# CHAPTER NINE

# Data Analysis 1: Prices

In this chapter and the next I will analyze the fifty-five economic time series with respect to the historically defined phase periods of the base dating scheme (cycle time). In this chapter I consider the price series, which include fourteen price indexes and fourteen series for individual commodity prices. I examine the "fit" of different types of price series (from different time periods, countries, and commodities) to the base dating scheme and then look for possible leads and lags in different price series relative to cycle time. I will reflect these results back on the hypotheses presented at the end of chapter 7 to test among alternative hypotheses advanced by different theoretical schools.[1] Chapter 10 will then take up the other five classes of economic variables in a similar manner.

## Phase Period Correlations

Growth rates for the price series generally follow the alternating pattern hypothesized (see table 9.1).

*Price Indexes*

The South English consumer price index fits the phase periods (base dating scheme) very well over the entire period 1495–1967 (see table 9.1; each line in the table represents one unit of cycle time,[2] and the growth rates alternate in every successive phase period). The growth rates for both the industrial and the agricultural price indexes for South England also fit the phase periods perfectly. Along with the above, this strongly corroborates the hypothesis of long price waves in preindustrial times in England. Unfortunately, no price indexes for countries other than England are available for this period.

In the period around 1650–1800, two Spanish and one English price indexes are available. The Spanish series show some degree of fit to the long wave pattern, but not as closely as in the earlier English series. Textile prices follow the phase periods

1. Central among these are the hypotheses concerning the existence of long waves in prices in preindustrial times.

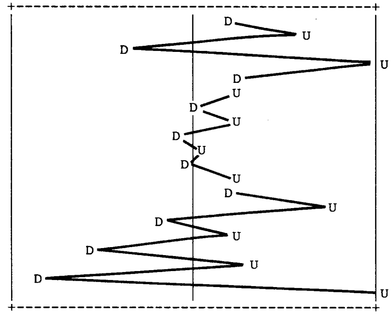
2. Over time, changes in the mean show the secular trend of the series and might also be useful in examining levels rather than growth rates in certain series (chap. 8).

# Table 9.1. Prices -- Growth Rates by Phase Period

## South English Consumer Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1495-1508 | 14 | 114.8 | .009 |
| U 1509-1528 | 20 | 141.9 | .026 |
| D 1529-1538 | 10 | 175.6 | -.016 |
| U 1539-1558 | 20 | 264.3 | .041 |
| D 1559-1574 | 16 | 317.7 | .010 |
| U 1575-1594 | 20 | 405.8 | .010 |
| D 1595-1620 | 26 | 573.7 | .001 |
| U 1621-1649 | 29 | 658.9 | .009 |
| D 1650-1688 | 39 | 697.3 | -.003 |
| U 1689-1719 | 31 | 708.3 | .002 |
| D 1720-1746 | 27 | 658.2 | -.002 |
| U 1747-1761 | 15 | 698.2 | .011 |
| D 1762-1789 | 28 | 885.9 | .007 |
| U 1790-1813 | 24 | 1485.3 | .031 |
| D 1814-1847 | 34 | 1384.4 | -.008 |
| U 1848-1871 | 24 | 1353.1 | .010 |
| D 1872-1892 | 21 | 1298.6 | -.023 |
| U 1893-1916 | 24 | 1165.2 | .013 |
| D 1917-1939 | 23 | 1762.5 | -.037 |
| U 1940-1980 | 15 | 3098.1 | .062 |

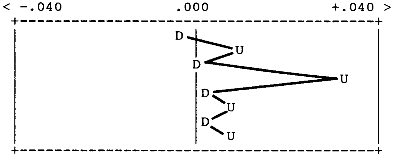
Average Annual Growth Rate
< -.040 .000 +.040 >



## South English Industrial Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1495-1508 | 14 | 95.0 | -.003 |
| U 1509-1528 | 20 | 103.5 | .010 |
| D 1529-1538 | 10 | 109.3 | -.000 |
| U 1539-1558 | 20 | 152.5 | .034 |
| D 1559-1574 | 16 | 218.5 | .002 |
| U 1575-1594 | 20 | 240.2 | .008 |
| D 1595-1620 | 26 | 285.6 | .003 |
| U 1621-1649 | 20 | 316.3 | .008 |

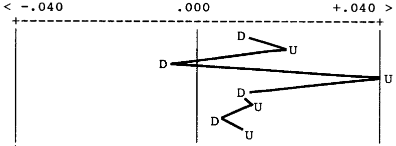
Average Annual Growth Rate
< -.040 .000 +.040 >



## South English Agricultural Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1495-1508 | 14 | 106.4 | .009 |
| U 1509-1528 | 20 | 128.5 | .022 |
| D 1529-1538 | 10 | 146.8 | -.008 |
| U 1539-1558 | 20 | 227.6 | .045 |
| D 1559-1574 | 16 | 309.3 | .010 |
| U 1575-1594 | 20 | 384.3 | .014 |
| D 1595-1620 | 26 | 536.6 | .004 |
| U 1621-1649 | 20 | 649.1 | .011 |

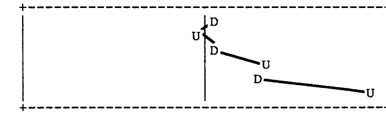
Average Annual Growth Rate
< -.040 .000 +.040 >



## Spanish Textile Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1650-1688 | 38 | 123.7 | .001 |
| U 1689-1719 | 31 | 106.1 | -.002 |
| D 1720-1746 | 27 | 97.2 | .003 |
| U 1747-1761 | 15 | 107.5 | .014 |
| D 1762-1789 | 28 | 121.7 | .012 |
| U 1790-1813 | 11 | 168.1 | .038 |

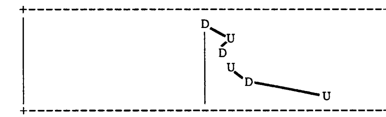
Average Annual Growth Rate
< -.040 .000 +.040 >



## Spanish Animal Product Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1650-1688 | 38 | 112.9 | -.000 |
| U 1689-1719 | 31 | 83.8 | .006 |
| D 1720-1746 | 27 | 84.5 | .004 |
| U 1747-1761 | 15 | 96.8 | .006 |
| D 1762-1789 | 28 | 117.6 | .010 |
| U 1790-1813 | 11 | 165.5 | .029 |

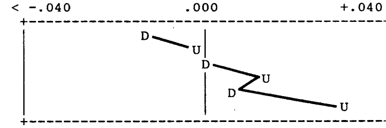
Average Annual Growth Rate
< -.040 .000 +.040 >



## English Producers' Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1650-1688 | 28 | 93.3 | -.014 |
| U 1689-1719 | 31 | 92.7 | -.003 |
| D 1720-1746 | 27 | 84.3 | -.001 |
| U 1747-1761 | 15 | 86.0 | .014 |
| D 1762-1789 | 28 | 97.6 | .006 |
| U 1790-1813 | 12 | 119.9 | .032 |

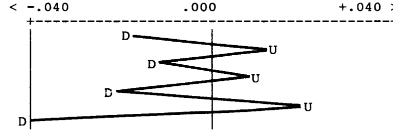
Average Annual Growth Rate
< -.040 .000 +.040 >



## British Commodity Price (Kondratieff)

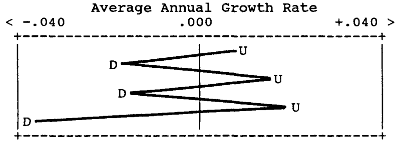
| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1762-1789 | 10 | 95.7 | -.020 |
| U 1790-1813 | 24 | 126.5 | .013 |
| D 1814-1847 | 34 | 100.6 | -.013 |
| U 1848-1871 | 24 | 91.0 | .010 |
| D 1872-1892 | 21 | 80.3 | -.025 |
| U 1893-1916 | 24 | 73.3 | .023 |
| D 1917-1939 | 6 | 156.9 | -.080 |

Average Annual Growth Rate
< -.040 .000 +.040 >



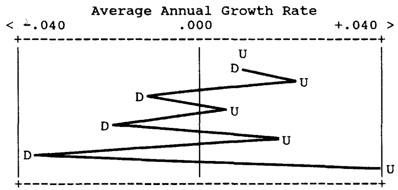
## U.S. Commodity Prices (Kondratieff)

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| U 1790-1813 | 23 | 142.4 | .010 |
| D 1814-1847 | 34 | 107.0 | -.020 |
| U 1848-1871 | 24 | 98.3 | .019 |
| D 1872-1892 | 21 | 84.3 | -.018 |
| U 1893-1916 | 24 | 80.4 | .021 |
| D 1917-1939 | 6 | 169.6 | -.040 |



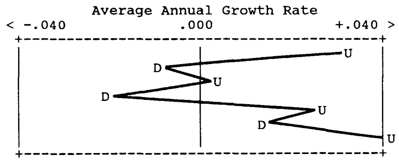

## British Wholesale Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| U 1747-1761 | 12 | 100.8 | .009 |
| D 1762-1789 | 28 | 117.9 | .007 |
| U 1790-1813 | 24 | 185.9 | .025 |
| D 1814-1847 | 34 | 149.1 | -.013 |
| U 1848-1871 | 24 | 132.7 | .008 |
| D 1872-1892 | 21 | 121.2 | -.022 |
| U 1893-1916 | 24 | 105.0 | .020 |
| D 1917-1939 | 23 | 181.4 | -.040 |
| U 1940-1980 | 36 | 511.9 | .042 |



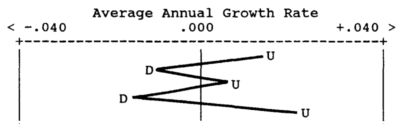

## French Wholesale Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| U 1790-1813 | 16 | 112.3 | .034 |
| D 1814-1847 | 34 | 81.0 | -.010 |
| U 1848-1871 | 24 | 78.2 | .005 |
| D 1872-1892 | 21 | 66.0 | -.022 |
| U 1893-1916 | 24 | 61.7 | .028 |
| D 1917-1939 | 23 | 311.8 | .015 |
| U 1940-1980 | 36 | 11919.7 | .058 |



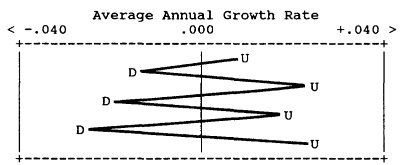

## German Wholesale Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| U 1790-1813 | 22 | 133.1 | .016 |
| D 1814-1847 | 34 | 88.7 | -.012 |
| U 1848-1871 | 24 | 92.6 | .008 |
| D 1872-1892 | 21 | 89.2 | -.019 |
| U 1893-1916 | 24 | 93.1 | .024 |



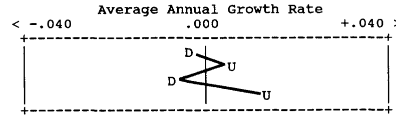

## U.S. Wholesale Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| U 1790-1813 | 13 | 92.0 | .010 |
| D 1814-1847 | 34 | 70.1 | -.016 |
| U 1848-1871 | 24 | 70.4 | .026 |
| D 1872-1892 | 21 | 57.8 | -.022 |
| U 1893-1916 | 24 | 54.1 | .021 |
| D 1917-1939 | 23 | 85.6 | -.028 |
| U 1940-1980 | 36 | 91.3 | .026 |



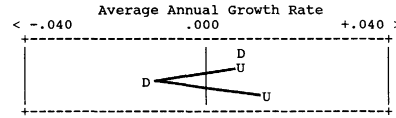

## Belgian Industrial Price Index

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1814-1847 | 26 | 91.3 | -.004 |
| U 1848-1871 | 24 | 94.6 | .006 |
| D 1872-1892 | 21 | 98.4 | -.009 |
| U 1893-1916 | 21 | 98.4 | .015 |




## Belgian Agricultural Price Index

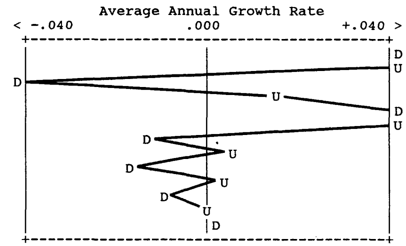
| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1814-1847 | 13 | 110.1 | .008 |
| U 1848-1871 | 24 | 120.5 | .008 |
| D 1872-1892 | 21 | 116.7 | -.015 |
| U 1893-1916 | 21 | 102.7 | .015 |




Commodity Prices:

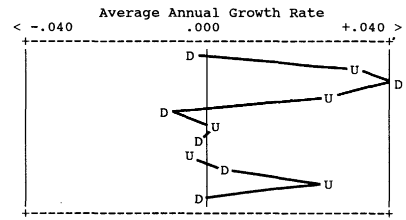
## French Wheat Prices (Paris)

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1495-1508 | 14 | 226.7 | .076 |
| U 1509-1528 | 20 | 335.4 | .052 |
| D 1529-1538 | 10 | 522.4 | -.074 |
| U 1539-1558 | 20 | 631.1 | .017 |
| D 1559-1574 | 16 | 1280.6 | .070 |
| U 1575-1594 | 20 | 2138.8 | .067 |
| D 1595-1620 | 26 | 1889.5 | -.014 |
| U 1621-1649 | 29 | 2458.1 | .006 |
| D 1650-1688 | 39 | 2749.8 | -.017 |
| U 1689-1719 | 31 | 3052.6 | .003 |
| D 1720-1746 | 27 | 3233.7 | -.010 |
| U 1747-1761 | 15 | 3257.2 | -.000 |
| D 1762-1789 | 27 | 4079.1 | .001 |




## German Wheat Prices (Cologne)

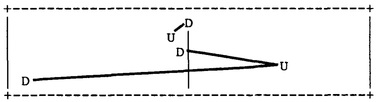
| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1529-1538 | 8 | 77.1 | -.005 |
| U 1539-1558 | 20 | 123.4 | .034 |
| D 1559-1574 | 16 | 203.2 | .049 |
| U 1575-1594 | 20 | 319.1 | .029 |
| D 1595-1620 | 26 | 349.1 | -.010 |
| U 1621-1649 | 29 | 494.0 | .001 |
| D 1650-1688 | 39 | 402.0 | -.003 |
| U 1689-1719 | 31 | 505.1 | -.005 |
| D 1720-1746 | 27 | 429.0 | .005 |
| U 1747-1761 | 15 | 537.1 | .028 |
| D 1762-1789 | 24 | 607.9 | -.001 |



## German Bread Prices (Cologne)

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1650-1688 | 31 | 132.5 | -.001 |
| U 1689-1719 | 31 | 167.0 | -.004 |
| D 1720-1746 | 27 | 150.0 | -.001 |
| U 1747-1761 | 15 | 180.2 | .023 |
| D 1762-1789 | 7 | 180.7 | -.039 |

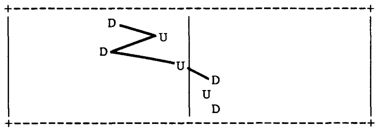
Average Annual Growth Rate
< -.040 .000 +.040 >



## Netherlands Prussian-Rye Prices (Amsterdam)

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1595-1620 | 24 | 66.6 | -.019 |
| U 1621-1649 | 29 | 90.5 | -.006 |
| D 1650-1688 | 39 | 84.0 | -.019 |
| U 1689-1719 | 31 | 87.3 | -.002 |
| D 1720-1746 | 27 | 66.3 | .005 |
| U 1747-1761 | 15 | 73.2 | .005 |
| D 1762-1789 | 22 | 87.6 | .006 |

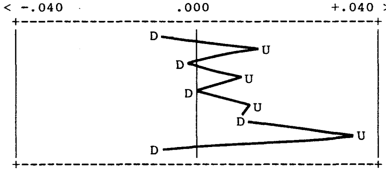
Average Annual Growth Rate
< -.040 .000 +.040 >



## English Malt Prices (Eton College)

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1595-1620 | 26 | 105.0 | -.009 |
| U 1621-1649 | 29 | 138.1 | .016 |
| D 1650-1688 | 39 | 126.8 | -.004 |
| U 1689-1719 | 31 | 136.2 | .012 |
| D 1720-1746 | 27 | 142.8 | -.002 |
| U 1747-1761 | 15 | 145.8 | .014 |
| D 1762-1789 | 28 | 199.3 | .011 |
| U 1790-1813 | 24 | 380.8 | .038 |
| D 1814-1847 | 18 | 416.2 | -.010 |

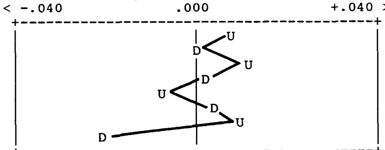
Average Annual Growth Rate
< -.040 .000 +.040 >



## English Hops Prices (Eton College)

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| U 1621-1649 | 28 | 68.2 | .008 |
| D 1650-1688 | 39 | 83.0 | .000 |
| U 1689-1719 | 31 | 94.1 | .013 |
| D 1720-1746 | 27 | 108.7 | .002 |
| U 1747-1761 | 15 | 76.7 | -.009 |
| D 1762-1789 | 28 | 105.4 | .004 |
| U 1790-1813 | 24 | 150.6 | .010 |
| D 1814-1847 | 16 | 173.0 | -.022 |

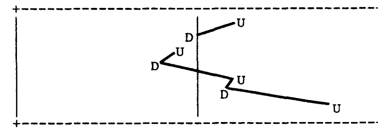
Average Annual Growth Rate
< -.040 .000 +.040 >



## English Wheat Prices (Winchester College)

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| U 1621-1649 | 20 | 78.4 | .010 |
| D 1650-1688 | 39 | 70.5 | -.003 |
| U 1689-1719 | 31 | 80.0 | -.004 |
| D 1720-1746 | 27 | 61.7 | -.009 |
| U 1747-1761 | 15 | 66.2 | .010 |
| D 1762-1789 | 28 | 91.5 | .006 |
| U 1790-1813 | 24 | 174.3 | .031 |

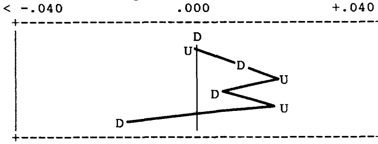
Average Annual Growth Rate
< -.040 .000 +.040 >



## English Coal Prices (Eton College)

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| D 1650-1688 | 36 | 97.4 | .001 |
| U 1689-1719 | 31 | 113.1 | -.001 |
| D 1720-1746 | 27 | 113.8 | .009 |
| U 1747-1761 | 15 | 133.0 | .020 |
| D 1762-1789 | 28 | 148.9 | .004 |
| U 1790-1813 | 24 | 209.1 | .020 |
| D 1814-1847 | 17 | 207.9 | -.017 |

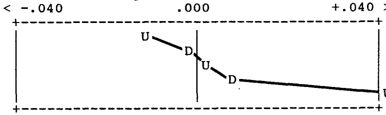
Average Annual Growth Rate
< -.040 .000 +.040 >



## English Bread Prices (Charterhouse)

| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| U 1689-1719 | 26 | 95.2 | -.012 |
| D 1720-1746 | 27 | 85.3 | -.003 |
| U 1747-1761 | 15 | 88.8 | .001 |
| D 1762-1789 | 28 | 116.6 | .008 |
| U 1790-1813 | 11 | 164.7 | .073 |

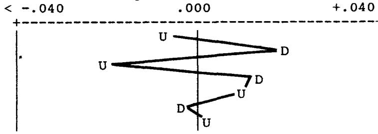
Average Annual Growth Rate
< -.040 .000 +.040 >



## Italian Wheat Prices (Milan)

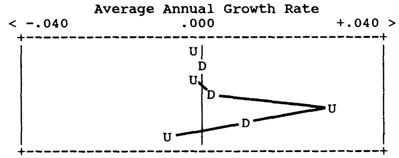
| Period | N | Mean | Gr.Rate |
|---|---|---|---|
| U 1689-1719 | 19 | 109.9 | -.007 |
| D 1720-1746 | 27 | 93.2 | .020 |
| U 1747-1761 | 15 | 114.9 | -.022 |
| D 1762-1789 | 28 | 137.5 | .013 |
| U 1790-1813 | 24 | 201.7 | .011 |
| D 1814-1847 | 34 | 181.8 | -.003 |
| U 1848-1871 | 13 | 198.8 | .003 |

Average Annual Growth Rate
< -.040 .000 +.040 >



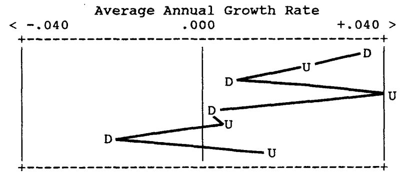
## Italian Hard Coal Prices (Milan)

| | Period | N | Mean | Gr.Rate |
|---|---|---|---|---|
| U | 1689-1719 | 19 | 102.1 | -.001 |
| D | 1720-1746 | 27 | 100.8 | .001 |
| U | 1747-1761 | 15 | 112.9 | -.002 |
| D | 1762-1789 | 28 | 112.3 | .003 |
| U | 1790-1813 | 24 | 148.9 | .031 |
| D | 1814-1847 | 34 | 216.0 | .010 |
| U | 1848-1871 | 13 | 232.2 | -.007 |



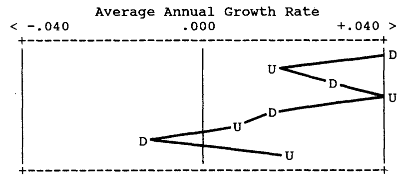

## Swedish Wheat Prices

| | Period | N | Mean | Gr.Rate |
|---|---|---|---|---|
| D | 1720-1746 | 15 | 138.5 | .039 |
| U | 1747-1761 | 15 | 182.2 | .023 |
| D | 1762-1789 | 28 | 340.3 | .006 |
| U | 1790-1813 | 24 | 875.9 | .065 |
| D | 1814-1847 | 34 | 1489.5 | .003 |
| U | 1848-1871 | 24 | 1921.8 | .006 |
| D | 1872-1892 | 21 | 1781.4 | -.022 |
| U | 1893-1916 | 22 | 1609.5 | .015 |



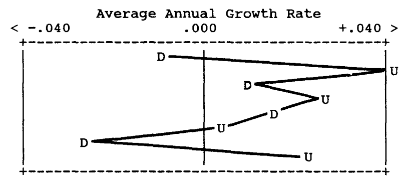

## Swedish Pine Wood Prices

| | Period | N | Mean | Gr.Rate |
|---|---|---|---|---|
| D | 1720-1746 | 12 | 118.8 | .046 |
| U | 1747-1761 | 15 | 173.3 | .015 |
| D | 1762-1789 | 28 | 308.0 | .030 |
| U | 1790-1813 | 24 | 637.0 | .055 |
| D | 1814-1847 | 34 | 1527.2 | .016 |
| U | 1848-1871 | 24 | 2431.3 | .008 |
| D | 1872-1892 | 21 | 3356.5 | -.014 |
| U | 1893-1916 | 22 | 3717.6 | .021 |




## Swedish Iron Ore Prices

| | Period | N | Mean | Gr.Rate |
|---|---|---|---|---|
| D | 1720-1746 | 15 | 102.2 | -.009 |
| U | 1747-1761 | 15 | 143.8 | .043 |
| D | 1762-1789 | 28 | 229.4 | .011 |
| U | 1790-1813 | 24 | 386.9 | .029 |
| D | 1814-1847 | 34 | 799.7 | .015 |
| U | 1848-1871 | 24 | 988.3 | .005 |
| D | 1872-1892 | 21 | 1222.4 | -.027 |
| U | 1893-1916 | 22 | 1483.3 | .024 |




Notes: N = number of years of data in each phase period. Average growth rates are graphed on standardized scale. Growth rates above 4% or below -4% are shown just outside the graphed range. "D" is plotted in a nominal downswing period, and "U" in a nominal upswing period.

only after 1720 (the 1689–1719 nominal upswing in fact saw a drop in prices). Prices of animal products follow the long wave phases except in 1762–89 (when the growth rate increases in a nominal downswing period). The English producers' price index in this period follows the phase datings fairly well.[3] These results suggest that long waves in prices around 1650–1800 are not limited to Britain, although they seem stronger in the British series.[4]

The remaining eight price indexes refer to industrial times (since about 1790). All show very strong correlations with the long wave phase periods. The commodity price indexes for Britain and the United States were put together by Kondratieff, and since I have adopted his dating of phase periods, the close fit is not surprising.[5] In the wholesale price indexes for Britain, France, Germany, and the United States, respectively, the growth rates in prices clearly alternate in successive phase periods. The two Belgian (industrial and agricultural) price indexes also fit the long wave phases well.[6]

These results for prices indexes may be summarized thus:

1. British prices fit the phase periods closely during all historical periods.
2. Since at least the late eighteenth century prices in all five countries closely follow the long wave phases, indicating a synchrony in these core economies.
3. In the period before 1650, the only available price indexes are British, and in the period 1650–1800 the only non-British indexes are for classes of Spanish commodities which fit the long wave, but not as closely as the British indexes.

*Commodity Prices*

The fourteen individual commodity price series are by their nature more sensitive to particular conditions and disturbances than the economy-wide price indexes. They cannot be expected to follow the long wave phase periods as closely as the price indexes, and indeed they do not. Nonetheless, they provide useful information, particularly since they cover a variety of countries.

The Paris wheat price series covers the entire period through 1788. Of the thirteen phase periods included, three are problematical, while the rest fit the long wave datings.[7] The two German (Cologne) price series, for wheat and bread, cover the

3. Only one downswing has higher growth than the previous upswing, and that by only a small amount; upswing growth rates, by contrast, are much higher than the previous downswings.

4. This could be because: (1) long waves were stronger in Britain than Spain in this period; (2) long waves were stronger in the overall price indexes (Britain) than in indexes for just one class of commodity (Spain); (3) long waves were more synchronous with the base dating in Britain than Spain; or (4) the British data are of higher quality.

5. These are the only two series for which the dating of turning points derives from the data series themselves (since Kondratieff's dates, which I use in the base dating scheme, came from these series, among others).

6. The industrial price index fits better in the first phase period but possibly only because the series starts earlier in the phase period, 1822 rather than 1835.

7. The three problem periods are the first, the last, and the period 1559–74—all nominal downswings marked by strong inflation. The first and last periods cannot be explained by the lack of data, since almost all years in the phase period are included.

period from 1531 and 1658, respectively, through the end of preindustrial times (1785, 1769). Neither series fits the long wave datings very well, although both series weakly correlate with the long wave.[8] Prices for Prussian rye on the Amsterdam produce exchange cover roughly the same period.[9] Through 1719, Amsterdam rye prices follow long wave datings, but later growth rates are relatively constant (and higher) across all phase periods.

English prices for malt, hops, wheat, coal, and bread, respectively, in the same seventeenth-to-eighteenth-century period, each come from just one original source (the records of one institution's purchases), so they are particularly subject to local disturbances. The price trends in the first four series fit the long wave periods fairly well, notwithstanding some anomalous phase periods for particular variables.[10] Only the bread price series does not match the long wave. Thus the English, Dutch, German, and French commodity price series in the seventeenth and eighteenth centuries generally support the existence of long waves in that era, most strongly in the case of Britain. These results supplement the indexes above (for which data are almost entirely British in the early centuries) and suggest that long waves exist in non-British countries in this era but appear stronger for Britain.[11]

The last five series cover late preindustrial and early industrial times for Italy and Sweden (1701–1860 and 1732–1914, respectively). Like Germany, Italy was not a core country in this period. The price trends for Milan wheat and coal do not follow the long wave pattern, and, in the first two, long waves even appear to be reversed with respect to the upswing and downswing phases. The Swedish series show mixed results.[12] Wheat prices follow the long wave after the first period,[13] iron ore prices show a weaker correlation, with some unusual behavior around 1848–71, and wood prices do not correlate with the long wave phase periods. These results suggest that long waves were absent or very weak in this era in Sweden and Italy.

The results for the individual commodity prices may be summarized as follows:

1. Commodity prices correlate with the long wave, but less consistently than price indexes.
2. The fit of price series to the long wave phase periods in preindustrial times decreases as one moves from British series to French, German, Prussian at

8. The wheat price series shows a tendency for growth rates on upswings to be higher than on adjacent downswings, but with several cases of the opposite tendency. The trends in bread prices parallel those of wheat. Both show low inflation in the nominal upswing of 1689–1719. Chapter 11 mentions other problems with dating the 1689–1719 phase period and suggests 1712 as possibly a better ending date.

9. In this period Amsterdam, unlike Germany, was at the center of the European world economy. Unfortunately the only series of suitable quality that I found for the Netherlands was for Prussian rye—a primary commodity imported from a noncore area.

10. Deflation during the nominal upswing of 1747–61 for hops and of 1689–1719 for wheat and coal.

11. Again, it is unclear whether the British prices actually followed long waves more closely or whether the British data are of higher quality.

12. The three Swedish series each derive from an average of a number of regional prices, which should make them more reliable than those drawn from a single location.

13. For which only half the years' data were available.

Amsterdam, Swedish, and Italian series in that order—corresponding roughly with outward movement from the core of the European world economy.

3. Wheat prices seem to follow the long wave pattern more closely than prices of bread and of nonfood commodities (coal, iron, wood); this may reflect either the centrality of grain in preindustrial economies or perhaps higher quality data for wheat prices.

*T-tests*

The above analyses for each of twenty-eight price series showed that many correlated well with the long wave phases hypothesized. But how strong is the correlation for the entire class of price series as a whole? And how strong is it in different subperiods of the total five-hundred-year period? I use the paired t-test (see chapter 8) to measure the overall fit to long wave phases.[14] I also make separate analyses of three shorter eras within the five-hundred-year period under study—1495–1650 (early preindustrial), 1650–1813 (late preindustrial), and 1790–1939 (the industrial period considered by Kondratieff).[15]

The t-test results for the twenty-eight price series as a class are shown in table 9.2. The "mean growth rate" columns give the average slope rates for the first phase periods of all pairs, then the average slope for the second periods, then the difference between them. The difference is hypothesized to be positive in comparing downswings to upswings, and negative in the upswing/downswing pairs, and this turns out to be the case in all the time periods analyzed. The "t" column gives the t statistic, which is then shown as a probability that the difference in slopes would occur randomly.

For the 1495–1975 period as a whole, the first line in the table indicates there were ninety-seven matched pairs consisting of a downswing and the following upswing among the twenty-eight price series (see table 9.2). The average growth rate was −.001 on the downswings and .018 on the upswings for a difference of .019. The value of t was 7.96, which is very high, indicating an extremely small probability of such a difference arising from random chance. In the next line, which shows upswings paired with following downswings, the sign of the difference is negative as hypothesized and t is still very high.[16]

The subperiod of 1790–1939 roughly matches the industrial era studied by Kon-

14. To recap, the input to the t-test consists of all the growth rates for all series available in a given era (different eras encompass different series). The growth rates are paired, and the t-test tests the difference across each pair. First downswing phase periods are paired with the following upswing periods (D/U), and then in a separate t-test the upswings are paired with the following downswings (U/D). Since the sign of the difference is as hypothesized (higher inflation on upswings), a one-tail probability is used here.

15. The period 1790–1939 is the one in which long price waves are most commonly assumed to exist. The earlier divisions follow roughly the divisions between series themselves, as well as the divisions between "eras" discussed in Part Three.

16. This and all other t-tests below used the 1968 turning point rather than 1980, but the effect was negligible. The t-statistic for the 28 price series, 1495–1975, using the 1980 date, comes out to 7.94 for the U/D pairs and −6.87 for the D/U pairs.

Table 9.2. T-test Results for 28 Price Series

| Variable | Period | Pairs[a] | Mean Growth Rate[b] 1st | 2d | Diff. | DF[c] | t | Probability[d] |
|---|---|---|---|---|---|---|---|---|
| Prices | 1495-1975 | Down/Up | -.001 | .018 | .019 | 96 | 7.96 | <.0005** |
| | | Up/Down | .016 | -.002 | -.017 | 90 | -5.47 | <.0005** |
| Prices | 1790-1939 | Down/Up | -.011 | .014 | .025 | 25 | 6.34 | <.0005** |
| | | Up/Down | .020 | -.017 | -.036 | 32 | -11.59 | <.0005** |
| Prices | 1495-1813 | Down/Up | .004 | .018 | .014 | 65 | 5.24 | <.0005** |
| | | Up/Down | .012 | .001 | -.011 | 57 | -3.23 | .001** |
| Prices | 1495-1649 | Down/Up | .004 | .022 | .018 | 20 | 3.08 | .003** |
| | | Up/Down | .029 | .002 | -.027 | 13 | -2.44 | .015* |
| Prices | 1650-1813 | Down/Up | .004 | .016 | .012 | 44 | 4.26 | <.0005** |
| | | Up/Down | .008 | .002 | -.006 | 34 | -1.94 | .030* |

a. Paired phases: D/U = Downswing with following upswing; U/D = upswing with following downswing. Note that for all subperiods under study except 1790-1939, the U/D runs always lop off the first phase period (a downswing) and the last one (an upswing), resulting in fewer degrees of freedom. For 1790-1939 (which begins with an up phase and ends with a down), the D/U run lops off the first and last phase period.

b. 1st = average growth rate for 1st phase in pair; 2d = average growth rate for 2d phase in pair; Diff. = difference in growth rates (2d phase minus 1st). (Differences may show discrepancy due to rounding.)

c. DF = Degrees of freedom = number of phase period pairs minus 1.

d. 1-tailed probability (D/U positive; U/D negative as hypothesized).

** indicates statistical significance level below .01;
* indicates statistical significance level below .05.

dratieff and most other long wave scholars (excluding both the controversial pre-1790 period and the controversial post-1940 period). Here the significance of t is even higher, indicating a very strong long wave pattern in prices.

For preindustrial times as a whole, 1495–1813, t remains very high and is significant at the .01 level (indeed, at the .001 level). Breaking this subperiod into two eras, both have slightly lower, but still significant, t statistics. The lower statistical significance may in part reflect the smaller number of cases in these earlier eras (fewer degrees of freedom). The era 1495–1649 (fourteen to twenty-one pairs) continues to show a significant difference between the paired downswing and upswing phases, though only at the .05 confidence level for the up-down pairs. The same result holds for the second era, 1650–1813, in which there are thirty-five to forty-five pairs.

Thus these t-tests corroborate the correlation of the twenty-eight price series as a whole with the long wave in both preindustrial and industrial times.[17] The results thus far, then, corroborate these hypotheses:

17. This conclusion is tempered only by the fact that most of the best correlations in the preindustrial period occurred in British series.

*Long waves exist.* [A]
(Most long wave researchers)

*Long waves at least in prices exist before 1790.* [A]
(Imbert, Braudel, Wallerstein)

*The dating of phases is captured in my base dating scheme.* [A]
(Goldstein, based on thirty-three scholars reviewed in chapter 4)

The following hypothesis is now *rejected:*

*Long waves exist only after about 1790.* [R]
(Kondratieff, Ischboldin)

## Lagged Correlations

As discussed in chapter 8, leads and lags in the correlations of different variables can be important in finding the "fine structure" of sequences in the long wave (within cycle time) as well as in clarifying confusion between methods of dating phases (by growth rates or by levels) that could lead to apparent time shifts.

In looking at these finer divisions of time (calendar time within phase-time, rather than just phase-time itself) there is an inescapable loss of precision, however. These methods are "weaker" statistically—the answers more tentative and more open to challenge—than the above correlations with the unlagged base dating scheme. Yet, despite these reservations, I will use the available information to the fullest in adducing the most plausible relationships in the long wave.[18]

*Lag Structures: An Example*

The lag structure of each time series in relation to the base dating scheme, as explained in chapter 8, graphs the relative fit of the time series to the nominal phase periods as those phase periods are shifted forward or backward through time.[19]

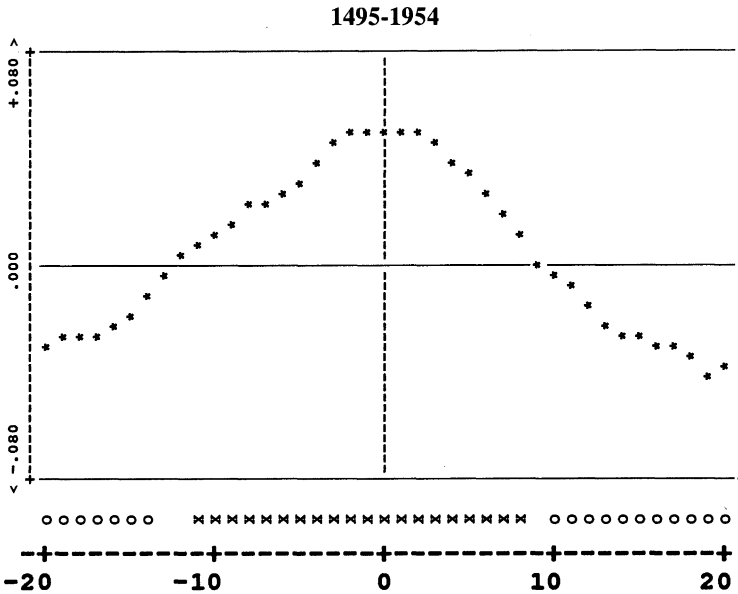
Consider the lag structure for the first price series, South English consumer price index, 1495–1954 (fig. 9.1). The figure represents the difference between two numbers: (1) the mean difference in the growth rates of downswings compared with following upswings, and (2) the mean difference when pairing upswings with following downswings.[20] The difference between these two is graphed, and

18. The data are, after all, given at the annual level.

19. A computer program shifts the entire base dating scheme back 20 years (keeping each phase the same length) and calculates the growth rates within each phase period and the differences between adjacent periods. The indicator of "fit" is the value of the "lag structure" for −20 years. The entire dating scheme is then shifted forward one year at a time, to +20, and the same procedure is repeated, yielding an indicator of the fit for each lag.

20. In this particular example the series is unusually long, so a mean growth rate is an average of about

Figure 9.1. Lag Structure, South England Consumer Prices, 1495-1954




this function will be at its maximum when the shifted dating scheme best fits the data.[21]

A direct correlation with the long wave is indicated when growth rates change in a positive direction when moving from downswing to upswing phase and in a negative direction when moving from upswing to downswing. The lags for which both these conditions are true are marked with an "X" at the bottom of the graph (the "X region" of the lag structure). Those lags for which the reverse is true, indicating an inverse (phase-reversed) correlation of the time series to the long wave phases, are marked with an "O."[22]

The lag structure of a variable provides three types of information about the variable. First, the location of the peak (if there is a clear peak) indicates whether the variable leads or lags the base dating scheme. A class of variables all tending to have peaks around the same lag indicates a lagged correlation of that class of variables. Second, the amplitude of the peak indicates how strongly the data fit a long wave pattern at that peak. Third, the lag structure indicates the sensitivity of the correlation to the particular dates of turning points by shifting all the turning points together

ten phase changes. For shorter series the mean may be the average of as few as two to three phase changes. Also, in a given series the number of phase changes included in this average may vary slightly in different lags (since turning points can shift past the beginning or end of the time series).

21. Or in the case of inverse correlations, minimum.

22. The remaining unmarked lags are those for which the mean change in the D/U and U/D columns have the same sign as each other.

backward and forward a year at a time (see chapter 8). The behavior of the curve in the few years around the peak shows how robust that peak is against minor dating shifts.

The lag structure of South English consumer prices (fig. 9.1) is a good example of robustness against minor time shifts. The peak is around zero lags, indicating a fit to the unlagged base dating scheme. The peak amplitude of 5.3 percent reflects an average change in growth rates of +2.8 percent at troughs and −2.5 percent at peaks. On either side of the peak, a time shift of two years does not affect the fit at all, and then for several more years the fit drops off. With fifteen to twenty years of shift in either direction, the lag structure becomes negative, or inversely correlated with the phases.

*Price Indexes*

The lag structure for the South English consumer price index (1495–1954) (fig. 9.1), is time-stable (robust) and shows no time shift from the base dating scheme. A similar pattern is found in the English industrial and agricultural price indexes (1495–1640). The respective peaks are around −3 to +9 lags and −2 to +2 lags. The agricultural price index is less robust than the industrial price index, which about equals the robustness of the English consumer price index.

The two Spanish price indexes (1651–1800) are less robust, but both seem to show at least a weak peak leading the base dating scheme by about five years. For the English producers' price index (1661–1801), the lag structure is less robust, with two peaks at around −12 and +1 lags. The highest peak of the curve is at 0 to +2 lags. This series thus correlates basically with the unshifted dating scheme but has some anomalous behavior.

In the four national wholesale price indexes—for Britain, France, Germany, and the United States—the peaks are high and very close to 0 lags (around +1 for Britain and the United States, +2 for France), and the lag structures are robust in all but Germany (fig. 9.2). This strong correlation of wholesale prices in the core industrial countries corroborates that the long wave in prices is internationally synchronous.

Both Kondratieff's British and American price indexes (1780–1922 and 1791–1922) have fairly robust lag structures (the British more so), peaking at +1 lags. The Belgian industrial and agricultural price indexes (1822–1913) also have a robust lag structure. They peak around 0, lagging just slightly (+2 to +3 lags).

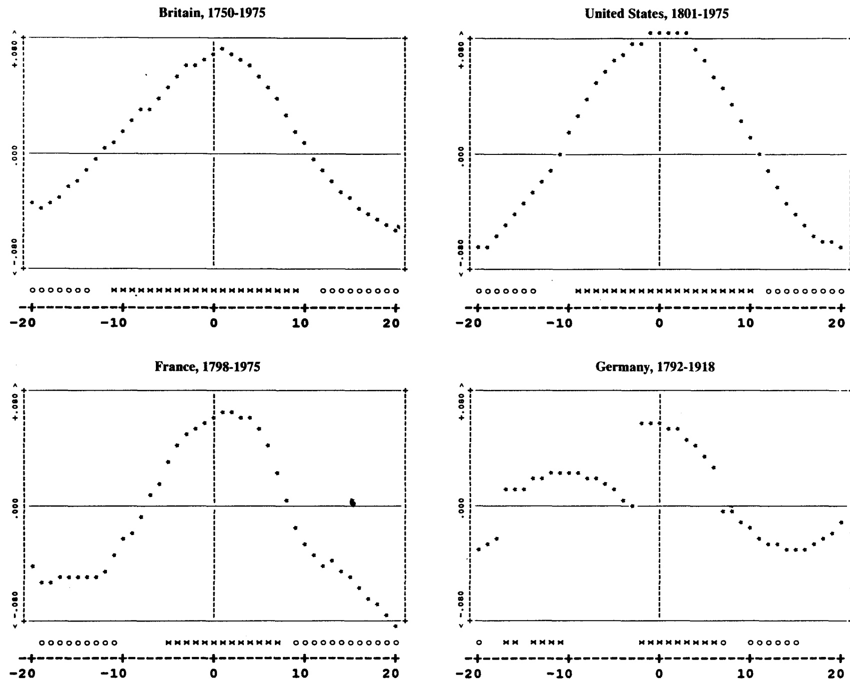
The fourteen price indexes, then, consistently show price waves to be synchronous with the nominal phase dating with no important lags in either direction.

*Commodity Prices*

For the individual commodity prices, the lag structures are less robust—curves are more jumpy and the location of peaks varies more. This is to be expected, since individual commodities are subject to more fluctuations from unrelated causes and local conditions.

The lag structure for French wheat prices (1495–1788) peaks at around 0. For

Figure 9.2. Lag Structures, Four National Price Indexes




German wheat and bread prices (1531–1786 and 1658–1772, respectively), the peaks fall somewhere between 0 and −15 lags (seemingly leading the nominal phase dating), though they are hard to identify.[23] The bread price lag structure is not very robust (especially around +13 lags). For the price of Prussian rye at Amsterdam (1597–1783), the lag structure is also rather jumpy but seems to peak at −14 to −11 lags.

For the five British commodity price series (malt, 1595–1831; hops, 1622–1829; wheat, 1630–1817; coal, 1653–1830; and bread, 1694–1800), the lag structures are not very robust but peak around zero—there is no clear shift for the whole set of variables. Malt, wheat, and coal, which have the more robust lag structures, seem to peak a few years before zero, while hops and bread peak a few years after zero but have extremely nonrobust lag structures.

The two Italian price series (wheat and coal, 1701–1860) lead the base dating scheme by about ten to twelve years and three to thirteen years, respectively. The lag structures are relatively robust, although in the case of coal prices the amplitude is small. The Swedish price series (1732–1914) are fairly robust (wood less so than

23. For wheat prices, the "X" region extends from at least −20 lags to +2, and within that region the peak period stretches from −15 to −2 lags (single highest peak at −3 lags). For bread prices, the "X" region similarly extends from at least −20 lags to +2, and there seem to be two peaks, one at −20 lags or less, and one around −3 to 0 lags.

wheat or iron), and all peak at around three years' lag (that is, reasonably close to zero).

To summarize for the fourteen individual commodity price series, some lag structures are more robust than others, and as a rule they are less robust than the price indexes. Nonetheless, the patterns of lag structures indicate a general correspondence to the base dating scheme, with sometimes a shift one way or the other for a particular country's prices.

While the data are really too fragmentary to draw any but the most tentative conclusions about the behavior of individual countries, the lag structures are suggestive of a possible lagged relationship among prices in different countries as follows:

| | | |
|---|---|---|
| 17th c. | Prussian/Amsterdam: | about −11 to −14 |
| 18th c. | Italian: | about −3 to −13 lags |
| 18th c. | Spanish | about −5 |
| 17th–19th c. | German | about 0 to −5 |
| 16th–20th c. | British | about 0 |
| 19th–20th c. | U.S. | about +1 |
| 16th–20th c. | French | about 0 to +2 |
| 19th c. | Belgian | about +2 to +3 |
| 18th–19th c. | Swedish | about +3 |

Could this indicate that price waves actually rolled across Europe from south to north, or from the semiperiphery to the core?[24]

To check on this possibility of a geographic pattern in price lags, I examined different researchers' datings of long waves in various countries (see chapter 4) and asked whether their datings were consistently shifted from the base dating (see table 9.3).[25] These lags do not correspond with those shown above, however. In fact, if anything the opposite is seen (the more central countries leading the more peripheral ones).

A better interpretation of my results is simply that both the price indexes and the commodity prices in core countries cluster around 0 lags, while commodity prices, especially in semiperipheral countries,[26] show more shifts in peaks and are less robust (see table 9.4). The first group of series, which shows leads, and the last group, which shows lags, are almost entirely commodity prices. The middle group of series, with 0 to +3 lags, are almost all national indexes. The data for national

24. The latter would be consistent if Sweden's positive lags were ignored and Prussian/Amsterdam was treated as Prussian. I examined phase correlations in the German, Spanish, Italian, and Prussian series with the dating scheme shifted up 10 years (−10 year lag). I also ran phase correlations with a shift of 5 rather than 10 years. The results were largely the same for the 5- as for the 10-year shift. The fit of the German and Italian series is considerably better than with no lags, but the improvements in the Prussian and Spanish series are not dramatic.

25. If a similar pattern emerged to that shown above, this could corroborate the idea of geographical lags in long waves. This attempt is difficult, since almost all the countries included are core countries.

26. Where data are worse and long waves seemed to be weak (see earlier in this chapter).

Table 9.3. Possible Lags in Other Authors' Datings

| | | |
|---|---|---|
| **For industrial times:** | | |
| Britain | -0.9 years | Imbert (1959) |
| Britain | -0.1 | Burns and Mitchell (1946) |
| United States | -1.3 | Imbert (1959) |
| United States | -2.3 | Burns and Mitchell (1946) |
| United States | +0.1 | Ischboldin (1967 |
| United States | -1.4 | Cole (1938) |
| France | +1.4 | Imbert (1959) |
| France | +2.0 | Burns and Mitchell (1946) |
| France | +5.0 | Simiand (1932b) |
| Germany | -0.2 | Imbert (1959) |
| Germany | 0.0 | Burns and Mitchell (1946) |
| Belgium | +2.6 | Imbert (1959) |
| Italy | +2.3 | Imbert (1959) |
| "Europe" | +1.0 | Ischboldin (1967) |
| **For preindustrial times:** | | |
| England | -2.7 | Imbert (1959) |
| France | -5.3 | Imbert (1959) |
| S. France | +5.1 | Baehrel (1961) |
| Spain | -5.3 | Imbert (1959) |
| Germany | -18.7 | Imbert (1959) |

Note: Numbers indicate average lag of a turning point from the comparable turning point in my base dating scheme.

indexes are simply of higher quality. On the whole, in twenty of the twenty-eight price series (including thirteen of the fourteen national indexes) the lag structures peak within three years of zero, corroborating that price waves in the core of the world system are internationally synchronized and synchronized with the base dating scheme.[27]

In sum, the empirical analysis strongly corroborates long waves in price data—both before and after the onset of industrialization in the late eighteenth century.[28] Price waves go back as early as the sixteenth century, although in the earliest centuries they seem strongest in the most central core countries (especially Britain) and weakest in outlying areas of Europe. Since the late eighteenth century, price waves appear in, and are synchronous among, various European countries, reflecting the expansion of the core of the world system and its increasing integration in the industrial era.

27. Outside the core, price waves seem to be weaker and less synchronous. Again, this may be partly due to lower quality data.

28. This also corroborates the idea of the world system itself as a useful unit of analysis with its own internal coherence. As Braudel (1984:75) notes, "prices that rise and fall in unison provide us with the most convincing evidence of the coherence of a world-economy penetrated by monetary exchange and developing under the already directive hand of capitalism."

Table 9.4. Summary of Lags in Price Series

| Series | "X Region" | | | Best |
|---|---|---|---|---|
| Amsterdam prices for Prussian rye (1597-1783) | -20 | to | +4 | -13 |
| Italian wheat prices (Milan) (1701-1860) | -20 | to | -5 | -10 |
| Italian hard coal prices (Milan) (1701-1860) | -14 | to | +9 | -6 |
| Spanish animal product price index (1651-1800) | -8 | to | -1 | -4 |
| English wheat prices (Manchester) (1630-1817) | -10 | to | +7 | -4 |
| Spanish textile price index (1651-1800) | -9 | to | -1 | -3 |
| German wheat prices (Cologne) (1531-1786) | -20 | to | +2 | -3 |
| English malt prices (Eton College) (1595-1831) | -20 | to | +4 | -2 |
| English coal prices (Eton College) (1653-1830) | -20 | to | +4 | -2 |
| German bread prices (Cologne) (1658-1772) | -20 | to | +2 | -1 |
| French wheat prices (Paris) (1495-1788) | -11 | to | +11 | 0 |
| South English consumer price index (1495-1954) | -11 | to | +8 | 0 |
| South English agricultural price index (1495-1640) | -12 | to | +6 | 0 |
| German wholesale price index (1792-1918) | -17 | to | +6 | 0 |
| English producers' price index (1661-1801) | -16 | to | +5 | +1 |
| British commodity prices [Kondratieff](1780-1922) | -7 | to | +9 | +1 |
| U.S. commodity prices [Kondratieff] (1791-1922) | -9 | to | +5 | +1 |
| British wholesale price index (1750-1975) | -11 | to | +9 | +1 |
| U.S. wholesale price index (1801-1975) | -9 | to | +10 | +1 |
| Belgian agricultural price index (1822-1913) | -7 | to | +12 | +1 |
| Swedish iron ore prices (1732-1914) | -6 | to | +10 | +1 |
| French wholesale price index (1798-1975) | -5 | to | +7 | +2 |
| S. English industrial price index (1495-1640) | -8 | to | +8 | +3 |
| Belgian industrial price index (1822-1913) | -5 | to | +13 | +3 |
| Swedish wheat prices (1732-1914) | -13 | to | +10 | +3 |
| Swedish pine wood prices (1732-1914) | -5 | to | +20 | +4 |
| English hops prices (Eton College) (1622-1829) | -1 | to | +14 | +6 |
| English bread prices (Charterhouse) (1694-1800) | -11 | to | -4 | +6 |