Volume Title: International Financial Transactions and Business Cycles

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Volume Publisher: Princeton University Press

Volume ISBN: 0-870-14091-4

Volume URL: http://www.nber.org/books/morg59-1

Publication Date: 1959

Chapter Title: The International Timing of Business Cycles

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Chapter URL: http://www.nber.org/chapters/c9462

Chapter pages in book: (p. 40 - 73)

CHAPTER II

THE INTERNATIONAL TIMING OF BUSINESS CYCLES

Section 1.
International Timing and Phase Comparison of Business Cycles

(1) Before taking up the financial statistics it is necessary to form an opinion about the covariation and possible interdependence of business cycles as a whole for the countries on which our study centers: the United States, Great Britain, France, and Germany. For this purpose we shall compare their *reference cycles* as determined by the National Bureau of Economic Research. These reference cycles are simply the dates of the upper and lower turning points of "general business" in the respective countries (Table 1).[1] Intercountry comparisons of this kind were initiated by Wesley C. Mitchell.[2] Our discussion of reference cycles will be carried only as far as is necessary to give a background against which the various specific series can be studied.

Reference cycles are obtained through a method that amounts essentially to an averaging of the specific cycles of numerous time series. The specific cycles of the individual time series are obtained from an inspection of the data. The dates of the upper and lower turning points of the general business cycle, but not the amplitude, are then deduced.

For the purposes of analyzing the international timing of business cycles for our four countries we have limited ourselves to the period from September 1879 to August 1914 (419 months) and from June 1919 to July 1932 (157 months). The break is for World War I, during which time there was much interaction between the economies of Great Britain, France, and the United States, but not between them and that of Germany, although the latter country

[1] For a more detailed description, and, in particular, a more precise definition of "reference cycles" and "reference dates," cf. Burns and Mitchell, *op. cit.*, Chap. 2, sec. 2. especially page 24, note 1.

[2] Cf. Thorp and Mitchell, *Business Annals*, Chap. 1. Compare the extensive discussion in O. Morgenstern, "International Vergleichende Konjunkturforschung," *Zeitschrift f.d. Gesamte Staatswissenschaft*, Vol. 83, 1927, pp. 261–290.

TABLE 1

Reference Dates of Business Cycles in Four Countries, 1854–1949

UNITED STATES *Reference dates by months*		GREAT BRITAIN *Reference dates by months*		GERMANY *Reference dates by months*		FRANCE *Reference dates by months*	
Peak	*Trough*	*Peak*	*Trough*	*Peak*	*Trough*	*Peak*	*Trough*
	Dec. 1854		Dec. 1854				
June 1857	Dec. 1858	Sept. 1857	Mar. 1858				Dec. 1865
Oct. 1860	June 1861	Sept. 1860	Dec. 1862			Nov. 1867	Oct. 1868
Apr. 1865	Dec. 1867	Mar. 1866	Mar. 1868			Aug. 1870	Feb. 1872
June 1869	Dec. 1870	Sep. 1872	June 1879			Sep. 1873	Aug. 1876
Oct. 1873	Mar. 1879	Dec. 1882	June 1886		Feb. 1879	Apr. 1878	Sept. 1879
Mar. 1882	May 1885	Sep. 1890	Feb. 1895	Jan. 1882	Aug. 1886	Dec. 1881	Aug. 1887
Mar. 1887	Apr. 1888	June 1900	Sep. 1901	Jan. 1890	Feb. 1895	Jan. 1891	Jan. 1895
July 1890	May 1891	June 1903	Nov. 1904	Mar. 1900	Mar. 1902	Mar. 1900	Sep. 1902
Jan. 1893	June 1894	June 1907	Nov. 1908	Aug. 1903	Feb. 1905	May 1903	Oct. 1904
Dec. 1895	June 1897	Dec. 1912	Sep. 1914	July 1907	Dec. 1908	July 1907	Feb. 1909
June 1899	Dec. 1900	Oct. 1918	Apr. 1919	Apr. 1913	Aug. 1914	June 1913	Aug. 1914
Sep. 1902	Aug. 1904	Mar. 1920	June 1921	June 1918	June 1919	June 1918	Apr. 1919
May 1907	June 1908	Nov. 1924	July 1926	May 1922	Nov. 1923	Sep. 1920	July 1921
Jan. 1910	Jan. 1912	Mar. 1927	Sep. 1928	Mar. 1925	Mar. 1926	Oct. 1924	June 1925
Jan. 1913	Dec. 1914	July 1929	Aug. 1932	Apr. 1929	Aug. 1932 *	Oct. 1926	June 1927
Aug. 1918	Apr. 1919	Sep. 1937	Sep. 1938			Mar. 1930	July 1932
Jan. 1920	July 1921					July 1933	Apr. 1935
May 1923	July 1924					June 1937	Aug. 1938
Oct. 1926	Nov. 1927						
June 1929	Mar. 1933						
May 1937	June 1938						
Feb. 1945	Oct. 1945						
Nov. 1948	Oct. 1949						

* The National Bureau of Economic Research has not determined reference dates for Germany after 1932.

CHART 1

Timing of Reference Cycles for Four Countries, Prewar and Postwar; 1879–1914, 1919–1938

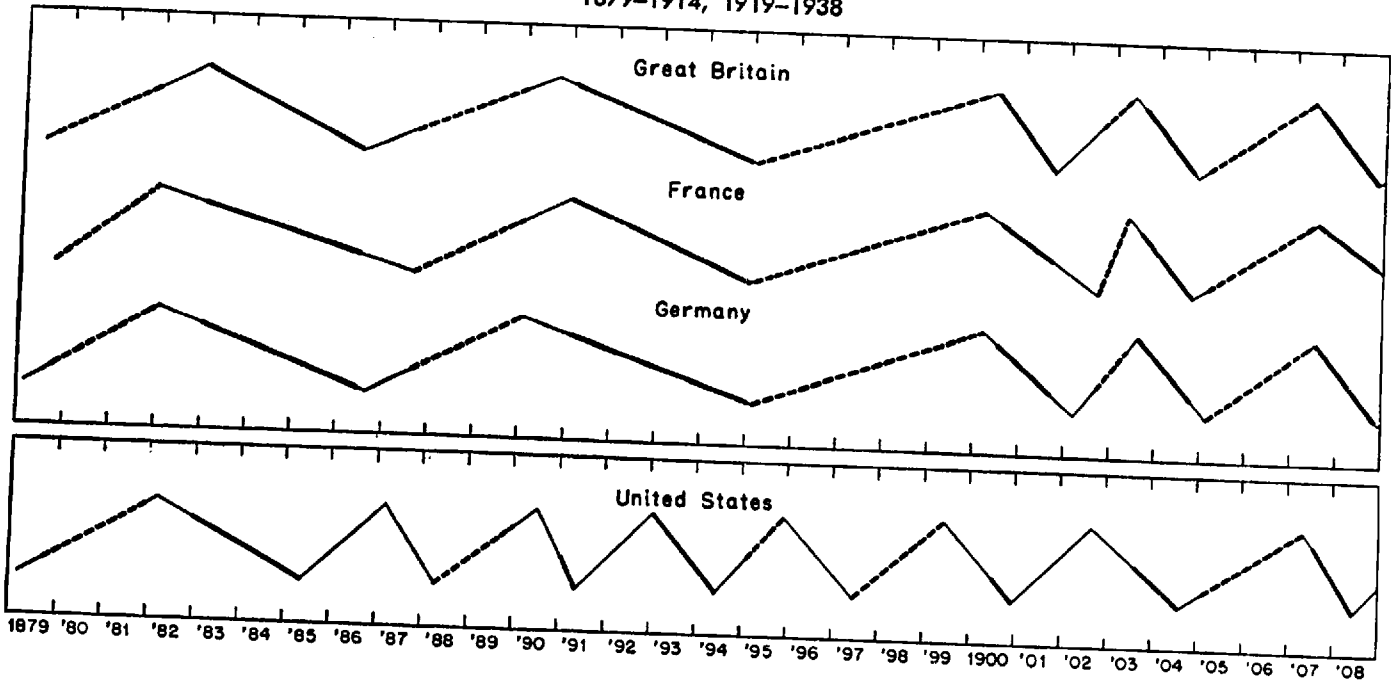
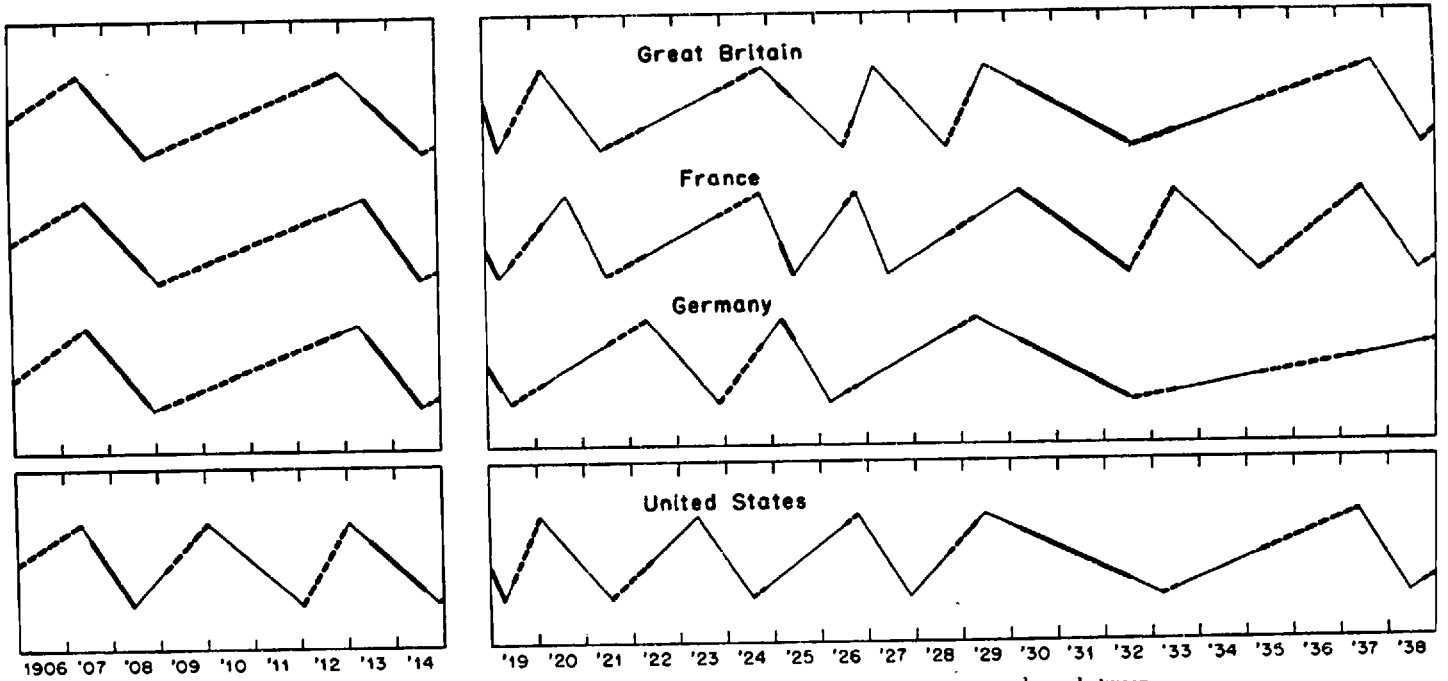


CHART 1, concluded



For the three European countries, the heavy solid line represents correspondence between the three countries in contraction; the dash line, correspondence in expansion; and the fine solid line, no correspondence.

For the United States, the three types of lines indicate correspondence or no correspondence between the U.S. and all three European countries.

Source: National Bureau of Economic Research data, Table 1.

also experienced a cycle of similar duration as did the first three. After 1932 no reference dates have been set by the National Bureau of Economic Research for Germany because of the peculiar experiences her economy underwent, the untrustworthiness of some of the essential statistics, and its preparation for war. It is not certain that it will ever be possible to fix reference dates for them according to the criteria used for the earlier periods. On the other hand it cannot be doubted that there were wide fluctuations in business conditions. This may be noted here as indicating a possible serious difficulty with the notion of a *continuous* sequence of cycles.[3] In fact between two cycles may be undefined fluctuations that do not conform to common characteristics of "cycles."

(2) We shall first examine by a simple conspectus the behavior of the reference cycles of the four countries in relation to one another. Chart 1 shows the turning points and Tables 2 and 3 summarize the essential statistics.

The chart indicates clearly that a considerable degree of uniformity in upturns and downturns can often be observed; also, it indicates that there is a rather striking difference between the cycles of the United States on the one hand and those of the three European countries on the other. Greater regularity is evident during the period up to 1914 than after World War I.

All this corresponds fairly well with our general intuitive knowledge about these phenomena. The reasons for the great independence of the American cycle are not quite clear at first sight, but the more closely knit performance of the three European cycles is more easily understandable, i.e., if interaction among them or a common factor is assumed to have been operative. Until 1914 the contacts of these European countries were intimate and growing rapidly, especially in their financial and commercial relations. The common gold standard had a strongly unifying influence.

(3) Table 2 indicates for how many months all four, and separately the three European, countries were "in the same phase." To avoid possible misunderstandings, we are considering turning points only. If we say that countries are in the same phase, we do not mean more than that the respective reference cycle chronologies are between the same sequence of turning points. Since the under-

[3] This is expounded in O. Morgenstern, "Organisation, Leistungen und weitere Aufgaben der Konjunkturforschung," *Public Statistical Institute for Economic Research*, Sofia, Vol. 1, No. 1, 1935, pp. 14–28, esp. pp. 25–26.

TABLE 2

Phase Comparison of Reference Cycles

	PREWAR PERIOD[a]		POSTWAR PERIOD[b]	
	Number of months	*Per cent of total*	*Number of months*	*Per cent of total*
Three European countries				
1. All three expand	199	47.5	40	25.5
2. All three contract	149	35.6	31	19.7
3. All three in same phase (1 + 2)	348	83.1	71	45.2
4. In different phase	71	16.9	86	54.8
Total	419	100.0	157	100.0
Four countries				
5. Three European countries expand, United States expands	131	31.3	28	17.8
6. Three European countries expand, United States contracts	68	16.2	12	7.7
7. Three European countries contract, United States expands	56	13.4	3	1.9
8. Three European countries contract, United States contracts	93	22.2	28	17.8
9. Three European countries in same phase, United States in opposite phase (6 + 7)	124	29.6	15	9.6
10. Four countries in same phase (5 + 8)	224	53.5	56	35.6
11. Four countries in different phase (4 + 6 + 7)	195	46.5	101	64.4
Total	419	100.0	157	100.0

[a] September 1879–August 1914, 419 months.
[b] June 1919–July 1932, 157 months.

lying series often show many more fluctuations between two turning points, it is quite possible that at any given moment some of the data underlying the determination of the troughs and peaks show an upward movement for one country and a downward movement for another. In this narrower sense numerous individual series need not at all be in the same phase. None of these movements could however be considered important enough to require another demarcation of the turning points of the whole business cycle actually chosen.

Before World War I *all four countries* were in the same phase in 53.5 per cent of all months,[4] expansion with 31.3 per cent

[4] The significance of this percentage and of all such following numbers has to be tested. Cf. below, pages 53 ff.

TABLE 3

Timing Comparison of Reference Cycles for Six Pairs of Countries, 1854–1938

TIMING COMPARISONS[a]	UNITED STATES–GREAT BRITAIN		UNITED STATES–FRANCE		UNITED STATES–GERMANY		GREAT BRITAIN–FRANCE		GREAT BRITAIN–GERMANY		FRANCE–GERMANY	
	Number of comparisons at:											
	Peaks	*Troughs*	*Peaks*	*Troughs*	*Peaks*	*Troughs*	*Peaks*	*Troughs*	*Peaks*	*Troughs*	*Peaks*	*Troughs*
						1879–1914						
Lead > 3 mos.	3	4	3	3	2	5	2	2	1	1		1
Lead 1 to 3 mos.	2	2	1	1	2		1	2	2	3	2	1
Coincidence										1	2	1
Lag 1 to 3 mos.	1	1	1		1	1	2	3	1	1	1	1
Lag > 3 mos.				2	1	1	1		2	1	1	3
						1919–1933						
Lead > 3 mos.	1	1	2				2	2	1		1	1
Lead 1 to 3 mos.	2				1			1		1		2
Coincidence		1	1	2			1	1		1		
Lag 1 to 3 mos.		1			1		1	1	1			
Lag > 3 mos.		1		2	1	2	1	2		1	1	
	Full period covered:											
	1854–1938		*1865–1938*		*1879–1933*		*1866–1938*		*1879–1932*		*1879–1932*	
Lead > 3 mos.	6	6	6	5	2	5	6	3	2	1	1	2
Lead 1 to 3 mos.	6	4	2	2	2	1	1	3	2	4	2	3
Coincidence		2	1	2				1		2	3	1
Lag 1 to 3 mos.	2	2	3		3	1	4	5	2	1	1	1
Lag > 3 mos.	1	2		4	2	3	3	2	3	2	2	3

[a] Lead or lag of reference cycle peaks and troughs of first country with respect to those of the second.

substantially larger than contraction with 22.2 per cent.[5] After the war they were in the same phase in only 35.7 per cent of the months, equally divided between expansion and contraction with 17.8 per cent. Thus a considerable increase in the irregularities must be noted. Significantly, the United States was out of step—that is, in a different phase when the three European countries were in the same phase—less in the postwar than in the prewar period.

[5] It must be noted that the difference between the percentages in the same phase in expansion and in contraction does *not* necessarily indicate that the countries are more closely associated in one phase than in the other. These percentages depend partly on the relative duration of the expansions and the contractions. That is, in the case of two countries, if there are more months of expansion than contraction for the two countries taken together, the percentage in the same phase in expansion must exceed that for contraction, whether the cycles in the two countries are related or not. Moreover this "bias" cannot be entirely corrected by relating the number of months in the same phase in expansion to the total number of months in expansion for the two countries together, for this percentage too will exceed the corresponding one for contraction whenever the total duration of expansion in the two countries taken together exceeds the total duration of contraction, and vice versa. Similar tendencies are present when more than two countries are compared.

Let E_1 and E_2 be the percentage of months in expansion in countries 1 and 2; C_1 and C_2 the percentage in contraction. Let e be the percentage of months the two countries are in the same phase in expansion, c the same for contraction, and d the percentage in different phase. Then

$$E_1 + E_2 = 2e + d$$
$$C_1 + C_2 = 2c + d$$

Hence, if $E_1 + E_2 > C_1 + C_2$, it follows that $e > c$. Also,

$$\frac{e}{E_1 + E_2} > \frac{c}{C_1 + C_2}$$

This holds regardless of the relation between the two countries. In the case of independence, the "expected" proportions in the same phase in expansion and contraction respectively are E_1E_2 and C_1C_2. If $E_1 + E_2 > C_1 + C_2$, it follows that $E_1E_2 > C_1C_2$, and

$$\frac{E_1 E_2}{E_1 + E_2} > \frac{C_1 C_2}{C_1 + C_2}$$

With more than two countries the same results cannot be inferred generally, but they do hold as the expected results in the case of independence provided the E's are equal or not too unequal.

The values of E for Tables 3 and 4 are:

	Sept. 1879–Aug. 1914	June 1919–July 1932	June 1919–Sept. 1938
United States	0.54	0.46	0.55
Great Britain	0.61	0.44	0.56
France	0.53	0.66	0.62
Germany	0.55	0.56	n.a.

n.a.: not available.

To put it differently, the three European countries became less in step with each other but more in step (as a group) with the United States.

As far as the *three European countries* are concerned, we observe that the increase in irregularity was marked. Before World War I they were in the same phase in 83.1 per cent of the months, expansion with 47.5 per cent leading over contraction with 35.6 per cent. After the war however the percentage in the same phase is only 45.2, expansion accounting for 25.5 per cent and contraction for 19.7 per cent of the months. We shall see later that individual series behave differently; in particular there occurred some fairly definite changes regarding the predominance of expansion over contraction out of the total number of months for which timing correspondence exists.

The much weaker covariation after World War I for both groups, the disappearance of the predominance of expansion as the chief common phase for all four countries, and the decline of the extent of this predominance for the three European countries reveal a great change in the international covariation of business cycles. While this may be partly due to systematic, structural changes inherent in a differentiating economic development of the four countries, it is perhaps chiefly attributable to the effects of World War I.[6] It must however be borne in mind that economic policy—especially cycle policy and restrictive, autarchic trade measures—played a much bigger role in the postwar period than ever before. This may be another potent factor which counteracted the "natural" rhythm shown before the war and increased differentiation.

(4) As far as *pairs of countries* are concerned, Table 4 reveals some rather striking facts. Before World War I the closest similarity prevailed between Great Britain and Germany, with the extraordinary value of 90.2 per cent of all months in the same phase, followed closely by France–Germany with 89.7 per cent and Great Britain–France with 86.2 per cent. Any pair containing the United States is at least 21 points below the lowest of these three figures, indicating a much weaker covariation whenever the United States is involved.

This setup is quite different after World War I. Now the highest percentage for being in the same phase is shown by the United

[6] Although it should also be noted that there were fewer cycles in the postwar period, thus increasing the possibility of variability from the larger prewar sample.

TABLE 4

Phase Comparison of Reference Dates for Six Pairs of Countries, 1879–1932

PAIRS	SAME PHASE IN: Expansions (months)	SAME PHASE IN: Contractions (months)	SAME PHASE IN: Total (months)	DIFFERENT PHASE (months)	SAME PHASE IN: Expansions (percentages)	SAME PHASE IN: Contractions (percentages)	SAME PHASE IN: Total (percentages)	DIFFERENT PHASE (percentages)
Prewar (September 1879–August 1914, 419 months)								
G.B.–France	210	151	361	58	50.1	36.0	86.2	13.8
G.B.–Germany	221	157	378	41	52.7	37.5	90.2	9.8
France–Germany	204	172	376	43	48.7	41.1	89.7	10.3
U.S.–G.B.	167	105	272	147	39.9	25.1	64.9	35.1
U.S.–France	143	113	256	163	34.1	27.0	61.1	38.9
U.S.–Germany	148	113	261	158	35.3	27.0	62.3	37.7
Postwar, including Germany (June 1919–July 1932, 157 months)								
G.B.–France	61	47	108	49	38.9	29.9	68.8	31.2
G.B.–Germany	47	48	95	62	29.9	30.6	60.5	39.5
France–Germany	65	31	96	61	41.4	19.7	61.1	38.9
U.S.–G.B.	43	60	103	54	27.4	38.2	65.6	34.4
U.S.–France	64	46	110	47	40.8	29.3	70.1	29.9
U.S.–Germany	45	42	87	70	28.7	26.8	55.4	44.6
Postwar, excluding Germany* (June 1919–September 1938, 231 months)								
G.B.–France	98	58	156	75	42.4	25.1	67.5	32.5
U.S.–G.B.	93	70	163	68	40.3	30.3	70.6	29.4
U.S.–France	94	58	152	79	40.7	25.1	65.8	34.2

* The National Bureau of Economic Research has not determined reference dates after 1932 for Germany. If the comparisons for the other countries are extended through September 1938, the results for the period since June 1919 (231 months) are as shown.

States–France with 70.1 per cent (note, however, that when the period is extended to 1938 the highest position goes to the United States–Great Britain, 70.6 per cent). The three European pairs, in the same sequence as in the previous paragraph, have 60.5, 61.1 and 68.8 per cent respectively. Not only is the order of magnitude reversed (which is of lesser significance, the figures in both instances deviating only moderately), but the percentages are much reduced. This expresses a greater independence of movement, a decrease of prewar "harmony," if this word be permitted. This is evidenced especially by Germany: the three percentages involving Germany are the lowest in the table. The three pairs containing the United States show a much greater spread of the percentages than the three European pairs of countries. Two are higher than

before the war, the United States–Great Britain and the United States–France. United States–Germany with 55.4 per cent was the lowest in the postwar period, 5.7 points below the lowest of the prewar pairs.

The fact that Great Britain–Germany in the prewar period were not only first in the scale but showed an exceedingly high percentage (90.2) is not very surprising in view of the great interaction between their economies as expressed, for example, by the large volume of foreign trade which passed between them. We know much less about either short-term or long-term capital movements but during the first decade of this century they increased greatly in volume (see Chapter X).

(5) The relationship between expansion and contraction is more complicated and the prewar and postwar patterns are no longer very simple. Before World War I, *expansion* led for all six pairs of countries over contraction. The highest percentage for expansion is found in the case of Great Britain–Germany with 52.7; this pair shows also the highest value for both phases together, as stated above. Again the three pairs of European countries have substantially higher percentages for being together in the phase of expansion than the three pairs containing the United States, of which the pair formed by the United States and France with 34.1 per cent shows the lowest.

The highest correspondence for *contraction* obtains with 41.1 per cent for France–Germany, the lowest with 25.1 per cent for the United States–Great Britain. We observe once more that the three pairs of European countries have substantially higher percentages for being together in the phase of contraction than the three pairs containing the United States.

After World War I the picture changes; the greater covariation of the cycles of the three European countries over that of the three pairs formed with the United States is no longer to be found, either for expansion or for contraction. No other systematic grouping of pairs of countries has taken the place of that before the war. Thus we have greater irregularity. The highest correspondence for expansion was 41.4 per cent for France–Germany, the greatest correspondence for contraction 38.2 per cent for United States–Great Britain, which pair gave however the lowest value, 27.4 per cent, for all cases of expansion. On the other hand France–Germany gave the lowest value (with 19.7 per cent) of all cases of con-

traction. The great difference as compared with the prewar situation is thus amply illustrated.

(6) In general in the prewar period the United States cycle led those of the three European countries at both peaks and troughs (Table 3). No consistent timing relationship appears among the three European countries. After the war the pattern was less definite, although the United States cycles continued to lead British and French cycles at peaks. These comparisons lend some support to the notion that the United States "exported depressions," but further examination of other data, such as indexes of production, would be required before it could be given full credence. Some financial data are examined from this point of view in later chapters.

(7) The singularly different rhythm of the American cycles—as expressed by the different timing of their turning points and their shorter average duration—compared with that of the other countries is a frequently mentioned phenomenon of considerable interest. It will have to be examined further. It is plausible to consider the youth of this country, the rapidity of its development in technology and population, its great geographical distance from Europe, all as contributing factors making for independence of movement. There are furthermore significant differences especially in the financial organization, notably the absence of a central bank in the European sense, before 1914.

The possibility should not be dismissed easily that the great geographical distance of the United States from Europe and the fact that Americans were much less prone to foreign investment or lending may be partly responsible for a markedly different rhythm of its business cycles. Since interest rates have always been recognized as playing an important though still rather obscure role in shaping the business cycle, the factor of distance (often a form of risk) may indeed have been of not inconsiderable importance. If it combines with marked institutional differences, as mentioned above, then we may have a powerful group of factors making for a different structure of American cycles, to the extent to which that expresses itself in timing relationships.

The three European countries showed great similarity in the timing of their cycles before 1914 (cf. Chart 1). This similarity is even preserved when the duration of the cycles varies. There are very long cycles from 1882 to approximately 1900, during which period they move closely together. Then follow shorter cycles, but

again the general parallelism is not disturbed. In the postwar period nothing of this sort can be observed. The sequences of shorter or longer cycles are more irregular within each country so that for all three together or any pair nothing like the previous harmony, invariant against changes in the length of the cycles, is shown.

(8) The earlier and significant invariance of the parallel movement against the change in the duration of the cycle—which can be seen from inspection of Chart 1—provides us with a strong presumption that the contact between these three countries was of an organizational character. Indeed the fact that the parallelism was maintained during both shorter or longer reference cycles gives support to the thesis that we are not only observing a mere covariation of independent factors, but a transmission and an interlocking of the cycles. It is probably safe to rule out the possibility that the maintenance of the covariation was produced by some cause outside of all three countries. We know enough about the economic organization of the world and the role of these three countries to question such a hypothesis. The charts tell us nothing, however, about the nature of the transmission, its speed, the kind and strength of the forces involved, etc.

The interaction of the three countries was apparently profoundly affected after the war, and probably by the war itself. Among the chief changes were the brief duration and partly different management of the gold standard, and its adoption by fewer countries. The interaction between the countries was then carried out by a mechanism that no longer produced the prewar regularities. Nor did it give rise to easily discernible new regularities, perhaps of a more complicated order. There might, for example, be a parallelism only for long cycles, or between some pairs of countries. The period from 1919 to 1932—of which 1925 to 1931 covers the regime of the gold standard for three countries—is obviously too short for the observation of such possible new and in all likelihood more intricate regularities. Besides, the above remark of the increased role of powerful economic policies must be recalled. To the extent that they were successful and independent of each other, they would modify the international pattern profoundly. We shall see later in the discussion of the behavior of short-term interest rates that references to specific economic policies are indispensable in view of the changing cyclical behavior of these series after the war and of our knowledge of the reasons for that change.

(9) It could perhaps be argued that the greater disharmony in

the relations of the reference cycles after World War I is due to an improvement of the material upon which their determination is based. Thus the phenomenon would not be a true one; it might hold equally for the prewar time, if our knowledge of the earlier data had been as complete as it is for the postwar period.

While it is true that our recent information is often superior to that for earlier cycles, the difference is certainly not so big as to warrant the above hypothesis that there was as much disorder before 1914 in the relations of the reference cycles as after 1919. Furthermore exactly the same phenomenon emerges for many individual series to be discussed in subsequent chapters. There, no such difference in the accuracy of our information exists, as e.g., in the case of many interest rates, exchange rates, etc. Since all these series enter in the determination of the reference cycles, the latter reflect, to some extent at least, their behavior and thus show no spurious phenomenon.

*Section 2. Significance Test for Phase Comparisons**

(10) At this point the question of the significance of the comparison in the behavior of reference cycles arises. Upon examining these cycles, and in particular the six pairwise phase comparisons which are obtained from them, we have drawn a number of general inferences concerning the business cycles in the four countries, France, Germany, Great Britain, and the United States. The question of significance arises both for the period of 419 months preceding World War I and for the 157 months after World War I.

To characterize the inferences further, we repeat two of them here: (1) during the prewar period, the three European reference cycles exhibit a high degree of correlation, whereas the corresponding American cycle is not so highly correlated with the rest; (2) the postwar reference cycles appear to be much less correlated with each other than the prewar. There seems to have appeared a degree of randomness which may or may not be a direct consequence of the war.

If these statements are based on the reference cycles alone, the question arises what the significance of the inference is; it takes in

* The test described in this section was suggested to the author by his colleague Professor John Tukey; in the execution he was greatly assisted by Mr. Carl Ohman, and Mr. H. J. Arnold, also of the mathematics department of Princeton University.

particular the form that an answer must be found to the problem whether the apparently high correlations between the European reference cycles represent a real covariation among the business cycles of these countries or whether these correlations could have arisen by chance alone.

Since in the future parts of this volume the same technique for measuring covariation and general behavior of various time series will be applied, a detailed significance test is carried out at this point. It will not be repeated at later instances, because the reader can easily reconstruct the test on the basis of what follows here. Furthermore the statistical situation in all future cases is very similar to the one to be described in the following paragraphs, so that an application of the results to be exhibited below is possible.

(11) To answer these critical questions and others like them, let us consider the make-up of one of our reference cycle sequences. It consists of a sequence of numbers written in two columns side by side. One column represents "months in expansion" (e) while the other gives the corresponding "months in contraction" (c). The numbers in each column range between 6 and 72. (This follows from the definition of a business cycle [cf. Burns and Mitchell, *op. cit.* p. 3], which requires that a business cycle will not be less than twelve months long or longer than twelve years. We arbitrarily divide by two to get the range for expansions and contractions.) The reference cycle sequence is split into two parts representing the prewar and postwar periods respectively. In the former the numbers from both columns add to 419; in the latter, 157. As an illustration the reference cycles for Great Britain (see Table 1) are:

Prewar		*Postwar*	
e	c	e	c
*39	42	*9	15
51	53	41	20
64	15	8	18
21	17	10	*36
31	17		
49	20		

This means that starting from the date when we began our reference cycle (September 1879) we had 39 months of expansion followed by 42 months of contraction, 51 months of expansion, etc. The asterisks indicate that we started out (finished) in the midst of a contraction or an expansion.

If we take two such reference cycle sequences side by side, and

add up (1) the number of months during which both cycles are expanding (e), (2) the number during which they are both contracting (c), and (3) the number of months when they are out of phase (d), repeating this for both prewar and postwar parts, we have a phase comparison of the two cycles. The pairwise phase comparisons of our four cycles are given in Table 4.

Now suppose that we used as reference cycles not the intervals given in Table 1 but rather numbers from a table of random numbers. What sort of phase comparisons would we get and how would they compare with those in Table 4? Certainly if our reference cycles were constructed from random numbers and we had a large number of such series, we should expect that pairs of such cycles would be out of phase (in phase) 50 per cent of the time *on the average*. Just what one should expect from taking only four such random series of reference cycles is another matter.

To see what sort of phase comparisons one might expect from random numbers, let us construct some random cycles. To start out we select two sequences of about 70 numbers each, each number consisting of the sum of 3 numbers from a table of random numbers (such as the Interstate Commerce Commission's *Table of 105,000 Random Decimal Digits*) ranging from 2 to 24. The sum of 3 numbers between 2 and 24 is used to produce numbers between 6 and 72 so as to obtain numbers which are approximately normally distributed. Setting these two lists side by side and calling one column expansion (e) and the other contraction (c), we will have constructed one long random "reference cycle" sequence covering over 5,500 "months." We then draw from our random number table 40 numbers between, say, 0 and 5,000. We use these 40 numbers as random starting points. For example, if one of the numbers were 1,000, we would look at our long reference cycle sequence and count down to the 1,000th month in the series. Starting from there we select the next 419 months as a random prewar cycle sequence and the succeeding 157 as the corresponding postwar cycle sequence. In this way we obtain 40 "random reference cycle" sequences of the required length. We then compute the corresponding 60 possible phase comparisons by taking these 40 random reference cycle sequences in groups of 4. Each group will give 6 possible comparisons. Comparisons of these with the numbers from Table 4 will give us a good idea of the amount of randomness present in our reference cycles and will supply some notion of the validity of statements (1) and (2) as well as others made in subsequent chapters.

To illustrate this procedure, here is a 5,500+ month random reference series:

e	*c*	*Total*	*e*	*c*	*Total*	*e*	*c*	*Total*
		0						
47	43	90	46	62	2,134	47	36	4,058
40	56	186	38	43	2,215	62	40	4,160
52	33	271	15	25	2,255	36	44	4,240
28	54	353	40	43	2,338	36	26	4,302
28	26	407	27	32	2,397	49	35	4,386
26	32	465	36	27	2,460	17	40	4,443
46	43	554	37	23	2,520	46	53	4,542
47	30	631	38	37	2,595	25	39	4,606
59	28	718	43	62	2,700	59	35	4,700
32	33	783	36	43	2,779	41	22	4,763
20	38	841	54	15	2,848	27	37	4,827
56	46	943	37	24	2,909	39	51	4,917
42	23	1,008	47	33	2,989	37	31	4,985
32	49	1,089	31	35	3,055	57	26	5,068
23	47	1,159	58	24	3,137	53	40	5,161
28	49	1,236	24	45	3,206	52	31	5,244
34	41	1,311	47	35	3,288	34	36	5,314
28	37	1,376	22	35	3,345	46	43	5,403
26	37	1,439	44	45	3,434	46	50	5,499
48	43	1,530	54	38	3,526	40	51	5,590
46	25	1,601	50	58	3,634			
38	48	1,687	41	48	3,723			
56	67	1,810	57	34	3,814			
46	45	1,901	65	37	3,916			
63	62	2,026	35	24	3,975			

We then pick 40 random numbers between 0 and 5,000.

1. 1,301	9. 2,745	17. 1,592	25. 4,179	33. 2,446
2. 1,429	10. 4,951	18. 4,970	26. 4,637	34. 1,751
3. 1,968	11. 444	19. 4,801	27. 2,367	35. 1,945
4. 3,317	12. 2,414	20. 972	28. 4,358	36. 3,627
5. 3,411	13. 2,373	21. 2,887	29. 3,042	37. 809
6. 0,302	14. 832	22. 587	30. 4,971	38. 2,789
7. 3,267	15. 2,508	23. 3,998	31. 3,520	39. 4,260
8. 3,137	16. 3,055	24. 3,659	32. 4,684	40. 4,661

Using these as starting points, we construct our random reference cycle sequences.

Series 1, for example, will be:

Prewar		*Postwar*	
e	*c*	*e*	*c*
	•10	•23	67
28	37	46	•21
26	37		
48	43		
46	25		
38	48		
•33			

Having written down in like manner the 40 random reference cycle sequences corresponding to the 40 random starting points, we can compute 60 phase comparisons as follows:

	Prewar			*Postwar*		
	In same phase			In same phase		
	ee	*cc*	*out of phase*	*ee*	*cc*	*out of phase*
1 – 2	90	84	245	54	61	42
1 – 3	99	133	187	36	27	94
1 – 4	61	118	240	69	43	45
2 – 3	75	112	232	45	24	88
2 – 4	111	112	196	66	33	58
3 – 4	41	92	286	76	27	54
5 – 6	99	91	229	33	28	96
5 – 7	39	29	351	32	7	118
5 – 8	108	88	223	53	53	51
6 – 7	121	120	178	49	14	94
6 – 8	59	48	312	26	36	95
7 – 8	91	78	250	16	26	115
9 –10	158	103	208	54	68	35
9 –11	129	71	219	10	10	137
9 –12	140	81	198	23	26	107
10–11	134	82	203	13	8	136
10–12	154	101	164	23	21	113
11–12	134	100	185	61	47	49
13–14	113	133	173	73	39	45
13–15	105	95	219	89	39	29
13–16	129	134	156	51	26	80
14–15	112	109	198	68	63	26
14–16	95	83	241	42	62	53
15–16	116	74	229	45	49	63
17–18	138	112	169	72	63	22
17–19	102	80	237	51	48	58
17–20	66	109	244	31	31	95
18–19	188	127	104	64	55	38
18–20	126	130	163	23	17	117
19–20	126	134	159	13	13	131
21–22	78	49	292	6	27	124
21–23	123	93	203	55	64	38
21–24	155	109	155	9	10	139
22–23	100	72	247	8	35	114
22–24	136	79	224	55	75	27
23–24	173	128	118	16	24	117
25–26	150	150	119	91	43	23
25–27	48	80	291	64	3	90
25–28	85	112	222	25	13	119
26–27	41	34	344	72	6	79
26–28	105	93	221	33	16	108
27–28	116	136	167	57	27	73
29–30	108	63	248	20	14	123
29–31	137	98	184	30	13	114
29–32	163	124	132	63	57	37
30–31	146	87	186	53	27	77
30–32	92	33	294	15	0	142

	Prewar			*Postwar*		
	In same phase			In same phase		
	ee	*cc*	*out of phase*	*ee*	*cc*	*out of phase*
31–32	159	106	154	53	27	77
33–34	109	112	198	24	26	107
33–35	88	98	233	35	19	103
33–36	99	48	272	64	25	68
34–35	95	139	185	45	70	42
34–36	85	68	266	26	28	103
35–36	99	89	231	55	39	63
37–38	150	145	124	62	61	34
37–39	134	160	125	57	66	34
37–40	98	119	202	61	54	42
38–39	145	109	165	51	44	62
38–40	98	57	264	62	39	56
39–40	113	103	203	47	34	76

We now have only to compare these phase comparisons with those given in Table 4. In Chart 2 the number of months out of phase is plotted for the 60 random pairs and the 6 actual pairs. Each x represents a random pair, each # a European pair, and each circle represents a pair involving the United States. In Chart 3 the plotting is repeated for the number of months *ee* and *cc*. Practically the same results appear in both:

(a) In the *prewar phase* comparisons, whereas the out of phase numbers range from 100–350, with most falling in the range 120–310, for the random pairs, the three European pairs are each out of phase 40–60 months. This seems to indicate, with a high degree of assurance, that the correlation between the European cycles prewar is real and cannot be ascribed to chance effects.

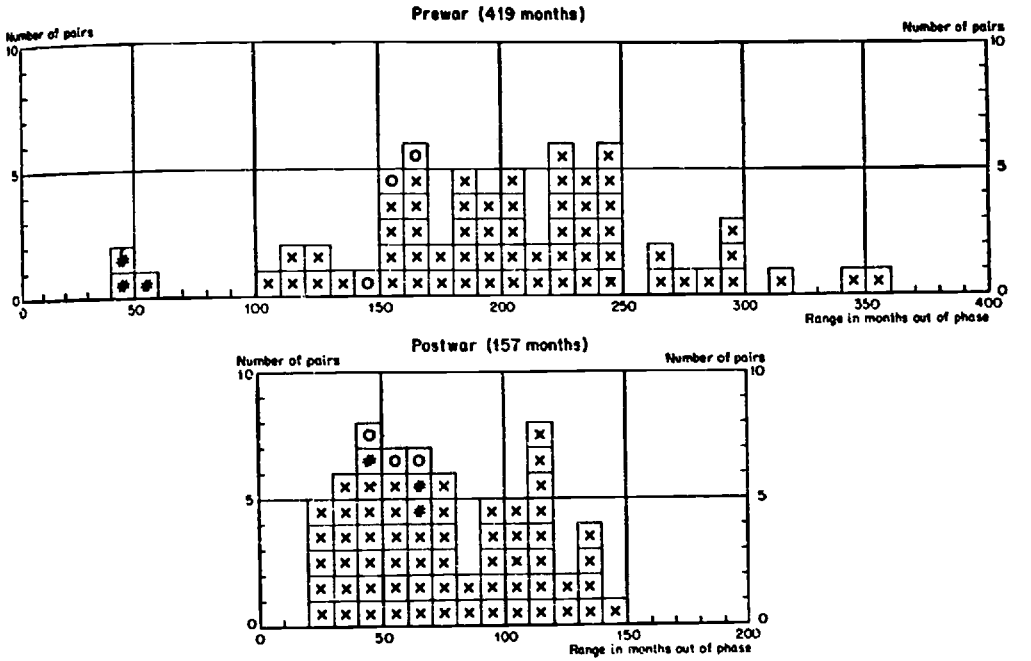
(b) The same cannot be said of the pairs involving the United States, *prewar*. Although these are all in one tail of the random distribution, indicating some depature from randomness, there is no conclusive evidence that the correlation here is real. One thing which can be said with a good deal of assurance is that the correlation among prewar European cycles is significantly greater than that between the United States and European cycles.

(c) As to the *postwar situation:* here there is nothing to indicate significant departure of the cycles from randomness. Since the European pairs were so far out in the tails prewar, this seems to indicate a significant trend toward randomness following World War I. This appearance, however, is due in no small measure to the fact that we are considering only one-third as many months as in the prewar period. Notwithstanding, the significant prewar covariation among the European reference cycles has disappeared.

CHART 2

Total Months out of Phase, Random and Actual Pairs, Prewar and Postwar

× Random pair
\# European pair
O Pair involving U. S.



Source: Table 4.

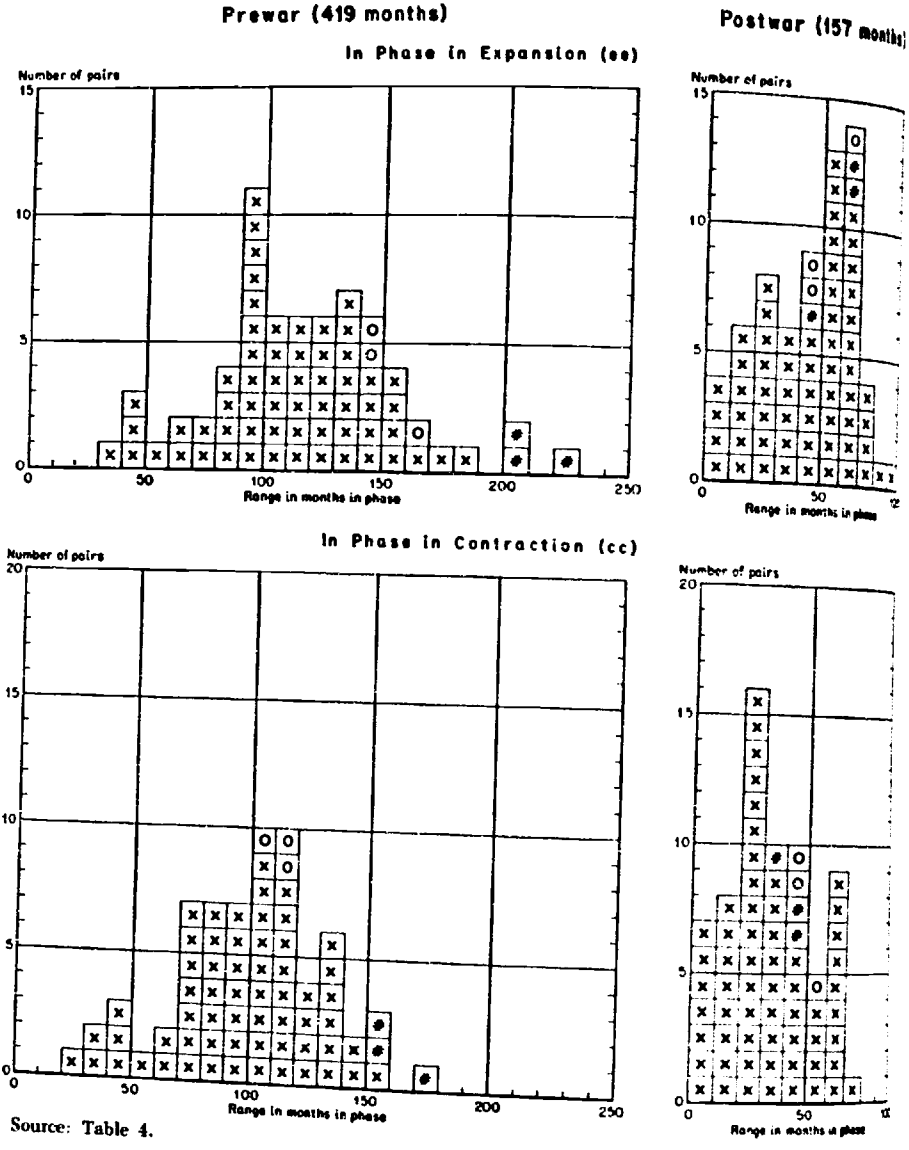
Thus we arrive at a reasonable justification of the statements (a) and (b) made at the beginning of this section.

(12) The reader should be cautioned not to take the results of this test too literally as the test itself is based on a number of approximations. One notable approximation is in the construction of the long sequence of random "reference cycles." Here the numbers that composed the cycle were the sum of three random numbers ranging from 2 to 24. It was assumed that the length of half-cycles is approximately normally distributed. The composition of the random reference cycles was hence made approximately normal. Further the length of expansions and contractions were assumed to be equal. However the distribution of expansions probably differs from that for contractions.

CHART 3

Total Months in Phase, Random and Actual Pairs, Prewar and Postwar

× Random pair
European pair
O Pair involving U. S.



Source: Table 4.

This discrepancy can be eliminated by designing a more refined test. However it is this author's view that the errors arising from this approximation will not affect the outcome sufficiently to warrant correction.

The above test is only one of a number that can be used in testing the significance of covariance of reference cycles. For instance, if one wishes only to answer the question whether the covariation between the prewar cycles of, say, France and Great Britain is significant, a reasonably simple and accurate answer can be obtained using a two-by-two chi-square contingency test. Here the data are arranged as in the following instance (prewar, France and Great Britain):

		Great Britain		
		e	*c*	
France	*e*	*210*	*12*	222
	c	*46*	*151*	197
		256	163	419

If there were no association between the two sets of cycles, then the individual cell frequencies should be proportional to the marginal totals on the average. The corresponding test is described in detail in such statistical texts as R. A. Fisher, *Statistical Methods for Research Workers;* G. U. Yule, and M. G. Kendall, *An Introduction to the Theory of Statistics.* In the present problem this chi-square contingency test would tell us that, if there had been no association between the two cycles, the chances of turning up with a table like this would be about one in a million.

(13) The chi-square contingency test likewise utilizes assumptions regarding the character of the data. In particular it assumes that each of the entries in the table is an independent observation. This is clearly not correct in the present case, since each reference phase contains many months and all months in a phase are treated alike. The new test proposed above meets this point by treating each phase as a unit.

Section 3. Duration of Cycles, Concentration, and Spread of Turning Points

(14) We shall now consider the *average duration* of reference cycles in two periods (Table 5). There were only six full cycles (before 1914) in each of the three European countries, ten in the

TABLE 5

Number and Duration of Reference Cycles of Four Countries

	NUMBER OF:			AVERAGE DURATION OF[b]: (*months*)			AVERAGE PER CENT OF DURATION OF REFERENCE CYCLES[c]	
	Expansions	*Contractions*	*Full cycles*[a]	*Expansions*	*Contractions*	*Full cycles*	*Expansions*	*Contractions*
	Prewar (January 1879–December 1914, 431 months)[d]							
Great Britain	6	6	6	43.0	27.5	70.5	61.0	39.0
France	6	6	6	37.2	32.7	69.9	53.2	46.8
Germany	6	6	6	39.2	31.8	71.0	55.2	44.8
United States	10	10	10	23.2	19.7	42.9	54.1	45.9
	Postwar (January 1919–December 1932, 167 months)							
Great Britain	4	4	4	17.5	22.5	40.0	43.8	56.2
France	4	4	4	26.2	13.5	39.8	66.0	34.0
Germany	3	3	3	29.3	23.3	52.6	55.7	44.3
United States	4	3	3	18.5	16.0	34.7	53.6	46.4

[a] Only complete cycles are counted; parts of cycles at both ends of a series are dropped. Cycles are measured from trough to trough. Similarly only complete expansions and contractions are counted in their respective columns.

[b] Durations of only complete cycles, expansions, and contractions are included in the respective columns.

[c] The percentages are calculated from a base equal to the average duration of expansions plus that of contractions. This sum equals the average duration of cycles only when the number of full cycles is the same as the number of expansions and contractions.

[d] The periods selected are slightly longer than those in other tables. This is done so as to include all phases and cycles which are included in the other tables.

United States; in both cases there were the same respective number of expansions and contractions. The average duration of a full cycle in Europe varied only from 69.9 months to 71.0 months; the American average was naturally much lower: 42.9 months.

When the average length of the expansions and contractions is expressed as a percentage of the average duration of the entire cycle we see that expansions were without exception longer and that France, Germany, and the United States form one group yielding figures with only slight variation: 53.2, 55.2, and 54.1 per cent respectively. Great Britain with 61.0 per cent shows the highest relative average duration of expansions.

(15) This picture again altered materially after the war. The average cycles were without exception much shorter, the United

States with 34.7 months (as compared with 42.9 months before the war) still having the briefest cycle. For Great Britain and France we find a cycle 30 months shorter while the German cycle has been shortened only by 18.4 months. These changes may be due partly to the smaller number of months covered for the whole period, but we shall find the same experience with some individual series. The percentages for expansion of the average cycle vary little for Germany and the United States from their respective prewar figures. But France gives 66.0 per cent for expansion and Great Britain only 43.8 per cent. The latter would conform with a general study of British postwar developments, while the same cannot be said with similar confidence for France. Here the statistics hardly corroborate widely held opinions about French postwar economic development. Our results would be different if the comparison of reference cycles extended past 1932, since from then on long upward movements occurred in Germany, Great Britain, and the United States, or if the degrees of the movements, i.e., their amplitudes, could be considered.

(16) We now have to raise a somewhat different question, whether a conspectus of reference cycles will disclose truly "international cycles." The answer, in general, is in the negative. To begin with there exists no convenient list of "international reference dates." In fact it is not always clear, *prima facie*, what an international cycle would be, as was pointed out elsewhere,[7] although such notions are widely used both in everyday parlance of businessmen and in economic literature. There is fairly general agreement that there were numerous international crises, e.g., among others in 1873, 1890, 1893, 1907, 1921, 1929, 1931, 1937.[8] In the literature these were always understood to have been times when there was not a mere coincidence of crises in our various countries but when there was evidence of a genuine international spread of the disturbances.

Now it will be noted that some of the above-mentioned dates do not even occur in our Table 1, i.e., they form no part of the reference cycle pattern. This may turn out to be highly significant. Consider for example the complete absence of the year 1931, which witnessed one of the greatest disturbances of the economies of most countries, with a complicated setup of interactions crisscrossing in many

[7] Cf. Chap. I, sec. 7.

[8] Observe that 1893 occurs only for the United States in Table 1 and hence not at all in Table 6. Yet there was a grave international crisis then!

directions. These crises certainly were felt—though to varying degrees—within each of the four domestic economies. Sometimes the international disturbances may be coincident with the peaks of reference cycles; this is to a limited extent true for 1907, but not for the month in which the actual international crises occurred.

If the international (financial) crises and disturbances are on the one hand sufficiently marked as to enter our general experience and to appear in most economic records, but on the other hand do not often show up in the reference dates,[9] then a simple conclusion suggests itself: it is possibly a characteristic of the international financial relations that the crises within that field are sharp and even violent but do not necessarily give rise to that sequence of events usually associated with reference cycle turning points. Most likely they will occur quite typically *after* the reference cycle peaks. The study of this property and sequence—if they exist at all—will require the detailed examination of the various statistics which are analyzed in the following chapters.

In any case an attempt should be made to establish independently the dates of great international financial tensions and, if possible, to describe them in some detail. Since this would not necessarily yield continuous cycles, we are in the same early stage of our investigation as were those who studied economic fluctuations chiefly in terms of distinct crises, rather than to insist upon a cyclical aspect which is of a later vintage. The parallelism may end here, since it is not at all certain that in the international field (finance or other) it will again be possible to make the transition from disconnected crises to closely interwoven entire cycles. One of the reasons why the chances for the establishment of cycles are smaller now is found in the fact that the international economy is of much looser organization and structure and more complicated than any domestically closed economy. Under these conditions changes in structure, which are apt to upset cyclical regularity (if found), occur much more easily. The tendencies in that direction have gained moreover from the growing influence of governmental interference into international economic relations. In order to distinguish international cycles we would finally have to recognize *international troughs* as well as crises, the latter synonymous with

[9] We will see later (cf. Chaps. VII and X) that this extends even to specific indexes for the international and domestic aspects of the activities which the indexes describe. We shall find, *loc. cit.*, that certain international stock market panics do not even cause a ripple in some important stock market *indexes*. However, then we may question the validity of the index.

upper turning points, which is not necessary. But at the present stage this cannot be done. It is not at all clear intuitively when such a trough has been reached and how it is to be circumscribed.

(17) Our reference cycles can and should be subjected to still another examination by determining the concentration and dispersion of turning points. This will prove to be of some interest and the method to be applied will find further use in later chapters (cf., e.g., Table 22, etc.). The procedure is again quite simple; it will be explained fully here.

In a comparison of a number of time series, we observe that their cycle turning points are sometimes concentrated within a very short period, sometimes spread over a considerable number of months. This can be seen on Chart 1 for the reference cycles and on numerous other occasions later for specific cycles (cf., e.g., Chart 5). Our two different phase comparisons have expressed something about the concentration or dispersion of turning points since 100 per cent agreement is not observed. But we can obtain additional and more direct information on this point. If there is a high concentration, then we may look upon those months and years from the point of view of *international turning points*, while, when there is a great dispersion, this would describe a very different situation. To some extent this can be established in a purely qualitative manner by visual inspection of the charts. But it is worth while to devise some more objective way of dealing with the evidence, which would allow a more direct comparison of these concentrations of turning points belonging to different economic activities. All this, however, as well as the question where truly international peaks, crises, and troughs occurred, belongs to later stages of our investigation.[10] Here we are restricted to reference cycles, and great as their value may be, it would be rash to use them now for such wider purposes.

(18) This is the procedure: Let

$$\text{Max } {}^{i}_{i}, \ldots, \text{Max } {}^{i}_{n}; \quad \text{Min } {}^{j}_{1}, \ldots, \text{Min } {}^{j}_{n}, \quad {}^{i=1,\ldots,m;}_{j=1,\ldots,m}$$

be consecutive maxima or minima, i.e., turning points respectively of the different time series 1, . . . , *n*., one series for each country. (The asterisks, as before, indicate beginning or ending in the midst of a contraction or expansion.) In our present case, they are

[10] It would be desirable to study these possibilities in terms of international series. As to the various kinds of "international series," cf. the observations in Chap. I, and note 35 there.

the reference dates, in other instances they will be specific cycle turning points. These points are considered as *coinciding*, if within an interval of, e.g., Max $\frac{1}{1}$ and Max $\frac{1}{n}$ there is no opposite turning point.[11] This criterion relates the coinciding turning points to each other in a unique way; i.e., if Max $\frac{1}{1}$ coincides with Max $\frac{1}{2}$, . . . , Max $\frac{1}{n}$ then there can clearly be no other Max $\frac{2}{1}$ also coinciding with Max $\frac{1}{2}$, . . . , since between Max $\frac{1}{1}$ and Max $\frac{2}{1}$ there must be Min $\frac{1}{1}^{*}$ (or Min $\frac{2}{1}^{*}$, as the case may be).

The period covered by this statistic begins where the first three maxima or minima occur, which according to the above definition are coinciding. If the maximum or minimum of the fourth series falls earlier than the coinciding turning points and does not belong with them by virtue of an intervening opposite turning point of its own, the period covered by this statistic nevertheless starts with the month preceding this excluded turning point. The analogous rule is observed for the termination of the period which the measurement covers. These rules are necessary in order to eliminate arbitrariness in determining the total number of peaks, P, and troughs, T, occurring. From these totals the percentages p/P and t/T are computed, where p or t represent the number of coinciding peaks or troughs.

From these coinciding turning points a simple arithmetic mean is computed. The underlying monthly data do not refer, in general, to any particular part of the month; therefore the average turning points are rounded off to whole months. Only if they fall exactly between two months, the figure is not rounded off and both months are reported in the tables, e.g., July–August 1890 for reference cycle peaks; cf. Table 6.

(19) The degree of concentration is measured by the dispersion around the average turning points. The mean deviation D is used[12] in conformity with its other applications in the National Bureau technique for similar purposes. From these the average mean deviation $\overline{D}$ is computed both for peaks and troughs in order to obtain a single measure for an entire period. However the mean deviations fluctuate often widely. Even for long periods there are usually only few turning points, e.g., there are only five coinciding

[11] This is an application or extension of the rule by which the National Bureau relates specific cycle turning points to reference cycle turning points. Cf. Burns and Mitchell, *op. cit.*, p. 118.

[12] It is computed from the mean before rounding off.

TABLE 6

Concentration and Dispersion of Reference Cycle Turning Points, January 1879–January 1915

(*432 months*)

	Average peak[b]	Mean deviation (months)	Average mean deviation (months)	Percentage coinciding
COINCIDING PEAKS[a]				
Four countries	Apr. 1882	4		
	July–Aug. 1890	3.50		
	Jan.–Feb. 1900	3.75	2.85	71
	June 1907	0.75		
	Mar. 1913	2.25		
Three European countries	Apr. 1882	5.11		
	Aug. 1890	4.44		
	Apr. 1900	1.33		
	June 1903	1.11	2.44	100
	July 1907	0.44		
	Mar. 1913	2.22		
COINCIDING TROUGHS[c]				
	Average trough[b]	Mean deviation (months)	Average mean deviation (months)	Percentage coinciding
Four countries	May 1879	2.50		
	Dec. 1894	2.88		
	Nov. 1904	1.75	2.18	62
	Nov. 1908	2.38		
	Sept. 1914	1.38		
Three European countries	June 1879	2.44		
	Nov. 1886	5.78		
	Feb. 1894	0.44		
	Mar. 1902	4	2.25	100
	Dec. 1904	1.56		
	Dec. 1908	1.11		
	Aug. 1914	0.44		

Average mean deviation of coinciding peaks as per cent of corresponding average for troughs

Four countries	131
Three European countries	108

[a] Coinciding peaks: no trough within the range of peaks.

[b] The arithmetical mean of the coinciding peaks or troughs is computed. If the average falls exactly between two months, both months are reported. If the average falls more closely into one month, only this month is reported.

[c] Coinciding troughs: no peak within the range of troughs.

peaks (all four countries) for 432 months.[13] Consequently our average mean deviations must be used with even greater care than most averages. Because of the small number of observations the inclusion of one more or less can make great differences. In order to show how representative these averages are, the percentage of coinciding turning points out of all turning points is computed. If this is below 50 per cent, averages are not computed.

(20) We now turn to the first application of this measure, i.e., to reference cycles. We have five average peaks and troughs for all four countries, but with one notable feature. Normally the two kinds of turning points would form a sequence, since it is obvious that there can be no two maxima in one time series without an intervening minimum and vice versa. However these average turning points need not form a continuous sequence; for example, there is an average trough in May 1879 followed by two average peaks in April 1882 and July–August 1890, and a final average trough September 1914.

Looking at the mean deviations of the average peaks and troughs we find those of the peaks consistently great except June 1907, where it is only 0.75 months. It is well known that this year witnessed one of the sharpest international crises, having its center of gravity in the United States. It will be examined later (e.g., in Chapter VIII) whether the reference cycles show the true character of internationally important turns or whether there are perhaps other indications which must be relied upon.

For the four countries the mean deviations of the average troughs are all lower than the mean deviation of the preceding peaks, except the one of 2.38 months which occurs in November 1908, following the great crisis of 1907. The lowest falls into September 1914, which reflects the rapid speeding up of economic expansion after the outbreak of war.

The two average mean deviations $\overline{D_p}$ and $\overline{D_t}$ are 2.85 and 2.18 respectively; the latter becomes 2.37 if the trough of 1914 is excluded. The difference between the two, $\overline{D_p}$ and $\overline{D_t}$ is fairly large and surprising. Most economists would probably have expected that the dispersion of turning points would be greater around the troughs than around the peaks. It is more plausible that peaks (or rather "crises") are more intimately related to each other, because of the many factors which could be mentioned as making the transmission of tensions and difficulties more likely than that

[13] This, in spite of a high degree of covariation of phases!

of the delicate and often weak stimulants which are registered for upturns.

(21) Taking the three European countries alone, this general relationship still holds: $\overline{D_p} = 2.44$, $\overline{D_t} = 2.25$. However, if August 1914 is omitted from the troughs, $\overline{D_t} = 2.56$. The small numbers involved make it almost impossible to decide whether to reject this evidence as showing a decisive difference. But even if it is rejected, the United States again remains apart from the more homogeneous behavior of European business cycles.

1907 stands out again with a mean deviation at the average peak of only 0.44 months, the smallest value recorded, whether for peaks or troughs. For the latter it occurs even twice: February 1894 and August 1914. The three consecutive average turning points—peak of April 1882, trough of November 1886, peak of August 1890—not only contain the highest peak dispersion (5.11 months) but is the sequence of the three greatest values; it can perhaps be taken as indicating a very diluted interaction—if it exists at all—while some others show a much more rapid mutual adjustment of the various business cycles. It is interesting to note that there is a slight tendency away from the biggest dispersions toward smaller ones. The greatest, as we saw, occur at the beginning of our series. In spite of covering 432 months—a substantial number for many statistics, and substantial especially for international comparisons of business cycles—the number of cycles is very small and does not allow us to generalize in one way or the other.

(22) Our data are subject to at least one further qualification, as mentioned before: It is important to know how large the percentage is of the coinciding extrema out of all extrema. For all four countries this is 71 per cent and 62 per cent for peaks and troughs respectively. Because of these differences in the percentages, the above-mentioned relations between the mean deviations of the two extrema must be viewed with a caution additional to that required by the small numbers. For the three European countries on the other hand the percentage is both times 100, i.e., all coinciding peaks and troughs exhaust each class of extrema.

Now we turn to the postwar period January 1919–December 1933. Here we have such a short interval of time that the computations are presented more for the sake of completeness rather than to suggest interpretations. Yet there are a few characteristics of these figures which bear mentioning. First of all Table 7 has been drawn up only for the United States, Great Britain, and France, because

TABLE 7

Concentration and Dispersion of Reference Cycle Turning Points, United States, Great Britain, France, March 1919–April 1933
(169 months)

	Average peak[b]	Mean deviation (months)	Average mean deviation (months)	Percentage coinciding
	COINCIDING PEAKS[a]			
Three countries	Apr. 1920	3.11	3.04	75
	Dec. 1926	2.22		
	Sept. 1929	3.78		
	COINCIDING TROUGHS[c]			
	Average trough[b]	Mean deviation (months)	Average mean deviation (months)	Percentage coinciding
Three countries	Apr. 1919	0	2.44[d]	80
	July 1921	1.11		
	Jan. 1928	5.33		
	Oct. 1932	3.33		
	Average mean deviation of coinciding peaks as per cent of corresponding average for troughs			
Three countries	125			

[a] Coinciding peaks: within the range of peaks is no trough.
[b] The arithmetical mean of the coinciding peaks or troughs is computed.
[c] Coinciding troughs: within the range of troughs is no peak.
[d] Excluding 1919, average mean deviation = 3.26.

the rhythm of the German economy—as the country defeated in war—falls so completely outside that of the others that its exclusion was indicated.[14]

The first entry is the average trough of April 1919 with mean deviation zero. This is the only instance where a zero occurs. It was of course the simultaneous beginning of the recovery from the short downturn after the war in the three countries, a downturn, incidentally, which allegedly had begun on the same date—June 1918—in France and Germany, five months before the end of the war. After fairly widely scattered peaks in 1920, the average trough in July 1921 had only a small deviation of 1.11 months.

[14] In subsequent instances no postwar computations could be made at all. It is therefore noteworthy that the reference cycles yield at least as much as they do.

Contrary perhaps to general belief, the average peak of September 1929 had the wide mean deviation of 3.78 months. This is an illustration of the fact that the peak is (internationally) more often than not associated with the collapse of prices on the New York and other stock exchanges, rather than with the turning of general business conditions which occurred earlier (except in France). The former may indeed have had much more to do with the transmissions of adverse influences[15] than the latter.

While the percentages $p/P = 75$ and $t/T = 80$ do not indicate a complete exhaustion of the available peaks and troughs, they are better than for all four countries in the prewar time.

(23) Another approach to the determination of an international reference cycle is by aggregating and cumulating the months of expansion and contraction. Thus for the four countries under study we add for each month the number expanding and substract the number contracting. The net for each month is then cumulated continuously from 1879. When for any month the number of countries expanding exceeds the number contracting, the cumulative aggregate increases; when the number contracting exceeds the number expanding, the cumulative aggregate declines. The peaks and troughs of our composite would be those months when the majority of the series started to decline or stopped declining respectively.[16]

Table 8 compares the peaks and troughs thus determined with our other method, the concentration and dispersion of turning points (Tables 6 and 7). In most instances the two are in close, and even exact, agreement (e.g., for the three European countries, the prewar troughs in June 1879, February 1895, March 1902, December 1908, and August 1914). There are a few significant differences, however. For the four countries, the cumulative method adds one prewar peak (June 1903) and two prewar troughs (August 1886 and March 1902). For the interwar period the peculiarities of the German cycle render comparison difficult, and it is not attempted.

[15] The peaks in European cycles may actually have been caused, or at least precipitated, by the shift of European short-term and long-term capital to the still rising New York Stock Exchange and the abrupt ending of American lending in Europe in 1928.

[16] For a more detailed explanation, cf. "New Facts on Business Cycles," *30th Annual Report*, National Bureau of Economic Research, 1950, pp. 3–37.

TABLE 8

Composite of Reference Cycle Peaks and Troughs, January 1879–January 191[illegible]

PEAKS: FOUR COUNTRIES		TROUGHS: FOUR COUNTRIES	
By cumulation	*By concentration*	*By cumulation*	*By concentration*
March 1882	April 1882	June 1879	May 1879
September 1890	July–August 1890	August 1886	
March 1900	January–February 1900	February 1895	December 1894
June 1903		March 1902	
July 1907	June 1907	November 1904	November 1904
April 1913	March 1913	December 1908	November 1908
		August 1914	September 1914
PEAKS: THREE EUROPEAN COUNTRIES		**TROUGHS: THREE EUROPEAN COUNTRIES**	
By cumulation	*By concentration*	*By cumulation*	*By concentration*
January 1882	April 1882	June 1879	June 1879
September 1890	August 1890	August 1886	November 1886
March 1900	April 1900	February 1895	February 1895
June 1903	June 1903	March 1902	March 1902
July 1907	July 1907	November 1904	December 1904
April 1913	March 1913	December 1908	December 1908
		August 1914	August 1914

Section 4. Alternative Approaches

(24) The question arises whether *indexes of general business activity* as computed for many countries would not serve better than the reference cycles, in view of the fact that besides giving dates of turning points they purport to show rates of change of activity; or, alternatively, whether the variations in national income would give us the needed description.

As to the *first* alternative, the usefulness of such global indexes is now frequently considered to be small.[17] They purport to show more than any single time series can possibly show: the entire business cycle. They are useful for popular visualization but not for expressing the complexities of multiple and interrelated cumulative processes. So at best they serve only as a different means to determine turning points. This is again done by a process of averaging, as in the case of the reference cycles. There is no reason to assume that the averages struck in this way are superior to the others. If there are disagreements between the two they can

[17] They are of a more popular nature in spite of their often complicated statistical appearance, involving the determination of "normal activities" and the like. We are referring to their conceptual structure.

probably be settled by reviewing the technique of reference cycle dating.

(25) As to the *second* alternative, there can be little doubt that the proper use of figures on *national income* would be very fruitful. The obvious difficulty here is of course that no trustworthy monthly figures are available for any significant stretch of time. National income statistics are a recent development; they are usually on a yearly basis which is not very suitable for business cycle analysis in view of the fineness of the variations of most processes under consideration. There is no point in trying to press further in this direction at present, because it must be considered as hopeless to try to take such sets of figures for the long periods which we deem essential for the study of our problem. It is unquestionably more important to try to close important gaps in our basic statistics, e.g., on capital movements, than to use income statistics which for most countries are of extremely doubtful value. In later years, when the present pioneering stage is past, this may be the right starting point. By that time the theoretical analysis, the "income approach," will also have settled down.