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Distance and Time Effects in Swedish Commodity Prices, 1732-1914

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Abstract

We study the role of distance and time in statistically explaining price dispersion across 32 Swedish towns for 19 commodities from 1732 to 1914. The resulting large number of relative prices (502,689) allows precise estimation of distance and time effects, and their interaction. We find an effect of distance that declines significantly over time, beginning in the 18th century, well before the arrival of canals, the telegraph, or the railway.

JEL classification: N70, F61, E37.

Keywords: distance effect, law of one price

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1. Introduction

Economic historians often have studied the integration of markets over time using prices in multiple locations, whether intranational or international. One key question of interest in price history is the extent of convergence of these prices and the speed at which this occurred. In some cases researchers also have documented the wartime blockades, tariff changes, or changes in transport costs associated with these trends.

We seek to contribute to research in price history with this study of Sweden, with data drawn from the work of Lennart Jörberg (1972) who led a team of researchers. This research choice has three appealing features. First, it allows a long span of data, from 1732 to 1914. Studying data back to the 18th century is not always possible in the related research, as noted by Jacks, O'Rourke, and Williamson (2011). Second, there is a large number of locations, with prices collected at up to 32 market towns. This geographical richness proves useful in studying the effect of distance on relative prices and how that effect evolved over time. Third, we also study 19 commodities, including a range of foodstuffs and manufactured goods. The list includes: baltic herring, bar iron, beef, butter, charcoal, hay, hops, log timber, oxen, pork, sawn batten, sheep, straw, tallow, tallow candles, tar, wax candles, wheat, and wool. Thus we can see whether price dispersion reflected the perishability or weight-to-value ratio of a specific commodity, for example.

The large span of years, commodities, and locations provides a great deal of statistical precision. We find an effect of distance on price dispersion, for almost all commodities. Pooling across the commodities, we find that the distance effect declines over time. This decline shows considerable variation from year to year. For example, it was interrupted during the early 19th century. Most notably, the process of convergence began in the 18th century, and specifically after 1760. This finding of early convergence mirrors results from recent studies of international and intranational grain markets.

2. Related Research

Our goal is to study intranational price dispersion in Sweden back to the 18th century and using a range of commodities. We can draw on a wealth of recent research that provides benchmarks for this study. This work looks at the extent of price convergence between locations, its evolution over time, and the causes of and obstacles to that convergence.

Jacks, O'Rourke, and Williamson (2011) provide a review of this research.

First, several studies assess the law of one price (LOP) internationally. For example, Rogoff, Froot and Kim (2001) describe the price differences between London and Amsterdam for 7 commodities over many centuries. O'Rourke and Williamson (1994) study 13 commodities traded between the US and UK from 1870 to 1913, and report a convergence trend. Klovland (2005) studies 39 commodities in Britain and Germany for a similar period, from 1850 to 1913, and again studies the persistence of LOP deviations.

Second, several studies examine LOP deviations intranationally. For example, Dobado-González and Marrero (2005) document how corn prices converged across 32 Mexican states from 1885 to 1908. Trenkler and Wolf (2005) study wheat flour prices across Polish cities in the interwar period. Slaughter (1995) studies the prices of 10 goods in US cities during 1820–1860 and describes how they tended to converge across cities over time. These studies of intranational prices draw one's attention to mechanisms such as improved transport and communication, which have been documented within a number of countries. For example, Slaughter describes the roles of canals, steamboats, and railroads in price convergence.

Third, a number of studies compare international and intranational price dispersion for a single commodity: wheat. Studying wheat has four distinct advantages: (a) it is storable (and was so historically); (b) it is internationally traded; (c) in some cases its price is recorded according to standardized varieties; and (d) in some cases shipping costs can be collected. These features suggest that arbitrage could operate, with the passage of time, as emphasized by Pippenger and Phillips (2008) in their study of wheat prices in the late 20th century. Shiue (2005) describes the differences in grain prices across cities in Germany and its neighbors as the zollverien customs union spread between 1815 and 1855. She compares these differences with those between German and non-German cities and finds a small border effect. Keller and Shiue (2008) use annual wheat prices for the 19th century in 68 central European cities, mostly in Germany, to investigate the conduits for price convergence. Jacks (2004, 2005, 2006, 2009) examines wheat prices for a wide range of time periods and cities. For example, Jacks (2005) studies the period 1800–1913 for up to 100 cities in 10 countries including the US, where quotations come from up to

11 cities. He documents price convergence using several different statistics. Jacks also discusses the causes of convergence and the impediments to it. He considers such factors as transport costs, other transactions costs or improvements such as the rise of bills of exchange, price manuals, marine insurance, the effects of wars, and mercantilist policy (such as the 17th century Navigation Acts in Britain). He also compares trade costs for wheat to price differentials, finding that the differentials are up to twice as large as reported trade costs. He also regresses measures of price dispersion on variables such as distance, exchange-rate volatility, and dummy variables for borders, port and railway status, or a common currency. He finds a decline in the effect of distance over time.

Several key studies also document interruptions in the process of convergence. Jacks (2011) documents the increase in commodity price dispersion within England during the Napoleonic Wars. He cites sources on the international effect of the wars as interrupting and then reversing commodity-market integration. He studies 4 grain prices in 52 counties from 1771 to 1815 and shows that intranational dispersion also increased. Jacks, O'Rourke, and Williamson (2011) study historical and contemporary data sources since 1700. They also document the increases in price volatility during 1776–1819 when trade in the Atlantic economies was disrupted by the Revolutionary War and the French Wars. Dobado-González, García-Hiernaux, and Guerrero (2012) comprehensively review debates on the timing of price convergence, and trace it back to the 18th century by studying wheat prices internationally.

3. Commodity Price Data and Currency History

Jörberg (1972) describes the Swedish price data, which apply to 32 towns or regions at various times and to many commodities. For some commodities quality could vary across towns, though goods were supposed to be of sufficient quality to satisfy payments due in kind. Scholars have used them to study the cost of living and real wages, but apparently not LOP deviations. Lagerlöf (2015) studies grain prices from this source for 1816–1870, within a broader study of Malthusian checks. He finds that local grain prices were correlated with local harvests, suggesting that grain markets were not fully integrated.

The numbers come from market price scales that were used for taxes, tithes, and other payments. The prices were averages of current annual prices in market towns within each region. For several items the prices were fixed between 1735 and 1756. At that point they were unfrozen because the state was losing revenue due to inflation. Prices were collected at Thomasmäss (December 21) each year. But then in 1775 the officials were allowed to forecast prices for grains over the next few months if they thought the Thomasmäss price was abnormal. The time of the year for collection was changed to November in 1803. The coverage and averaging across districts within a county changed several times. Jörberg (1972, p 12) summarizes the various refinements over time.

Table 1 lists the location codes and districts studied by Jörberg. It then lists the largest market town in each district, along with its latitude and longtitude. We measure the great circle distance between towns in kilometres. Of course the actual travel distance may have differed from this, but we have not found data on actual travel methods or times. Thus there may be some attenuation bias in distance effects due to measurement error. Figure 1 shows a map of the districts. The maximum number of districts for a commodity and year is 31.

The commodity list includes nine agricultural commodities (beef, butter, hay, hops, pork, straw, tallow, wheat and wool), two animals (oxen and sheep), one fish (baltic herring), four non-agricultural commodities (bar iron, log timber, sawn batten, and tar) and three sources of light or heat (charcoal, tallow candles, and wax candles). This mix of goods is typical of price history datasets. Since the number of towns in the study is 32, the number of possible pairs is 496 but the number of available location pairs differs substantially by commodity.

Sweden adopted a series of unusual monetary arrangements during the 18th century. From 1732 to 1775 prices are quoted in silver *dalers* (*daler silvermynt*) (with unit öre, with 32 per *daler*). From 1776 to 1802 they are quoted in *riksdaler* specie (with units shilling, with 48 per *riskdaler*). During this period there were two internal units of account: *riksdaler banco* and *riksdaler riksgälds*, that had a varying relative value. Jörberg (1972, p 79) notes that market price scales were quoted in *riksdaler riksgälds*. After 1803 all prices are in *kronor* (singular: *krona*) per metric unit. Weights and measures also varied over time.

Jörberg (pp 81–83) discussed at length the pitfalls in trying to convert prices into comparable, common currency units over time. Given those pitfalls, he advised against an attempt to convert all prices into, say, kronor for the entire period. We focus on relative prices across locations and how their dispersion varied over time—rather than on relative prices over time—and so automatically follow this advice. Thus the prices are in a common currency for a specific year but the currency units vary over time. The currency changes do not affect our calculations. However, they would preclude the use of some other methods, such as the time-series modelling adopted by Jacks (2005) or that of Dobado-González, García-Hiernaux, and Guerrero (2012) that measures mean-reversion.

Although we have found no data on travel times or shipping costs, outlines of Swedish history by Weibull (1993) and Kent (2008) document some of the milestones in transportation and communications during this period. The early 19th century saw the introduction of canals, including the Trollhätte canal in 1800 and the Göta canal in 1832. Railways and the telegraph followed during the 1850s and 1860s. Sweden was not an early industrializer, though. In 1900 half of employment remained in agriculture.

For other countries, some comparable sources of price data exist because of the work of the International Scientific Committee on Price History in the 1930s and 1940s, described by Cole and Crandall (1964). These sources include the monographs by Posthumus (1946) on Holland, Elsas (1936, 1949) on Germany, Hauser (1936) on France, Hamilton (1947) on Spain, and Pribram (1938) on Austria. The Danish price history project begun by Friis and Glamann (1958) is another rich source. Data from these and other studies can be found at the Global Price and Income History Group (`www.gpih.ucdavis.edu`), the IISH List of Datafiles of Historical Prices and Wages (`www.iisg.nl/hpw/`), or at `eh.net`. But data for these countries involve significantly fewer intranational locations.

4. Patterns in Commodity Price Integration

We next consider departures from the law of one price both by commodity and pooled over commodities, on average and as they evolved over time. Our analysis proceeds in two stages. First we consider time-invariant barriers, represented by the distance between towns. Second, we consider the possibility that the economic impact of distance changed over time. Obvious candidates are improvements in transportation that reduced the cost per kilometre of shipments. Less obvious, but also plausible, is the notion that expansions of the transportation network gave rise to new trading linkages where trade costs were initially prohibitive.

Consider a commodity i in year t that is priced in towns j and k: its price is denoted p. Begin with the log relative price:

$$q_{i,jk,t} = \ln p_{i,j,t} - \ln p_{i,k,t}. \tag{1}$$

The time-varying measure of dispersion then is defined as:

$$aq_{i,jk,t} = 100|q_{i,jk,t}|. \tag{2}$$

When the focus is time-invariant barriers, we work with the median of the absolute value of LOP deviations, where the median is taken over all time periods for which the bilateral relative price observations are available:

$$mdaq_{i,jk} = \text{median}_t(aq_{i,jk,t}). \tag{3}$$

We study the median absolute deviation to mitigate sensitivity to outliers as may arise due to measurement error.

In each sub-section of our analysis we present both pooled and good-specific results. This is important for three reasons. First, much research focuses on grain prices and because wheat is one of our commodities the disaggregated analysis provides a point of contact with this work. Second, since the question of interest is market integration broadly defined, it is important to know if results for wheat hold for other commodities in the cross-section. Third, pooling enables us to estimate parameters more precisely.

All standard errors are cluster-robust, so that they are not understated due to correlation across towns or years. We thus follow Cameron and Miller's (2015) guidelines for inference. In time-invariant statistical models we cluster over town pairs jk. In time-varying regressions we cluster over both town pairs jk and years t, using the multiway clustering of Cameron, Gelbach, and Miller (2011). (Cameron and Miller suggest that $I = 19$ is not a large enough number of commodities to cluster in that dimension.) In practice these standard errors are considerably larger than the traditional heteroskedasticity-robust ones, so the resulting inferences are conservative.

4.1 Time-Invariant Distance Effects

Denoting distance by d_{jk}, the statistical specification is:

$$mdaq_{i,jk} = \alpha_i + \beta \ln d_{jk} + \epsilon_{i,jk} \tag{4}$$

which includes fixed effects for commodities, labelled α_i. Fixed effects for town pairs jk are not included because they are very highly collinear with log distance.

Table 2 reports the results of estimating this statistical model (4) for each commodity. Commodity-specific intercepts are not shown. For 17 commodities the distance effect, as measured by $\hat{\beta}$, is significant at the 1% level; for 2 commodities (beef and wool) it is positive but statistically insignificant. The largest values are for charcoal, log timber, oxen, and hops. This heterogeneity in $\hat{\beta}_i$ could arise due to differences in value-to-weight ratios.

Table 3 reports the pooled regression results with coefficients on distance constrained to be the same across commodities. This involves 5268 observations on the 19 commodities in 32 Swedish towns. The row of results labelled α_i allows each commodity to have a different constant term in the regression (not reported) whereas the row labelled α forces all regressions to have the same constant term. The restriction on the constant has some effect on the value of $\hat{\beta}$, and these intercepts are clearly important since the fraction of variance explained drops from 76% to 6% when a common intercept is imposed. In either case the distance effect is statistically significant at the 1% level. The fact that price dispersion is rising in distance of course is consistent with research studies that use modern data and with previous studies of historical prices reviewed in section 2.

In summary, we have found evidence of a positive role of distance in accounting for price dispersion, both in the pooled estimation and in most commodity-level results. We next explore how this dispersion, and its correlation with distance, changed over time.

4.2 Time Variation

We report statistics that measure whether price dispersion varied over time and specifically whether we can attribute that variation to an evolving effect of distance. In a historical study spanning 182 years, it seems reasonable to expect improvements in transportation technology and infrastructure to alter price dispersion over time. We use year-specific effects to allow flexibility in measuring the rate of change of market integration.

The only new variable introduced is time itself. This can be thought of as exploratory data analysis, but an obvious advantage is that this covariate, time, is exogenous. The disadvantage of simply using time as a regressor is a loss of test power in assessing the effect of a specific event, such as a particular technological change such as the expansion of roads or railroads. But we have a lot of data, so this agnostic approach should detect both a trend to integration of commodity markets and interruptions to that trend, whatever their causes.

Given our earlier findings we begin by controlling for distance in the same way, but now we do not average the median absolute deviations across time. Thus the specification is:

$$aq_{i,jk,t} = \alpha_i + \alpha_t + \beta_t \ln d_{jk} + \epsilon_{i,jk,t}. \tag{5}$$

The variable α_t is a year-specific fixed effect: $\alpha_t = 1$ in a specific year and 0 otherwise. The coefficient β_t also is year-specific. Measuring the time-varying effects in this way allows for dispersion to increase or decrease with a wide range of patterns over time. There are 502,689 observations.

Table 4 gives the results, pooled across commodities. The first row allows for no time variation, but only commodity-specific intercepts, α_i, and a constant effect of distance, measured by β. We now study a time-varying measure of dispersion, $aq_{i,jk,t}$, yet it is striking that distance and commodity-specific fixed effects (which of course do not vary over time) still have a great deal of explanatory power. The R^2 statistic is 0.5990.

However, it also is easy to detect time variation. In the second row there are intercept time effects; in the third row there are only slope time effects; in the fourth row both are present. The changes in the R^2 are small numerically but statistically significant at any conventional level of significance, given the large number of observations. Thus we cannot reject the hypothesis that both the slope and intercept changed over time.

Given that both variations are significant, it is possible that one could find $\hat{\beta}_t$ falling from one year to another yet $\hat{\alpha}_t$ rising so that predicted price dispersion rose at many distances in the sample. Thus $\hat{\beta}_t$ may not be a good measure of the distance effect's variation over time. We note that there is a mild upward drift in $\hat{\alpha}_t$ and a marked downward drift in $\hat{\beta}_t$. Thus the distance function became flatter over time. These year-specific intercepts and slopes are estimated quite precisely for each year, because of the large number of locations and commodities. One thus can measure the overall effect of time (at a given distance d_{jk}) with the statistic $\hat{\alpha}_t + \hat{\beta}_t \ln(d_{jk})$. Figure 2 graphs this statistic against time, along with 95% confidence intervals, for each year from 1732 to 1914 and at the median distance. This overall time effect is volatile at the beginning of the sample, but then begins a marked decline after 1760. It falls fastest in the remainder of the 18th century, then continues a more gradual decline—with some volatility—until 1914.

It is interesting to explore whether this pattern holds true for each commodity. Again we take advantage of the many locations to explore the time path non-parametrically, without imposing a functional form on the trend. We estimate equation (5) but with commodity-specific, time-varying parameters $\alpha_{i,t}$ and $\beta_{i,t}$. The fit varies across commodities, with R^2 ranging from 0.06 for wax candles or 0.10 for beef to 0.34 for baltic herring or 0.44 for bar iron. The explanatory power for wheat, where $R^2 = 0.22$, is typical.

Figure 3 shows the commodity-specific distance function evaluated at the median distance: $\hat{\alpha}_{i,t} + \hat{\beta}_{i,t} \ln[\text{median}(d_{jk})]$. The 12 commodities shown are those with (i) more than 20,000 observations and (ii) observations spanning the entire period. This set includes 420,289 observations: 84% of the total used in table 4 and figure 2. The distance function becomes flatter over the entire time period for each commodity, except oxen. Moreover, this pattern clearly began in the 18th century for each commodity except oxen and straw. The disaggregated data thus show that figure 2 provides a good summary of the overall pattern of price convergence.

The last panel of figure 3 plots the distance function for wheat, and so allows comparison with other studies that focus on that commodity. Jacks (2005, section 4) studied intranational relative grain prices in several countries. He found marked declines in distance effects during the first half of the 19th century, with an error-correction model. Jacks (2009) studied distance effects in wheat prices during the 19th century in many countries using a linear trend and an interaction term. He found a large decline in the distance effect, with β falling by 63% over the century in intranational relative prices (and by even more in international ones). Jacks (2011) reported an increase in intranational price dispersion during the Napoleonic Wars, with an overall declining trend, using grain prices within England from 1771 to 1815. We do not find these same patterns within Sweden, where figure 3 shows that the distance function does not have a trend after 1800 and does not appear to tilt up during the Napoleonic Wars. Instead, we find most of the decline in wheat-price dispersion within Sweden occurred before 1800. However, the results pooled across commodities in figure 2 *do* show both a continuing decline in dispersion from 1800 to 1850 and some interruption in intranational convergence during the early nineteenth century.

5. Conclusion

This paper aims to contribute to research on price history by studying prices for 19 commodities in 32 Swedish towns from 1732 to 1914. These large ranges of commodities, intranational locations, and years are made possible due to the work of Jörberg (1972) and his colleagues. The large number of observations enhances precision in each statistical model and allows us to study time effects non-parametrically. The statistical model also allows for changes over time in the currency units that preclude construction of a continuous price series. We cluster standard errors so as not to overstate precision due to error correlation across towns or years.

We find a resilient effect of distance on price dispersion, for almost all commodities. Pooling across them, we find that the distance function became flatter over time, evidence of advances in communication and transportation. This pattern applied over most commodities. But it was by no means monotonic, with considerable variation from year to year. Notably, this process appears to have begun in the 18th century, before the arrival of canals, the telegraph, or the railway.

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Table 1: Swedish Towns

Code	District	Town	Latitude	Longtitude
1	Stockholm county	Stockholm	59.326	18.058
2	Uppsala county	Uppsala	59.857	17.639
3	Södermanland county	Nyköping	58.753	17.010
4	Östergötland county	Linköping	58.416	15.624
5	Jönköping county	Jönköping	57.782	14.159
6	Kronoberg county	Växjö	56.877	14.809
7	Kalmar county	Kalmar	56.661	16.363
7a	Isle of Öland	Borgholm	56.879	16.656
8	Isle of Gotland	Visby	57.641	18.296
9	Blekinge county	Karlskrona	56.160	15.586
10	Kristianstad county	Kristianstad	56.031	14.155
10a	Kristianstad	Kristianstad	56.031	14.155
10b	Ängelholm	Ängelholm	56.243	12.862
10c	Simrishamn	Simrishamn	55.556	14.350
11	Malmöhus county	Malmö	55.603	13.001
12	Halland county	Halmstad	56.674	12.857
13	Göteborg and Bohus	Gothenburg	57.697	11.987
14	Älvsborg county	Vanersborg	58.381	12.323
15	Skaraborg county	Skara	58.386	13.438
16	Värmland county	Karlstad	59.378	13.504
17	Örebro county	Örebro	59.274	15.208
17a	Närke	Örebro	59.274	15.208
17b	Nora, Linde, Karlskoga	Nora	59.519	15.040
18	Västmanland county	Västeras	59.616	16.552
19	Kopparberg county	Falun	60.602	15.633
20	Gävleborg county	Gävle	60.675	17.142
20a	Gästrikland	Gävle	60.675	17.142
20b	Hälsingland	Hudiksvall/Soderhamn	61.489	17.062
21	Västernorrland county	Härnosand	62.632	17.938
21a	Medelpad	Sundsvall	62.391	17.307
21b	Angermanland	Härnosand	62.632	17.938
22	Jämtland county	Östersund	63.222	14.602
22a	Härjedalen	Harjedalen	62.250	13.950
22b	Jämtland	Östersund	63.222	14.602
23	Västerbotten county	Umea	63.838	20.248
24	Norrbotten county	Lulea	65.584	22.155

Notes: Codes and districts are from Jörberg (1972). Town denotes the largest market town in each district, or the midpoint if two towns are listed. Latitude and longitude are in degrees.

Table 2: Commodity-by-Commodity Estimation 1732–1914

$$mdaq_{i,jk} = \alpha_i + \beta_i \ln(d_{jk}) + \epsilon_{i,jk}$$

Commodity	$\hat{\beta}_i$ (se)	R^2	N
Baltic Herring	7.58*** (1.06)	0.27	87
Bar Iron	8.78*** (2.04)	0.17	70
Beef	0.62 (1.09)	0.00	227
Butter	5.53*** (0.52)	0.15	531
Charcoal	23.44*** (5.80)	0.20	55
Hay	3.97*** (0.61)	0.07	527
Hops	12.48*** (1.56)	0.22	261
Log Timber	20.82*** (3.26)	0.13	249
Oxen	18.39*** (1.70)	0.24	237
Pork	8.58*** (1.07)	0.26	249
Sawn Batten	9.47*** (1.73)	0.08	429
Sheep	8.44*** (1.08)	0.12	292
Straw	10.01*** (1.29)	0.09	489
Tallow	4.96*** (0.63)	0.13	310
Tallow Candles	1.66*** (0.29)	0.08	432
Tar	8.46*** (1.44)	0.33	51
Wax Candles	4.05*** (0.93)	0.04	431
Wheat	2.94*** (0.50)	0.13	332
Wool	3.76 (9.26)	0.01	10

Notes: Distance is in kilometres. Standard errors in parentheses are clustered by town pair jk with $^{*}p<0.1$,$^{**}p<0.05$,$^{***}p<0.01$.

Table 3: Pooled Estimation 1732–1914

$$mdaq_{i,jk} = \alpha_i + \beta \ln(d_{jk}) + \epsilon_{i,jk}$$

Intercept	$\hat{\beta}$ (se)	R^2 (se)	N
α	7.44*** (0.50)	0.06	5268
α_i	5.60*** (0.33)	0.76	5268

Notes: Distance is in kilometres. Standard errors in parentheses are clustered by town pair jk where $^{*}p<0.1$, $^{**}p<0.05$,$^{***}p<0.01$. If jk dummy variables are included in these specifications the $\ln(d_{jk})$ variable is dropped due to multi-collinearity. Intercept i is for a specific commodity.

Table 4: Pooled Estimation with Time Effects 1732–1914

$$aq_{i,jk,t} = \alpha_i + \alpha_t + \beta_t \ln(d_{jk}) + \epsilon_{i,jk,t}$$

Parameters	$\hat{\beta}$ (se)	R^2	N
$\alpha_i,\ \beta$	5.37*** (0.33)	0.5990	502,689
$\alpha_i,\ \alpha_t,\ \beta$	7.35*** (0.46)	0.6228	502,689
$\alpha_i,\ \beta_t$		0.6200	502,689
$\alpha_i,\ \alpha_t,\ \beta_t$		0.6246	502,689

Notes: Distance is in kilometres. Standard errors in parentheses are clustered by town pair and year using the method of Cameron, Gelbach and Miller (2011) where $^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$. The dummy variables α_i and α_t apply to goods and years respectively.

Figure 1: Regions of Sweden

Source: Jörberg, Lennart (1972) *A History of Prices in Sweden 1732-1914. Volume I: Sources, Methods, Tables.* Lund: CWK Gleerup.

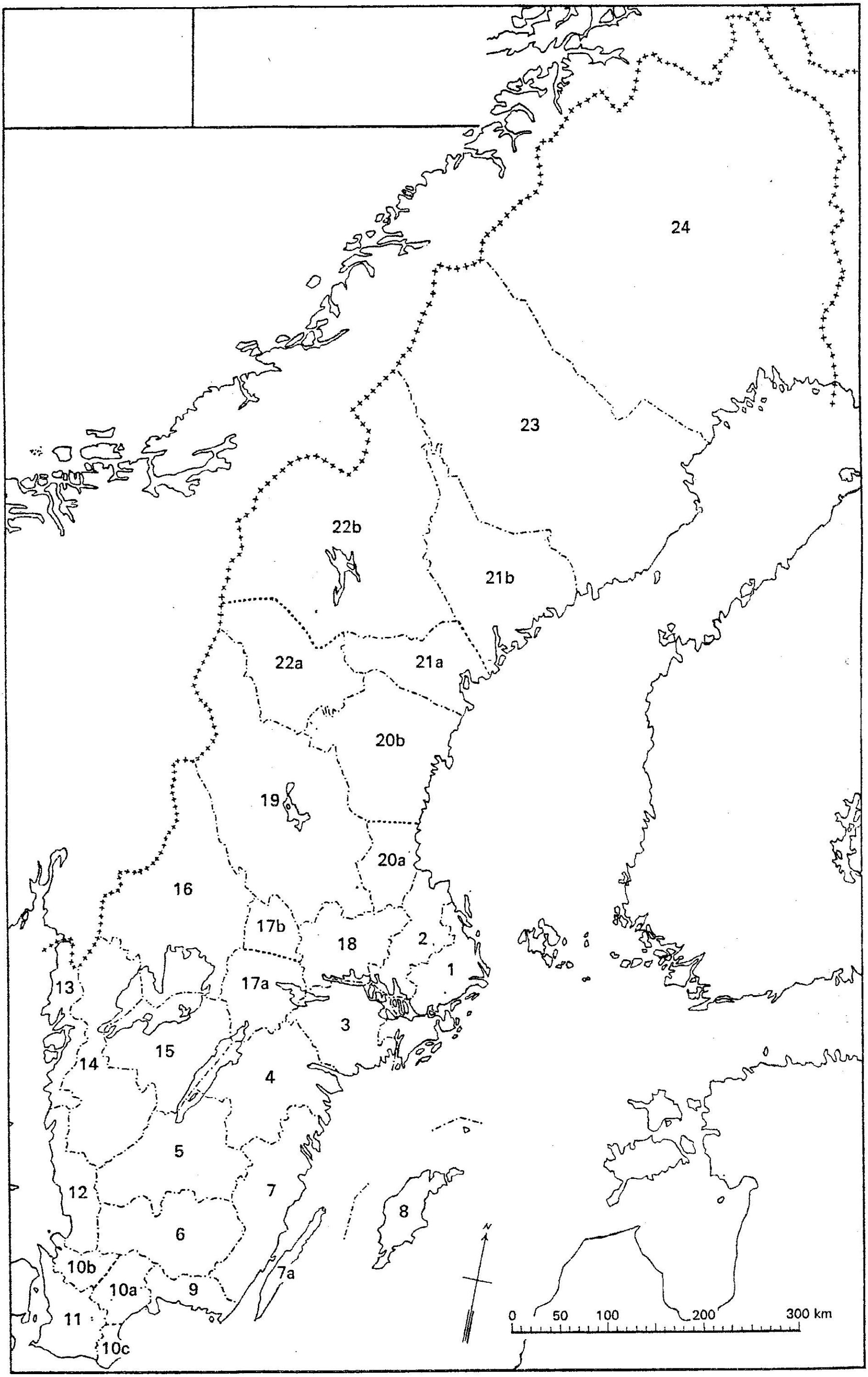
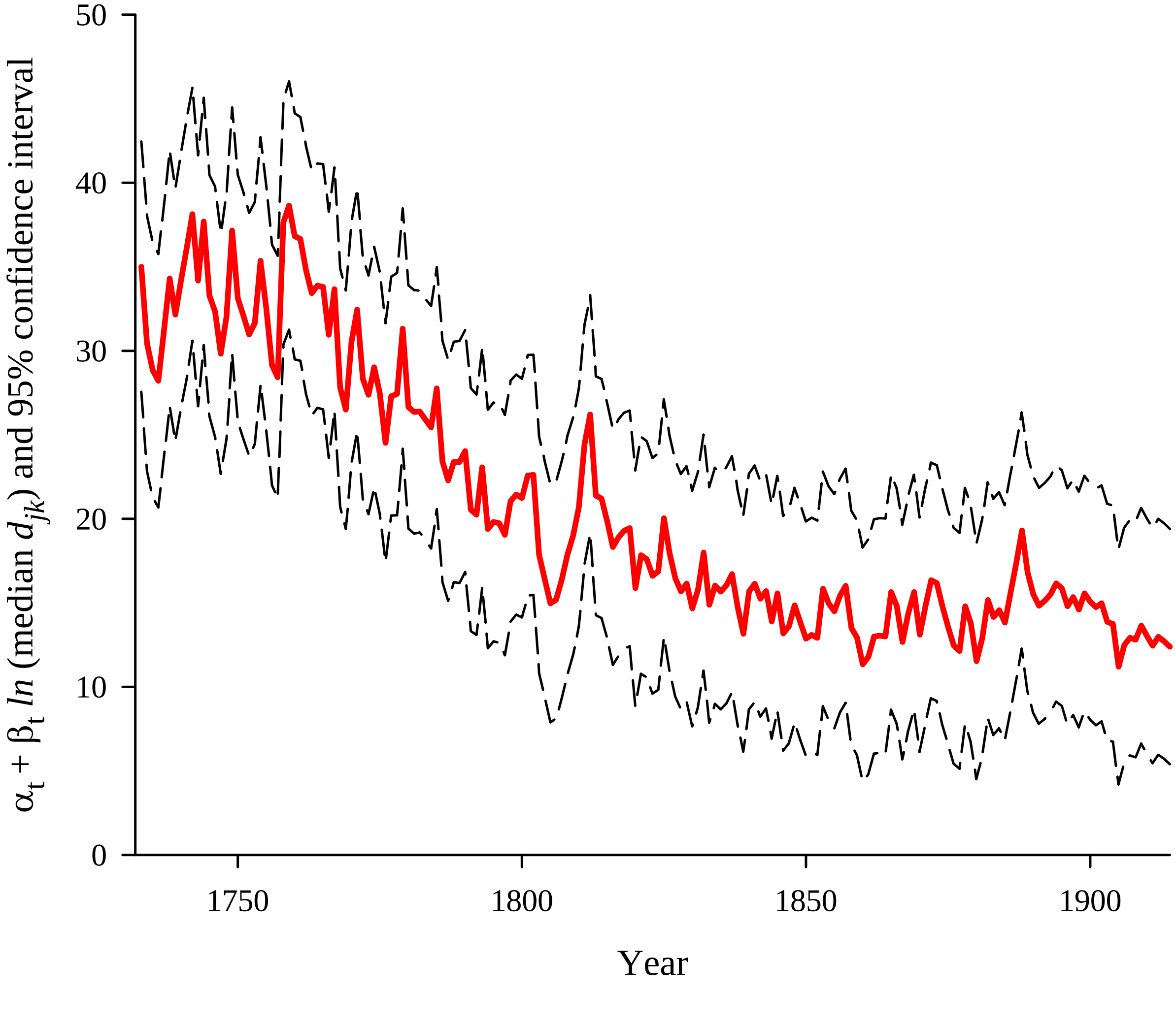

24
23
22b
21b
22a
21a
20b
19
20a
16
17b
18
2
1
13
17a
3
15
14
4
5
12
7
8
6
10b
10a
9
7a
11
10c
0
50
100
200
300 km

Figure 2: Median Distance Function, 1732–1914

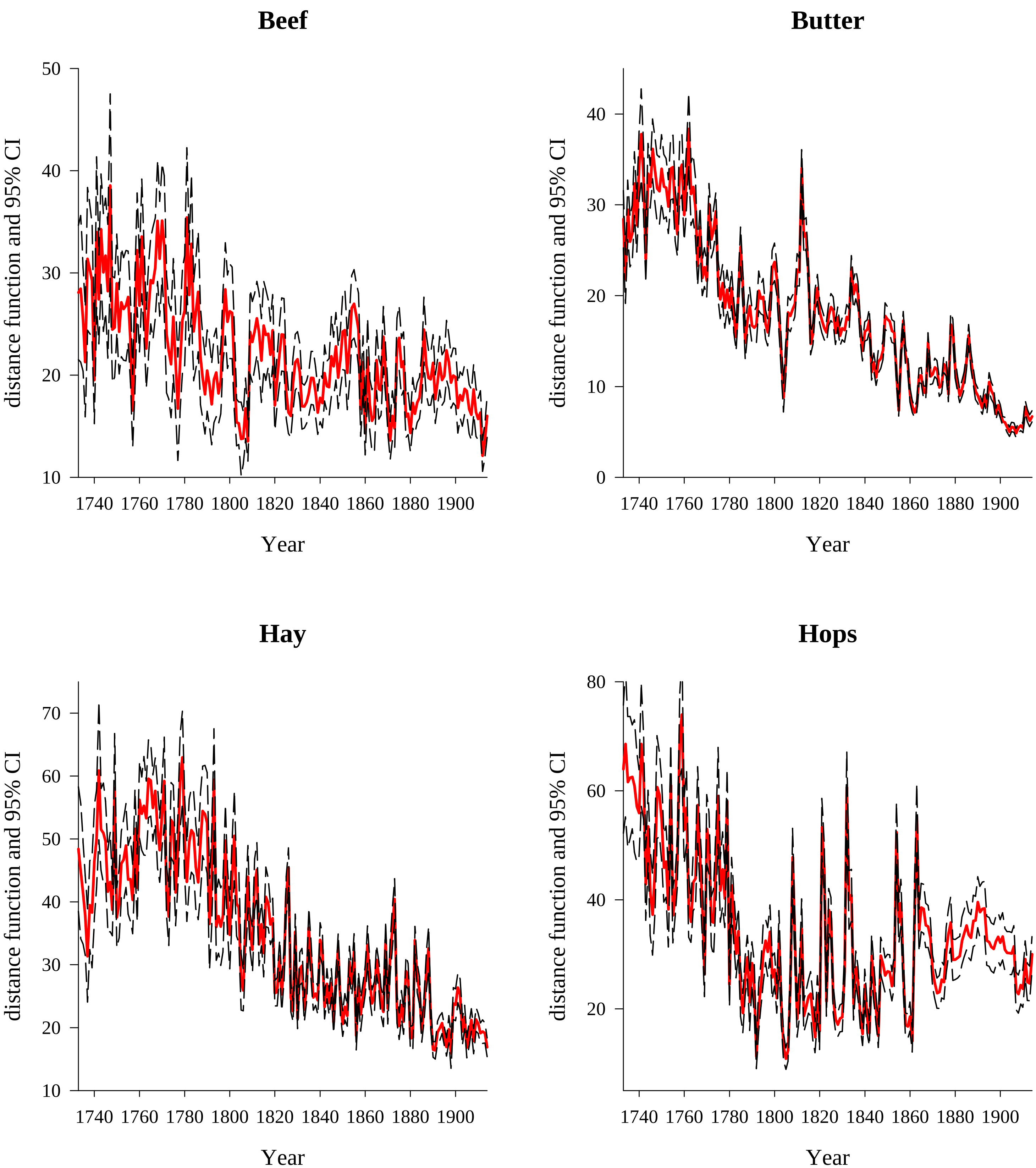
Source: The figure shows the time-varying component from equation (5), estimated pooling commodities, and evaluated at the median distance: $\hat{\alpha}_t + \hat{\beta}_t \ln[\text{median}(d_{jk})]$. Dashed lines give the 95% confidence intervals based on double-clustered standard errors.



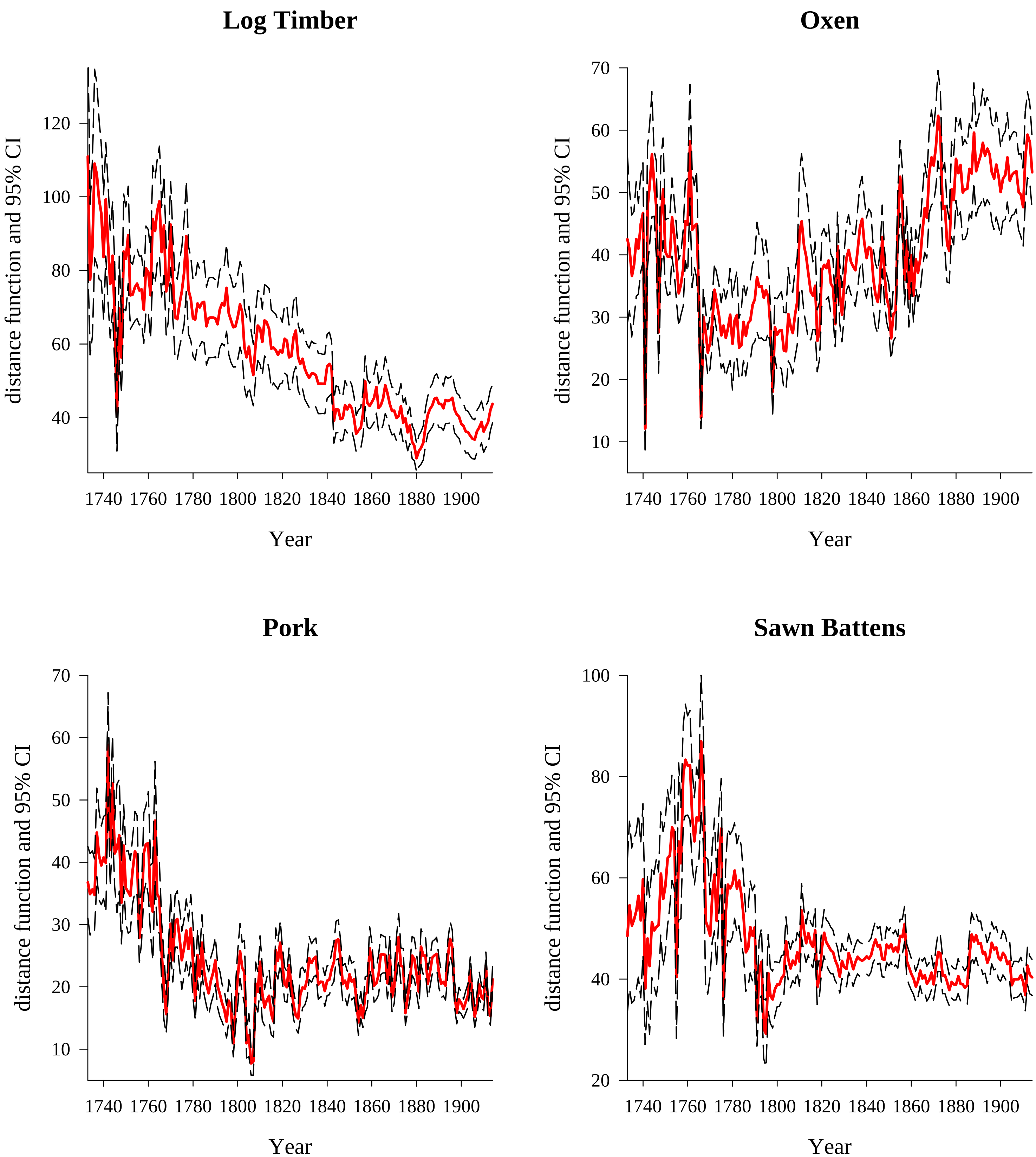
50
40
30
20
10
0
1750
1800
1850
1900
Year
$\alpha_t + \beta_t\, ln$ (median d_{jk}) and 95% confidence interval

Figure 3: Median Distance Function by Commodity, 1732–1914

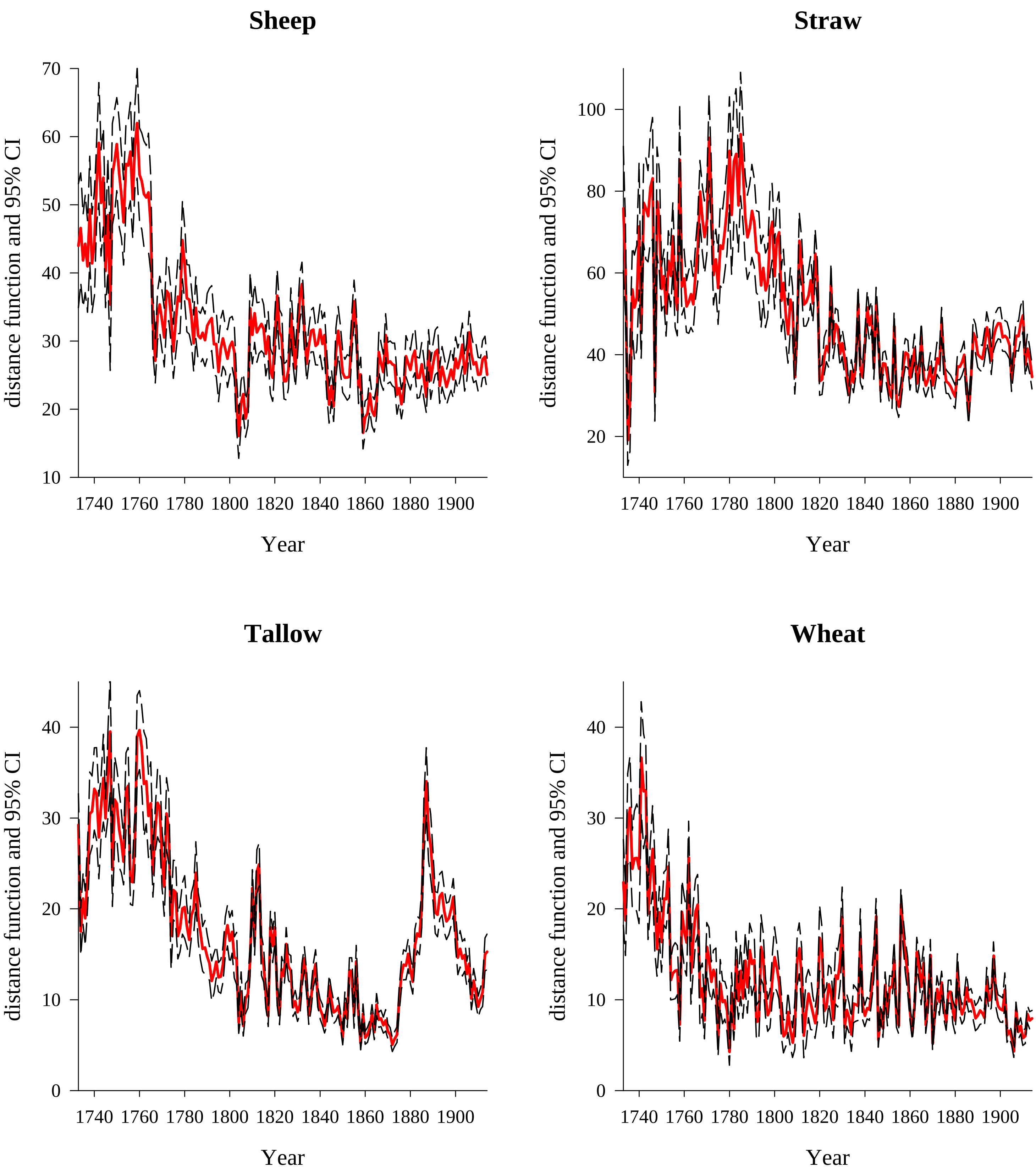
Source: The figures show the commodity-specific distance function evaluated at the median distance: $\hat{\alpha}_{i,t} + \hat{\beta}_{i,t} \ln[\text{median}(d_{jk})]$ for each year, and its 95% confidence interval. The 12 commodities are those with (i) more than 20,000 observations and (ii) observations spanning the entire period.



Beef
Butter
Hay
Hops
distance function and 95% CI
Year
1740 1760 1780 1800 1820 1840 1860 1880 1900
10 20 30 40 50
0 10 20 30 40
10 20 30 40 50 60 70
20 40 60 80



Log Timber
120
100
80
60
40
1740 1760 1780 1800 1820 1840 1860 1880 1900
Year
distance function and 95% CI
Oxen
70
60
50
40
30
20
10
1740 1760 1780 1800 1820 1840 1860 1880 1900
Year
distance function and 95% CI
Pork
70
60
50
40
30
20
10
1740 1760 1780 1800 1820 1840 1860 1880 1900
Year
distance function and 95% CI
Sawn Battens
100
80
60
40
20
1740 1760 1780 1800 1820 1840 1860 1880 1900
Year
distance function and 95% CI


Sheep
Straw
Tallow
Wheat
distance function and 95% CI
Year
1740 1760 1780 1800 1820 1840 1860 1880 1900
10 20 30 40 50 60 70
20 40 60 80 100
0 10 20 30 40