	0.75	0.22	0.03
39	Stockholm	0.12	0.84	0.04	0.62	0.27	0.11	0.57	0.36	0.07
40	Uppsala	0.2	0.76	0.04	0.28	0.23	0.49	0.29	0.36	0.35
41	Södermanland	0.14	0.8	0.06	0.6	0.36	0.04	0.35	0.24	0.41
42	Östergötland	0.16	0.75	0.09	0.65	0.31	0.04	0.56	0.38	0.06
43	Kalmar	0.13	0.76	0.11	0.66	0.3	0.04	0.39	0.28	0.33
44	Halland	0.11	0.29	0.6	0.62	0.28	0.1	0.47	0.27	0.26
45	Skaraborg	0.09	0.59	0.32	0.49	0.43	0.08	0.6	0.23	0.17
46	Örebro	0.07	0.69	0.24	0.57	0.38	0.05	0.34	0.34	0.32
47	Västmanland	0.08	0.84	0.08	0.59	0.38	0.03	0.51	0.42	0.07
48	Gästrikland	0.16	0.72	0.12	0.44	0.19	0.37	0.49	0.12	0.39
49	Hälsingland	0.07	0.7	0.23	0.12	0.1	0.78	0.44	0.13	0.43
50	Bergen	0.93	0.01	0.06	0.41	0.55	0.04	0.34	0.5	0.16
51	Christiania (Oslo)	0.71	0.15	0.14	0.16	0.76	0.08	0.12	0.67	0.21
52	Burgos	0.03	0.57	0.4	0.01	0.61	0.38	0.09	0.79	0.12
53	Cordoba	0.43	0.33	0.24	0.24	0.5	0.26	0.52	0.27	0.21
54	Gerona	0.09	0.48	0.43	0.01	0.75	0.24	0.04	0.8	0.16
55	Granada	0.21	0.66	0.13	0.01	0.78	0.21	0.34	0.51	0.15
56	Lerida	0.12	0.42	0.46	0.17	0.63	0.2	0.02	0.08	0.9
57	Oviedo	0.09	0.35	0.56	0.03	0.78	0.19	0.43	0.33	0.24
58	Segovia	0.14	0.64	0.22	0.01	0.86	0.13	0.45	0.25	0.3
59	Zaragoza	0.32	0.21	0.47	0.08	0.68	0.24	0.08	0.25	0.67
60	Santander	0.07	0.45	0.48	0.06	0.82	0.12	0.17	0.38	0.45

Table 3: Standard Deviations of Explained Variances. World, National and Local Components of Wheat Prices, 1830-1907.

		60 Markets, 1830-1907								
	σ	1830-1855			1856-1880			1881-1907		
		World	National	Local	World	National	Local	World	National	Local
1	Vienna	0.02	0.07	0.07	0.08	0.09	0.06	0.02	0.02	0.01
2	Lwow	0.02	0.14	0.13	0.12	0.07	0.07	0.02	0.02	0.02
3	Ljubljana	0.02	0.07	0.06	0.08	0.09	0.03	0.02	0.03	0.01
4	Krakow	0.02	0.09	0.08	0.08	0.08	0.03	0.02	0.02	0.01
5	Brugges	0.02	0.02	0.01	0.1	0.1	0.01	0.01	0.01	0.01
6	Ghent	0.02	0.02	0.01	0.1	0.1	0.01	0.01	0.01	0.01
7	Brussels	0.01	0.01	0.01	0.11	0.11	0.01	0.01	0.01	0.00
8	Bayeux	0.02	0.02	0.01	0.09	0.09	0.01	0.02	0.02	0.01
9	Saint-Brieuc	0.02	0.02	0.01	0.1	0.1	0.01	0.01	0.03	0.02
10	Toulouse	0.02	0.03	0.02	0.12	0.12	0.01	0.02	0.02	0.01
11	Bordeaux	0.02	0.02	0.01	0.11	0.11	0.01	0.02	0.02	0.01
12	Chateauroux	0.02	0.02	0.01	0.11	0.11	0.01	0.02	0.02	0.01
13	Mende	0.02	0.04	0.03	0.11	0.13	0.02	0.01	0.02	0.02
14	Barleduc	0.02	0.01	0.01	0.1	0.1	0.01	0.02	0.02	0.01
15	Arras	0.02	0.01	0.01	0.1	0.1	0.01	0.01	0.02	0.01
16	Pau	0.02	0.03	0.02	0.11	0.12	0.01	0.02	0.02	0.01
17	Lyon	0.02	0.02	0.01	0.1	0.1	0.01	0.02	0.02	0.01
18	Paris	0.02	0.01	0.01	0.08	0.08	0.01	0.01	0.02	0.01
19	Berlin	0.01	0.02	0.01	0.12	0.12	0.02	0.02	0.03	0.02
20	Konigsberg	0.02	0.04	0.04	0.15	0.15	0.02	0.02	0.02	0.01
21	Muenchen	0.02	0.02	0.03	0.08	0.07	0.03	0.02	0.03	0.02
22	Hamburg	0.02	0.01	0.02	0.14	0.14	0.02	0.01	0.02	0.01
23	London	0.02	0.02	0.00	0.14	0.14	0.01	0.03	0.03	0.00
24	Dover	0.02	0.02	0.00	0.13	0.13	0.01	0.03	0.03	0.01
25	Exeter	0.02	0.02	0.00	0.14	0.13	0.01	0.02	0.01	0.00
26	Gloucester	0.02	0.02	0.00	0.14	0.14	0.01	0.01	0.01	0.00
27	Worcester	0.02	0.02	0.00	0.14	0.14	0.01	0.02	0.02	0.00
28	Cambridge	0.02	0.02	0.00	0.15	0.15	0.01	0.02	0.02	0.00
29	Norwich	0.02	0.02	0.00	0.14	0.14	0.01	0.02	0.02	0.00
30	Leeds	0.02	0.02	0.00	0.15	0.15	0.01	0.02	0.02	0.01
31	Liverpool	0.02	0.02	0.01	0.15	0.15	0.01	0.02	0.02	0.00
32	Manchester	0.02	0.02	0.00	0.15	0.15	0.01	0.04	0.04	0.02
33	Newcastle	0.02	0.02	0.00	0.14	0.14	0.01	0.03	0.03	0.01
34	Carmarthen	0.02	0.02	0.00	0.14	0.14	0.01	0.02	0.02	0.01
35	New York City	0.02	0.03	0.02	0.03	0.04	0.02	0.02	0.02	0.01
36	Philadelphia	0.02	0.02	0.02	0.05	0.05	0.02	0.02	0.02	0.01
37	Cincinnatti	0.01	0.03	0.03	0.04	0.02	0.04	0.02	0.02	0.01
38	Alexandria	0.02	0.02	0.02	0.03	0.04	0.02	0.02	0.02	0.01
39	Stockholm	0.01	0.02	0.01	0.12	0.12	0.01	0.03	0.03	0.02
40	Uppsala	0.01	0.02	0.01	0.06	0.07	0.02	0.02	0.04	0.03
41	Södermanland	0.01	0.02	0.01	0.14	0.14	0.01	0.02	0.04	0.03
42	Östergötland	0.01	0.02	0.01	0.14	0.14	0.01	0.02	0.03	0.02
43	Kalmar	0.01	0.02	0.01	0.13	0.13	0.01	0.02	0.03	0.02
44	Halland	0.01	0.02	0.02	0.12	0.12	0.01	0.02	0.03	0.02
45	Skaraborg	0.01	0.02	0.02	0.15	0.16	0.02	0.02	0.02	0.02
46	Örebro	0.01	0.02	0.02	0.14	0.14	0.01	0.02	0.04	0.03
47	Västmanland	0.01	0.02	0.01	0.15	0.15	0.01	0.02	0.03	0.02
48	Gästrikland	0.01	0.02	0.02	0.13	0.13	0.02	0.02	0.03	0.02
49	Hälsingland	0.01	0.02	0.02	0.05	0.06	0.02	0.02	0.03	0.02
50	Bergen	0.01	0.01	0.01	0.09	0.09	0.04	0.02	0.1	0.10
51	Christiania (Oslo)	0.02	0.09	0.08	0.05	0.07	0.05	0.01	0.12	0.12
52	Burgos	0.01	0.07	0.07	0.04	0.05	0.04	0.01	0.05	0.05
53	Cordoba	0.02	0.04	0.04	0.1	0.1	0.04	0.02	0.03	0.02
54	Gerona	0.01	0.06	0.06	0.03	0.04	0.03	0.01	0.05	0.05
55	Granada	0.02	0.05	0.05	0.03	0.05	0.04	0.02	0.03	0.03
56	Lerida	0.01	0.06	0.06	0.1	0.1	0.03	0	0.03	0.03
57	Oviedo	0.01	0.07	0.06	0.05	0.07	0.04	0.03	0.04	0.03
58	Segovia	0.01	0.05	0.04	0.03	0.04	0.03	0.02	0.03	0.03
59	Zaragoza	0.02	0.04	0.04	0.06	0.07	0.03	0.01	0.04	0.05
60	Santander	0.01	0.07	0.07	0.06	0.08	0.03	0.02	0.05	0.04

Table 4: Medians of Explained Variances. World, National and Local Components of Wheat Prices, 48 Markets, 1806-1855.

48 Markets. 1806-1855							
	%		1806-1829			1830-1855	
		World	National	Local	World	National	Local
1	Vienna	0.12	0.76	0.12	0.75	0.13	0.12
2	Lwow	0.24	0.01	0.75	0.43	0.02	0.55
3	Ljubljana	0.21	0.62	0.17	0.62	0.13	0.25
4	Krakow	0.02	0.25	0.73	0.62	0.06	0.32
5	Brugges	0.5	0.44	0.06	0.88	0.09	0.03
6	Ghent	0.59	0.39	0.02	0.89	0.08	0.03
7	Brussels	0.58	0.36	0.06	0.92	0.06	0.02
8	Bayeux	0.66	0.18	0.16	0.73	0.17	0.1
9	Saint-Brieuc	0.58	0.22	0.2	0.8	0.14	0.06
10	Toulouse	0.38	0.48	0.14	0.42	0.52	0.06
11	Bordeaux	0.4	0.52	0.08	0.71	0.26	0.03
12	Chateauroux	0.44	0.44	0.12	0.74	0.2	0.06
13	Mende	0.68	0.24	0.08	0.37	0.39	0.24
14	Barleduc	0.67	0.23	0.1	0.85	0.05	0.1
15	Arras	0.69	0.23	0.08	0.9	0.04	0.06
16	Pau	0.42	0.24	0.34	0.43	0.5	0.07
17	Lyon	0.61	0.33	0.06	0.76	0.11	0.13
18	Paris	0.55	0.32	0.13	0.88	0.05	0.07
19	Berlin	0.16	0.75	0.09	0.92	0.05	0.03
20	Konigsberg	0	0.67	0.33	0.82	0.07	0.11
21	Muenchen	0.51	0.15	0.34	0.69	0.01	0.3
22	Hamburg	0.18	0.72	0.1	0.83	0.02	0.15
23	London	0.53	0.46	0.01	0.69	0.3	0.01
24	Dover	0.61	0.36	0.03	0.7	0.28	0.02
25	Exeter	0.76	0.15	0.09	0.68	0.27	0.05
26	Gloucester	0.6	0.32	0.08	0.63	0.35	0.02
27	Worcester	0.53	0.41	0.06	0.61	0.36	0.03
28	Cambridge	0.48	0.47	0.05	0.67	0.32	0.01
29	Norwich	0.54	0.41	0.05	0.7	0.29	0.01
30	Leeds	0.31	0.65	0.04	0.64	0.35	0.01
31	Liverpool	0.34	0.58	0.08	0.53	0.39	0.08
32	Manchester	0.29	0.66	0.05	0.61	0.37	0.02
33	Newcastle	0.21	0.64	0.15	0.6	0.36	0.04
34	Carmarthen	0.6	0.21	0.19	0.66	0.22	0.12
35	New York City	0.28	0.54	0.18	0.28	0.6	0.12
36	Philadelphia	0.38	0.55	0.07	0.24	0.73	0.03
37	Alexandria	0.52	0.4	0.08	0.2	0.77	0.03
38	Stockholm	0.06	0.65	0.29	0.16	0.79	0.05
39	Uppsala	0.18	0.47	0.35	0.24	0.71	0.05
40	Södermanland	0.06	0.69	0.25	0.18	0.75	0.07
41	Östergötland	0.08	0.74	0.18	0.21	0.71	0.08
42	Kalmar	0	0.84	0.16	0.16	0.73	0.11
43	Halland	0.01	0.72	0.27	0.13	0.31	0.56
44	Skaraborg	0.01	0.81	0.18	0.13	0.53	0.34
45	Örebro	0.05	0.76	0.19	0.1	0.64	0.26
46	Västmanland	0.14	0.69	0.17	0.11	0.81	0.08
47	Gästrikland	0.05	0.62	0.33	0.19	0.68	0.13
48	Hälsingland	0.01	0.54	0.45	0.09	0.69	0.22

Table 5: Medians of Explained Variances. World, National and Local Components of Wheat Prices, 48 Markets, 1856-1907.

48 Markets. 1856-1907							
	%		1856-1880			1881-1907	
		World	National	Lcoal	World	National	Local
1	Vienna	0.62	0.28	0.1	0.65	0.33	0.02
2	Lwow	0.81	0	0.19	0.51	0.33	0.16
3	Ljubljana	0.73	0.19	0.08	0.58	0.39	0.03
4	Krakow	0.85	0.06	0.09	0.54	0.43	0.03
5	Brugges	0.64	0.34	0.02	0.89	0.07	0.04
6	Ghent	0.65	0.34	0.01	0.89	0.1	0.01
7	Brussels	0.67	0.32	0.01	0.91	0.09	0
8	Bayeux	0.75	0.2	0.05	0.61	0.3	0.09
9	Saint-Brieuc	0.73	0.23	0.04	0.32	0.35	0.33
10	Toulouse	0.62	0.35	0.03	0.71	0.25	0.04
11	Bordeaux	0.71	0.28	0.01	0.65	0.3	0.05
12	Chateauroux	0.65	0.33	0.02	0.69	0.28	0.03
13	Mende	0.55	0.36	0.09	0.59	0.23	0.18
14	Barleduc	0.68	0.27	0.05	0.63	0.24	0.13
15	Arras	0.75	0.22	0.03	0.69	0.23	0.08
16	Pau	0.61	0.36	0.03	0.66	0.31	0.03
17	Lyon	0.7	0.27	0.03	0.69	0.28	0.03
18	Paris	0.67	0.16	0.17	0.72	0.22	0.06
19	Berlin	0.88	0.04	0.08	0.83	0.13	0.04
20	Konigsberg	0.9	0.07	0.03	0.83	0.12	0.05
21	Muenchen	0.7	0.01	0.29	0.72	0.11	0.17
22	Hamburg	0.95	0.03	0.02	0.86	0.1	0.04
23	London	0.87	0.12	0.01	0.91	0.08	0.01
24	Dover	0.9	0.09	0.01	0.9	0.07	0.03
25	Exeter	0.95	0.04	0.01	0.92	0.03	0.05
26	Gloucester	0.96	0.04	0	0.95	0.04	0.01
27	Worcester	0.94	0.05	0.01	0.94	0.04	0.02
28	Cambridge	0.91	0.08	0.01	0.92	0.07	0.01
29	Norwich	0.9	0.09	0.01	0.91	0.06	0.03
30	Leeds	0.91	0.07	0.02	0.91	0.07	0.02
31	Liverpool	0.91	0.07	0.02	0.94	0.05	0.01
32	Manchester	0.9	0.08	0.02	0.83	0.09	0.08
33	Newcastle	0.87	0.06	0.07	0.76	0.07	0.17
34	Carmarthen	0.87	0.11	0.02	0.94	0.02	0.04
35	New York City	0.22	0.69	0.09	0.76	0.22	0.02
36	Philadelphia	0.24	0.74	0.02	0.73	0.26	0.01
37	Alexandria	0.14	0.8	0.06	0.7	0.27	0.03
38	Stockholm	0.75	0.14	0.11	0.58	0.35	0.07
39	Uppsala	0.34	0.18	0.48	0.29	0.35	0.36
40	Södermanland	0.78	0.19	0.03	0.34	0.26	0.4
41	Östergötland	0.83	0.14	0.03	0.56	0.38	0.06
42	Kalmar	0.81	0.15	0.04	0.41	0.26	0.33
43	Halland	0.75	0.15	0.1	0.5	0.24	0.26
44	Skaraborg	0.71	0.2	0.09	0.63	0.21	0.16
45	Örebro	0.76	0.19	0.05	0.35	0.32	0.33
46	Västmanland	0.79	0.18	0.03	0.52	0.4	0.08
47	Gästrikland	0.63	0.03	0.34	0.49	0.13	0.38
48	Hälsingland	0.2	0.03	0.77	0.47	0.11	0.42

Table 6: Standard Deviations of Explained Variances. World, National and Local Components of Wheat Prices, 48 Markets, 1806-1907.

48 Markets, 1806-1855							
	% (σ)	1806-1829			1830-1855		
		World	National	Local	World	National	Local
1	Vienna	0.03	0.11	0.10	0.03	0.08	0.07
2	Lwow	0.05	0.03	0.05	0.04	0.13	0.12
3	Ljubljana	0.05	0.10	0.09	0.03	0.10	0.09
4	Krakow	0.03	0.09	0.09	0.04	0.09	0.08
5	Brugges	0.15	0.15	0.02	0.03	0.03	0.01
6	Ghent	0.15	0.15	0.01	0.03	0.03	0.01
7	Brussels	0.16	0.16	0.02	0.03	0.03	0.01
8	Bayeux	0.19	0.19	0.03	0.05	0.05	0.01
9	Saint-Brieuc	0.18	0.18	0.03	0.04	0.04	0.01
10	Toulouse	0.16	0.17	0.05	0.05	0.05	0.02
11	Bordeaux	0.17	0.18	0.03	0.05	0.05	0.01
12	Chateauroux	0.18	0.19	0.03	0.05	0.05	0.01
13	Mende	0.17	0.17	0.02	0.04	0.05	0.03
14	Barleduc	0.17	0.17	0.02	0.04	0.03	0.01
15	Arras	0.19	0.19	0.02	0.03	0.03	0.01
16	Pau	0.10	0.11	0.04	0.05	0.05	0.02
17	Lyon	0.17	0.17	0.02	0.04	0.04	0.01
18	Paris	0.18	0.19	0.03	0.04	0.03	0.01
19	Berlin	0.08	0.09	0.05	0.02	0.02	0.02
20	Konigsberg	0.02	0.06	0.06	0.03	0.05	0.03
21	Muenchen	0.10	0.09	0.04	0.03	0.03	0.05
22	Hamburg	0.07	0.09	0.05	0.03	0.04	0.02
23	London	0.18	0.18	0.01	0.03	0.03	0.01
24	Dover	0.19	0.19	0.01	0.03	0.03	0.01
25	Exeter	0.20	0.19	0.02	0.04	0.03	0.01
26	Gloucester	0.20	0.20	0.02	0.03	0.03	0.01
27	Worcester	0.19	0.19	0.01	0.04	0.04	0.01
28	Cambridge	0.17	0.17	0.01	0.03	0.03	0.01
29	Norwich	0.18	0.18	0.01	0.03	0.03	0.01
30	Leeds	0.13	0.13	0.02	0.04	0.03	0.01
31	Liverpool	0.15	0.15	0.01	0.03	0.04	0.01
32	Manchester	0.13	0.13	0.01	0.03	0.03	0.01
33	Newcastle	0.09	0.09	0.03	0.04	0.04	0.01
34	Carmarthen	0.18	0.17	0.02	0.03	0.03	0.01
35	New York City	0.07	0.11	0.09	0.03	0.03	0.02
36	Philadelphia	0.06	0.10	0.08	0.03	0.03	0.02
37	Alexandria	0.07	0.09	0.06	0.03	0.03	0.02
38	Stockholm	0.03	0.04	0.03	0.03	0.03	0.01
39	Uppsala	0.05	0.06	0.04	0.03	0.03	0.01
40	Södermanland	0.02	0.06	0.05	0.03	0.03	0.01
41	Östergötland	0.03	0.05	0.03	0.03	0.04	0.01
42	Kalmar	0.06	0.05	0.04	0.03	0.03	0.01
43	Halland	0.06	0.06	0.05	0.02	0.03	0.02
44	Skaraborg	0.03	0.04	0.03	0.02	0.03	0.02
45	Örebro	0.02	0.04	0.03	0.02	0.03	0.02
46	Västmanland	0.04	0.06	0.03	0.02	0.03	0.01
47	Gästrikland	0.03	0.04	0.04	0.03	0.04	0.02
48	Hälsingland	0.07	0.06	0.06	0.02	0.03	0.02

Table 7: Standard Deviations of Explained Variances. World, National and Local Components of Wheat Prices, 48 Markets, 1806-1907.

48 Markets, 1856-1907							
	% (σ)	1856-1880			1881-1907		
		World	National	Lcoal	World	National	Local
1	Vienna	0.03	0.06	0.05	0.06	0.06	0.01
2	Lwow	0.04	0.02	0.03	0.06	0.06	0.02
3	Ljubljana	0.03	0.04	0.03	0.06	0.07	0.01
4	Krakow	0.03	0.03	0.02	0.07	0.08	0.01
5	Brugges	0.03	0.03	0.01	0.04	0.03	0.01
6	Ghent	0.03	0.03	0.01	0.03	0.03	0.01
7	Brussels	0.03	0.03	0.01	0.04	0.03	0.01
8	Bayeux	0.03	0.03	0.01	0.07	0.07	0.01
9	Saint-Brieuc	0.03	0.03	0.01	0.05	0.06	0.02
10	Toulouse	0.03	0.03	0.01	0.05	0.05	0.01
11	Bordeaux	0.03	0.03	0.01	0.06	0.06	0.01
12	Chateauroux	0.03	0.03	0.01	0.08	0.08	0.01
13	Mende	0.04	0.04	0.01	0.05	0.05	0.02
14	Barleduc	0.03	0.03	0.01	0.08	0.09	0.02
15	Arras	0.03	0.03	0.01	0.08	0.08	0.01
16	Pau	0.03	0.03	0.01	0.06	0.06	0.01
17	Lyon	0.03	0.03	0.01	0.07	0.07	0.01
18	Paris	0.03	0.03	0.01	0.07	0.07	0.01
19	Berlin	0.03	0.03	0.02	0.05	0.05	0.01
20	Konigsberg	0.05	0.05	0.02	0.04	0.04	0.02
21	Muenchen	0.03	0.03	0.04	0.05	0.06	0.03
22	Hamburg	0.04	0.04	0.01	0.05	0.05	0.01
23	London	0.05	0.05	0.01	0.08	0.08	0.00
24	Dover	0.04	0.04	0.00	0.08	0.08	0.00
25	Exeter	0.04	0.04	0.00	0.06	0.06	0.01
26	Gloucester	0.04	0.04	0.00	0.08	0.07	0.01
27	Worcester	0.05	0.04	0.00	0.07	0.07	0.00
28	Cambridge	0.05	0.04	0.00	0.08	0.08	0.00
29	Norwich	0.04	0.04	0.00	0.09	0.09	0.01
30	Leeds	0.05	0.05	0.00	0.06	0.06	0.01
31	Liverpool	0.05	0.05	0.00	0.07	0.07	0.00
32	Manchester	0.05	0.05	0.00	0.07	0.06	0.01
33	Newcastle	0.04	0.04	0.01	0.06	0.06	0.02
34	Carmarthen	0.05	0.05	0.01	0.07	0.06	0.01
35	New York City	0.02	0.03	0.02	0.04	0.04	0.01
36	Philadelphia	0.02	0.03	0.02	0.05	0.05	0.01
37	Alexandria	0.02	0.03	0.03	0.04	0.04	0.01
38	Stockholm	0.04	0.04	0.01	0.07	0.07	0.02
39	Uppsala	0.03	0.04	0.03	0.03	0.04	0.04
40	Södermanland	0.04	0.04	0.01	0.07	0.10	0.04
41	Östergötland	0.04	0.04	0.01	0.06	0.06	0.02
42	Kalmar	0.04	0.04	0.01	0.06	0.06	0.02
43	Halland	0.04	0.04	0.01	0.06	0.06	0.02
44	Skaraborg	0.05	0.05	0.01	0.06	0.05	0.02
45	Örebro	0.04	0.04	0.01	0.03	0.05	0.03
46	Västmanland	0.05	0.04	0.01	0.05	0.05	0.02
47	Gästrikland	0.04	0.03	0.01	0.05	0.05	0.02
48	Hälsingland	0.02	0.02	0.02	0.04	0.04	0.02