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Source: *The Economic Journal*, Vol. 30, No. 118 (Jun., 1920), pp. 209-213

Published by: [Wiley](#) on behalf of the [Royal Economic Society](#)

Stable URL: <http://www.jstor.org/stable/2223013>

Accessed: 29-03-2015 22:33 UTC

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BRITISH EXPORTS AND THE BAROMETER—II.

IN the last number of the *ECONOMIC JOURNAL*, I called attention to certain regular fluctuations discoverable in the statistics of British exports and their apparent connection with variations of barometric pressure and harvests. I have now obtained further evidence which seems to support very strongly the hypothesis then advanced—of a periodic crisis in the climatic conditions of the earth as a whole which, at intervals averaging about $15\frac{1}{3}$ years, lowers the general productivity of harvests during one or more seasons. This evidence consists of (1) an analysis of the course of food prices in relation to other prices from 1782 to 1913; (2) more comprehensive barometric records; (3) investigation of the course of grain prices and other evidences of dearth before 1782. I cannot deal here with the last of these, but am glad to avail myself of the kind permission of the Editor of the *ECONOMIC JOURNAL* to supplement my previous article by two tables and a brief explanation on the first two points.

Relative Food Prices: The Index Number in Table I represents from 1782 to 1865 the fraction

$$\frac{\text{Grain} + \frac{1}{3} \text{ Tropical Food}}{\text{Mean of Copper, Lead, Tin, Iron, and Timber}}$$

from Jevons' Price Numbers; from 1865 to 1913 it represents the fraction

$$\frac{\text{All Food}}{\text{Mean of Copper, Lead, Tin, Iron, and Timber}}$$

from Sauerbeck's Price Numbers. The denominator is thus the same throughout. The numerator changes by the direct inclusion of animal food after 1865; the exclusion of animal food would not make much difference. The "tropical food" is weighted in the earlier period so as to give it about the same relative proportion to the whole as in the second period.

Division of food prices by the prices of articles not directly affected by the harvest should to a large extent eliminate the effect of the credit cycle and other general changes in price level, and should thus (since the demand for food is relatively steady) give a fraction showing mainly the fluctuations in the supply of food, that is to say, in the general yield of crops used for food or feeding stuffs. The Index Number, in fact, shows a marked fluctuation with a succession of maxima (i.e. bad harvests) at 1784, 1800, 1817, 1831, 1847, 1861-2, 1878, 1893, 1909. The last six dates are identical

with those indicated by the "new exports index" discussed in my previous article. The three earlier dates continue the 15-16 year period backwards, with only the trifling discrepancy of 1817 in place of 1816; from other indications I have no doubt that the tendency to divide the 30 odd years into two unequal sections (or usually 14 and 16 or 17 years) is inherent in the cycle itself. In addition to the maxima named above, the index number has high points at 1795 and 1867-8 (each of which can, in fact, be connected with climatic events), but they lie in each case under the line joining the regular maxima on each side.

Generally, this analysis—which I owe to a suggestion of Mr. R. G. Hawtrey—seems to confirm directly and strongly the hypothesis of a general weather and harvest cycle.

Barometric Pressures: Table II compares for each year from 1873 to 1913 the mean barometric pressures at fifty stations in North America and the Eastern Hemisphere, covering most of the habitable globe. In this table three years out of the whole period of forty years stand out as abnormal. They are 1878, 1893 and 1909—that is to say, exactly the years selected as critical by the "new export index" and the index of relative food prices. Their abnormality consists not only in their being actually the years of lowest pressure in the three main world divisions taken as a whole (col. 5); they are yet more clearly marked as the epochs of greatest fall in the barometer from a preceding maximum. These are also years of exceptionally low pressure in each of the divisions taken separately, though particular divisions have also other low years, e.g. India, etc. in 1898, Europe in 1873, 1885 and 1895, and North America in 1885 and 1902. Within each of the main divisions much the same holds. The lowering of pressure at or about the three critical years 1878, 1893, 1909 appears to be a general movement affecting the greater part of the habitable globe; the movements of different regions at intermediate dates often, though not always, cancel one another.

The South American stations (shown in the table) take a directly contrary course, but equally signalise the years about 1878, 1893 and 1909 as critical, by high pressure following a very low pressure.

Before 1873 barometric records are relatively scanty, but again agree with the economic records in singling out the years about 1847 and 1862 as critical. The average of the seven stations for which I have as yet obtained continuous records before 1850 (Bombay, Madras, Cape Town, Brussels, Stykkisholm in Iceland, Toronto and Providence, Rhode Island) gives 1846-8 as years of low pressure with the actual minimum at 1848 and 1862

as the next minimum. The latter crisis, indeed, is peculiar; 1862 is the lowest year on record in Bombay and Cape Town as 1863 is for Adelaide and Styckisholm, but the Russian stations on this occasion run, like the South American ones, to a high maximum. This and the lack of North American figures make it difficult to construct a satisfactory combined index, but there can be little doubt as to the place of 1862 and 1847-8 in the cycle.

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TABLE I.

RELATIVE FOOD PRICES.

(Prices of Food Divided by Prices of Metals and Timber :
1865=100)

Year.	Index Number.	Year.	Index Number.	Year.	Index Number.
1780	—	1825	93	1870	103
1	—	6	102	1	108
2	88	7	105	2	91
3	94	8	106	3	92
4	113	9	108	4	102
1785	98	1830	120	1875	108
6	94	1	129	6	115
7	95	2	116	7	124
8	92	3	102	8	136
9	98	4	101	9	132
1790	108	1835	93	1880	120
1	92	6	84	1	119
2	89	7	96	2	114
3	98	8	100	3	121
4	103	9	118	4	122
1795	121	1840	—	1885	118
6	107	1	109	6	112
7	81	2	102	7	105
8	84	3	114	8	92
9	98	4	120	9	106
1800	130	1845	107	1890	103
1	116	6	111	1	115
2	75	7	138	2	115
3	63	8	114	3	120
4	69	9	107	4	120
1805	83	1850	97	1895	115
6	73	1	102	6	105
7	80	2	103	7	112
8	82	3	93	8	104
9	65	4	107	9	76
1810	75	1855	109	1900	74
1	63	6	107	1	86
2	102	7	99	2	91
3	115	8	102	3	86
4	76	9	98	4	88
1815	74	1860	108	1905	81
6	94	1	115	6	68
7	131	2	115	7	70
8	125	3	105	8	89
9	111	4	92	9	91
1820	104	1865	100	1910	88
1	86	6	104	1	83
2	74	7	120	2	77
3	90	8	119	3	74
4	97	9	104		

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TABLE II.

COMPARATIVE BAROMETRIC PRESSURES 1873—1913.

(Excess or Deficiency in thousandths of inch on 40 year average)

Year. 1	North America (12). 2	Europe and Mediterranean. (14). 3	Australia, East Indies, Africa, etc. (19). 4	Mean of three World Divisions (cols. 2-4). 5	South America (4). 6
1873	- 7	-21	- 9	-10	- 6
1874	+ 7	+ 7	- 1	+ 4	+22
1875	- 4	+13	-14	- 2	+14
1876	- 8	- 7	- 2	- 6	- 6
1877	- 5	- 3	+27	+ 6	-28
1878	-52	-40	- 6	-33	+ 2
1879	0	-13	-15	- 9	+ 6
1880	+ 2	- 7	0	- 2	-10
1881	-11	- 5	+ 6	- 4	- 8
1882	+ 9	+19	- 6	+ 7	+ 6
1883	+24	+17	- 1	+13	+ 2
1884	- 2	+23	+ 5	+ 9	- 2
1885	-22	-13	+17	- 6	- 6
1886	- 2	+ 3	+ 4	+ 2	+10
1887	+ 1	-11	+ 2	- 3	-10
1888	+ 5	-13	+13	+ 2	-14
1889	+ 1	+19	+ 3	+ 8	0
1890	+ 9	+ 7	- 9	+ 2	+10
1891	+ 6	+11	+13	+10	- 2
1892	+ 5	-21	-17	-11	+12
1893	-18	-19	-12	-16	+24
1894	+ 8	- 1	- 6	0	+14
1895	- 4	-25	- 3	-11	0
1896	+11	+22	+ 5	+13	+ 6
1897	+ 6	+22	+ 3	+10	+10
1898	- 1	- 1	-17	- 6	-12
1899	- 1	- 9	+ 7	- 1	-34
1900	- 5	- 1	+ 5	0	-12
1901	-15	- 9	+ 6	- 6	+ 6
1902	-23	- 9	+ 4	-10	-26
1903	+ 3	+ 3	- 2	+ 1	+ 8
1904	+18	+19	+11	+13	+ 2
1905	+ 5	+13	+10	+ 9	- 4
1906	+23	- 1	- 2	+ 7	0
1907	+ 9	+19	- 3	+ 8	- 2
1908	+13	+23	+ 1	+11	+16
1909	- 6	-13	-15	-11	+14
1910	+ 4	-13	-11	- 7	+ 2
1911	+23	+15	0	+13	—
1912	+ 3	- 5	+ 2	- 2	—
1913	—	—	+ 4	—	—

NOTES ON TABLE II.

The fifty stations included in columns 2 to 5 are as follows :

N. America : Key West, Galveston, Nashville, Mobile, Albany, Washington, Denver, Duluth, Winnipeg, Toronto, Montreal, Sydney (Nova Scotia).

W. Europe : Christiansund, Hamburg, Vienna, Basel, Brussels, Madrid, Lisbon, and Ponta Delgada (Azores).

Mediterranean : Abbassia (Egypt), Algiers, Athens, Beirut.

Russia : Warsaw, Petrograd, Moscow, Archangel, Astrachan, Tiflis, Ekaterinbourg.

Australia : Adelaide, Sydney, Perth.

East Indies : Calcutta, Bombay, Agra, Madras, Colombo, Rangoon, Singapore and Bushire (Persian Gulf).

Far East : Tokio, Tsi-ka-wei (China), Manila, Batavia.

Africa (S. and E.) : Cape Town, Durban, Mauritius and Aden (Arabia).

The South American stations are Rio de Janeiro, Buenos Ayres, Cordoba and Santiago.

The figures for each Division represent the mean of all the stations therein ; the figures in Column 5 are the mean of the three preceding columns, thus allowing equal weight to each Division. There can be little doubt that, in fact, greater weight ought to be allowed to Australia, East Indies, etc., whether regard is had to size or total production. This would accentuate the position of the years 1878, 1893 and 1909.

The pressures have been taken mainly from the Report of the Solar Physics Committee (1908) and from Vol. XXI, Part 12, of the Memoirs of the Indian Meteorological Department.