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III. AVERAGE WEEKLY HOURS IN MAJOR MANUFACTURING INDUSTRIES

Incidence of Leads and Lags

The general lead of weekly hours in total manufacturing over business cycle turns might theoretically result either from widely varying behavior of hours in different industries or from early turning points in most industries. How widely is the lead of average hours in Manufacturing spread among the constituent industries? Table 13 contains the pertinent measures: summaries of timing incidences for each of our three collections of data. There is also a summary line for the period as a whole, in which, to avoid duplication, the NICB information is used until 1935, and BLS data thereafter. It should be understood that this summary line combines measures derived from three different types of industrial classification.

The evidence indicates that the tendency for hours to lead is widely spread throughout manufacturing industries. Of 224 instances for which turning points of hours in individual manufacturing industries could be matched with turns in general business conditions,[1] 161 (or 72 per cent) showed leads, 46 showed lags and 17 coincided. Each of the three collections of data on which this observation is based showed a clear prevalence of leads, although this prevalence was smallest in the case of the NICB series.

Was there any marked difference between the incidence of leads and lags at peaks and at troughs? The percentages given at the right side of Table 13 show a higher incidence of leads at peaks than at troughs, for the summary as well as for each of the three separate collections.

The lowest panel of Table 13 relates turning points of weekly hours to the corresponding turns of employment in the neighborhood of business cycle peaks and troughs. Among the 197 cases in which hours turns could be matched with turns of employment, there was a lead in hours over

[1] Of 252 theoretical opportunities (business cycle turns times number of industries for which a record of hours was available at these turns), matching was possible in 224 instances, that is, in 89 per cent. The percentage matchable is 86 per cent for peaks and 91 per cent for troughs.

Table 13

Weekly Hours in Manufacturing
Number of Leads, Lags, and Coincidences at Matched Turns, 1920-1956

	PEAKS				TROUGHS			
	Leads	*Coincidences*	*Lags*	*Total*	*Leads*	*Coincidences*	*Lags*	*Total*
				Hours Relative to Business Cycles				
(A) 20 NICB series, 1920-41	43	3	20	66	57	14	18	89
(B) 20 NICB series, 1920-35	25	3	18	46	41	11	17	69
(C) 14 BLS series, 1935-41	13	1	0	14	11	2	1	14
(D) 21 BLS series, 1947-56	40	0	0	40	31	0	10	41
Total of (B), (C), and (D)	78	4	18	100	83	13	28	124
				Employment Relative to Business Cycles				
(A) 20 NICB series, 1920-41	19	5	41	65	33	16	37	86
(B) 20 NICB series, 1920-35	16	4	27	47	29	13	25	67
(C) 14 BLS series, 1935-41	3	2	9	14	1	6	6	13
(D) 21 BLS series, 1947-56	27	7	2	36	17	2	19	38
Total of (B), (C), and (D)	46	13	38	97	47	21	50	118
				Hours Relative to Employment[a]				
(A) 20 NICB series, 1920-41	46	4	9	59	55	12	11	78
(B) 20 NICB series, 1920-35	30	2	9	41	39	10	10	59
(C) 14 BLS series, 1935-41	12	1	1	14	12	1	0	13
(D) 21 BLS series, 1947-56	23	2	8	33	32	2	3	37
Total of (B), (C), and (D)	65	5	18	88	83	13	13	109

Table 13 (Continued)

	Peaks and Troughs				Leads in Per Cent of Total		
	Leads	*Coinci-dences*	*Lags*	*Total*	*Peaks %*	*Troughs %*	*Peaks & Troughs %*
				Hours Relative to Business Cycles			
(A) 20 NICB series, 1920-41	100	17	38	155	65	64	65
(B) 20 NICB series, 1920-35	66	14	35	115	54	59	57
(C) 14 BLS series, 1935-41	24	3	1	28	93	79	86
(D) 21 BLS series, 1947-56	71	0	10	81	100	76	88
Total of (B), (C), and (D)	161	17	46	224	78	67	72
				Employment Relative to Business Cycles			
(A) 20 NICB series, 1920-41	52	21	78	151	29	38	34
(B) 20 NICB series, 1920-35	45	17	52	114	34	43	39
(C) 14 BLS series, 1935-41	4	8	15	27	21	77	15
(D) 21 BLS series, 1947-56	44	9	21	74	75	45	59
Total of (B), (C), and (D)	93	34	88	215	47	40	43
				Hours Relative to Employment[a]			
(A) 20 NICB series, 1920-41	101	16	20	137	78	71	74
(B) 20 NICB series, 1920-35	69	12	19	100	73	66	69
(C) 14 BLS series, 1935-41	24	2	1	27	86	92	89
(D) 21 BLS series, 1947-56	55	4	11	70	70	86	79
Total of (B), (C), and (D)	148	18	31	197	74	76	75

[a] Only at turns which can also be matched with business cycle turns. The findings, in particular the percentages of leads reported in the last three columns, change but little if specific turns are included that cannot thus be matched.

For a description of the basic data and for a list of the industries included, see Appendix and Table 14.

Table 14
Weekly Hours in Manufacturing Industries
Number of Leads, Lags, and Coincidences, and Average Timing
(a) NICB, 1921-1941

Industries	Timing Relative to Business Cycles: Number of Leads	Number of Coincidences	Number of Lags	Average Timing (months)	Timing Relative to Employment: Number of Leads	Number of Coincidences	Number of Lags	Average Timing (months)
Durable Goods								
Lumber and millwork	6	1		− 6.3	6	1		− 7.0
Furniture	5	2	2	− 2.2	4	1	2	− 2.3
Iron and steel	5	2	2	− 2.6	7	1	1	− 3.7
Foundries and machine shops	5	1	3	− 0.7	6	1	2	− 3.3
Agricultural implements	5	1	3	− 2.7	5	1	1	− 2.4
Electrical equipment	6	1	2	− 4.0	9			− 4.0
Automobiles	9			− 6.3	7		2	− 4.9
Total or average[a]	41	8	12	− 3.4	44	5	8	− 3.9
Nondurable Goods								
Meat packing	4	1	2	− 1.3	4		1	− 3.2
Silk and rayon	6	1	2	− 5.3	6	1	1	− 4.4
Wool	5	1	3	− 1.3	6	3		− 1.4
Hosiery and knit goods	1		4	− 0.8	2	1	1	− 0.2
Boots and shoes	3	1	1	+ 0.2	1	2	1	+ 5.2
Paper and pulp	5	1	2	− 1.5	4	2	2	− 1.5
Paper products	4		1	− 3.8	4	1		− 5.0
Printing, book and job	6		1	− 3.3	5			− 5.6
Printing, news and magazine	3		4	+ 5.7	3		1	− 1.8
Chemicals	6	1	2	− 2.9	5	1	1	− 0.4
Paint and varnish	4	1	2	− 3.0	4		3	− 0.9
Rubber	6	1		− 6.1	7			− 5.0
Leather tanning and finishing	6	1	2	− 4.6	6		1	− 3.0
Total or average[a]	59	9	26	− 2.3	57	11	12	− 2.3
All Industries								
Total or average[a]	100	17	38	− 2.8	101	16	20	− 3.0

Table 14 (Continued)
(b) BLS, 1935-1941

Industries	Timing Relative to Business Cycles: Number of Leads	Number of Coincidences	Number of Lags	Average Timing (months)	Timing Relative to Employment: Number of Leads	Number of Coincidences	Number of Lags	Average Timing (months)
Durable Goods								
Iron & steel products, excluding machinery	2			− 5.5	2			− 7.5
Lumber and allied products	2			− 1.5	2			− 2.5
Stone, clay and glass	2			− 3.0	1	1		− 2.5
Nonferrous metals & their products	2			− 1.5	2			− 2.5
Machinery—not including transportation	1	1		− 1.0	2			− 3.0
Transportation equipment	2			− 7.0	2			− 9.5
Total or average[a]	11	1		− 3.2	11	1		− 4.6
Nondurable Goods								
Food and kindred products	2			− 4.5	2			− 7.5
Tobacco manufactures	1		1	+ 3.5	0		1	+ 5.0
Textiles & their products "fabrics"	2			− 5.0	2			− 4.5
Textiles and their products "wearing apparel"	2			− 5.5	2			− 3.5
Paper and printing	1	1		− 2.5	1	1		− 3.0
Chemical, petroleum and coal products	2			− 1.5	2			− 3.5
Rubber products	2			− 7.5	2			− 8.0
Leather and its manufactures	1	1		− 3.0	2			− 3.5
Total or average[a]	13	2	1	− 3.2	13	1	1	− 4.1
All Industries								
Total or average[a]	24	3	1	− 3.2	24	2	1	− 4.3

Table 14 (Continued)
(c) BLS, 1947-1956

Industries	Timing Relative to Business Cycles: Number of Leads	Coincidences	Lags	Average Timing (months)	Timing Relative to Employment: Number of Leads	Coincidences	Lags	Average Timing (months)
Durable Goods								
Ordnance and accessories	3		1	− 6.8	3			−10.7
Lumber and wood products	4			− 8.2	1		2	+ 1.0
Furniture and fixtures	4			− 8.0	4			− 4.0
Stone and clay and glass prod.	3			− 6.3	3			− 6.3
Primary metal industries	3		1	− 2.2	3		1	− 2.5
Fabricated metal products	4			− 7.0	3			− 6.3
Machinery, except electrical	2		2	− 2.8	2	1	1	− 0.8
Electrical machinery	4			− 6.8	3		1	+ 0.8
Transportation equipment	4			− 9.8	3		1	− 5.5
Instruments and related prod.	3		1	− 2.8	3			− 5.7
Miscellaneous mfg. industries	4			− 6.2	4			− 6.0
Total or average[a]	38		5	− 6.1	32	1	6	− 4.2
Nondurable Goods								
Food and kindred products	2		1	− 9.0	1		1	+ 2.0
Tobacco manufacturing	4			− 6.8				
Textile—mill products	4			− 4.8	2		2	+ 1.2
Apparel and other finished textiles	4			− 6.8	4			− 2.5
Paper and allied products	4			− 5.2	4			− 5.0
Printing, publishing and allied industries	1		2	+ 1.0	1			− 2.0
Chemicals and allied products	3		1	− 5.2	1	2	1	0
Products of petroleum and coal	3		1	− 3.0	3		1	− 4.0
Rubber products	4			− 9.8	3	1		− 3.8
Leather and leather products	4			−11.8	4			− 7.0
Total or average[a]	33		5	− 6.2	23	3	5	− 2.6
All Industries								
Total or average[a]	71		10	− 6.1	55	4	11	− 3.4

[a] The average timing is derived from the basic observations, not from the industry averages given in this table.

employment in 75 per cent of the turns, with practically no difference in the incidence at peaks and at troughs.

Is the incidence of leads and lags spread fairly evenly over all industries, or are the lags concentrated in a few industries that characteristically deviate from the "norm?" According to the industry averages presented in Table 14, there are few industries in which the incidence of lags is larger than that of leads. The NICB data show a predominance of lags in hosiery and in news printing; the postwar BLS data in printing and publishing. No industry shows a predominance of lags when turns in hours are compared with those of employment. The lead of hours over business cycle turns and over employment can, for practical purposes, be regarded as a characteristic of each manufacturing industry.

Average Length of Leads and Lags

For the 224 matched turns in the combined sample described by Table 15,[2] the turning points of hours occurred, on the average, four months before those in general business conditions. This is the same lead as that found in the aggregate measure of hours in All Manufacturing. In the tables in this study, timing measures are computed not only as averages of all leads, lags and coincidences, but also separately for all leads and for all lags. The separate measures may have some bearing on the use of hours data for indicator purposes. If the leads and the lags are measured separately, the average of all leads amounts to six and one-half months, the average of all lags, to four months.

Generally, the lead of hours is longer at peaks than at troughs. For 100 matched peaks, the average lead was about five months; for 124 troughs the average lead was only about three months.[3] The more pronounced lead of turns at peaks is found in all three collections of data, although the difference between the average lead at peaks and at troughs varies. The longer lead of hours at peaks than at troughs can also be established cycle by cycle. In our data there are six opportunities to compare the timing of hours at peaks with that at subsequent troughs. In five of these six instances, the average lead for all industries at peaks is

[2] If no statement to the contrary is made, the averages given in the summary tables of this paper are weighted by incidence. In the present table, for instance, timing measures given in each of the lines (A), (B), (C), (D) are derived from individual industry turning points, not from average leads per cycle or per industry. The averages of (B), (C), and (D), presented in the summary line, are similarly derived.

[3] These measures are the results of averaging all timing comparisons — leads, coincidences, and lags.

Table 15

Weekly Hours in Manufacturing, Average Timing at Matched Turns, 1920-1956

Lead (−), Lag (+), or Coincidence (0), at Business Cycle Turns, in Months

	PEAKS			TROUGHS			PEAKS AND TROUGHS		
	Leads	*Lags*	*All*[a]	*Leads*	*Lags*	*All*[a]	*Leads*	*Lags*	*All*[a]
				Hours Relative to Business Cycles					
(A) 20 NICB series, 1920-41	−6.3	+2.8	−3.2	−5.9	+ 6.7	−2.4	−6.0	+4.7	−2.8
(B) 20 NICB series, 1920-35	−8.0	+2.9	−3.2	−6.6	+ 7.1	−2.2	−7.1	+4.9	−2.6
(C) 14 BLS series, 1935-41	−4.2	—	−3.9	−4.1	+ 8.0	−2.6	−4.1	+8.0	−3.2
(D) 21 BLS series, 1947-56	−8.2	—	−8.2	−6.1	+ 1.9	−4.2	−7.3	+1.9	−6.1
Averages of (B), (C), and (D)	−7.5	+2.9	−5.3	−6.1	+ 5.2	−2.9	−6.7	+4.3	−4.0
				Employment Relative to Business Cycles					
(A) 20 NICB series, 1920-41	−4.8	+3.1	+0.6	−5.4	+ 4.1	−0.3	−5.2	+3.6	+0.1
(B) 20 NICB series, 1920-35	−5.4	+3.5	+0.2	−5.8	+ 3.6	−1.2	−5.6	+3.5	−0.6
(C) 14 BLS series, 1935-41	−3.7	+2.2	+0.6	−1.0	+ 1.7	+0.7	−3.0	+2.0	+0.7
(D) 21 BLS series, 1947-56	−8.5	+3.5	−6.2	−2.9	+ 2.9	+0.2	−6.3	+3.0	−2.9
Averages of (B), (C), and (D)	−7.1	+3.2	−2.1	−4.7	+ 3.1	−0.5	−5.9	+3.1	−1.3
				Hours Relative to Employment[b]					
(A) 20 NICB series, 1920-41	−5.7	+3.3	−3.9	−5.2	+10.2	−2.2	−5.4	+7.1	−3.0
(B) 20 NICB series, 1920-35	−5.6	+3.3	−3.4	−4.3	+11.0	−0.9	−4.9	+7.4	−2.0
(C) 14 BLS series, 1935-41	−5.7	+5.0	−4.5	−4.5	—	−4.2	−5.1	+5.0	−4.3
(D) 21 BLS series, 1947-56	−5.0	+5.0	−2.2	−5.2	+ 2.3	−4.4	−5.2	+4.3	−3.4
Averages of (B), (C), and (D)	−5.4	+4.2	−3.1	−4.7	+ 9.0	−2.5	−5.0	+6.2	−2.8

[a] This column measures the average timing of all leads, lags, and coincidences.

[b] Hours are related to employment only for turns which can be matched with business cycle turns. Inclusion of other corresponding turns in hours and employment would change the averages but little.

For a description of the basic data and for a list of the industries included, see Appendix and Table 14.

larger. There are five opportunities to compare the timing at peaks with that at immediately preceding troughs. In this case, leads at peaks are larger in three instances. (See Table 20 for the timing measures used.) The exceptions to the hypothesis all occur during the interwar period. The incidence of longer leads at peaks can also be analyzed industry by industry, in each of the three samples. In the prewar samples, longer average leads at peaks occurred in only about half the industries; in the postwar BLS sample, 17 of 21 industries showed longer average leads at peaks than at troughs. Thus the thesis of "longer leads at peaks" is well supported by the postwar evidence, but not by previous experience.

Inferences from quantitative information gain strength from theoretical plausibility. Explanations for longer average leads at peaks may lie in attempts by management to cut overtime pay at the earliest possible moment. The reduction of overtime is preferable to lay-offs because it does not involve disorganization of the work force and permits fast readjustments if demand picks up again. These considerations are less forceful at troughs. Here penalty payments for overtime work are at a minimum—and, wherever they may exist, delay rather than advance the upturn of hours. Also the consideration of keeping the work force together does not apply. One could ask why, under these circumstances, average hours lead at all at troughs. First of all, technologically, labor input changes must generally precede output changes. Furthermore, an upward adjustment of average hours has some advantages over hiring new labor whenever the average hours of the regular workforce are low, and when it is still doubtful whether additions to the force can be made on a fairly permanent basis. Under these circumstances, employers will attempt to minimize the costs of breaking in new workers. The fact that hiring rates do lead average hours at troughs does not affect the validity of the explanation for the lead of hours at troughs—quite apart from the fact that these rates do not lead the diffusion index of hours.

To what extent do both the average and differential timing behavior of hours reflect characteristics of particular industries? In other words do hours lead more at peaks than at troughs, more in one industry than in another and so forth, because of the output and employment behavior in the respective industries? In order to get at this question, we systematically compare the turning points of hours not only with those in business conditions at large but also with related employment turns in a specific industry. Timing for employment is given in the second panel, and timing of hours related to employment in the third panel of the tables.[4]

The industry detail summarized in Table 15 shows employment, on the average, leading business cycle turns by one month, and hours leading employment by another three months. Thus, on the average, the lead of hours is reduced when related to industry-specific employment turns rather than to business cycle dates. What about the difference of timing measures at peaks and at troughs? The last line of the second panel of the table shows that employment leads at peaks by two months while it coincides at troughs. Consequently, in the average timing of hours vs. employment, given in the last line of the third panel, the difference between peaks and troughs is sharply cut.

Closer inspection of Table 15 shows that employment sometimes leads and sometimes lags business cycle turns. It follows that leads in hours are not consistently reduced, if hours turns are measured against employment rather than against business cycle turns. The sharp cut of the difference between leads at peaks and troughs is largely, though not entirely, the result of the occasional atypical behavior of employment, which, for instance, at the 1948 business cycle peak leads by nine months.[5] On the basis of the currently available statistical evidence, a longer lead of hours at peaks than at troughs may be suspected but cannot be definitely established.

Let us glance at the evidence, industry by industry, as presented in Table 14. Almost all averages for weekly hours in specific industries lead business cycle turns. The few lags are due to special circumstances. Thus the average for boots and shoes, in the NICB sample, is dominated by one long lag (at the March 1933 turn); this is true also for tobacco products, in the BLS sample, at the 1938 trough. Only in the case of printing—an activity perhaps somewhat apart from typical manufacturing industries—does the high incidence and the length of the average lag suggest the possibility of systematic causes for the deviant behavior. If turns in hours are compared with those of employment, average lags are converted into leads (NICB news printing, and BLS printing, postwar), lags are increased (NICB boots and shoes, BLS tobacco 1935-41), or new lags are introduced (BLS postwar data). Where lags were introduced by this

[4]The second panel of the tables summarizes all employment turns that can be matched to business cycle turning points, whether comparable hours turns exist or not. The third panel measures those hours turns which can be matched with both business cycle and employment turns.

[5]Exclusion of this turn would restore the difference in timing, between peaks and troughs, to 1 month.

comparison, they were usually very small—one or two months. Where lags were increased, this was usually the result of a single observation. We have found no manufacturing industry in which hours turns systematically lag behind those of employment.

Dispersion of Turning Points

The high incidence of leads and the existence of a substantial average lead of hours over business cycle turns, in each of the three samples, should not obscure the marked lack of uniformity in timing of cyclical turns in hours. The longest lead in the 264 cases of matched turns in all three samples was 21 months, the longest lag 24 months. And this range

Table 16

Weekly Hours in Manufacturing, 1920-1956

Average Dispersion of Industry Turns, in Months

	Peaks	*Troughs*	*Peaks and Troughs*
		Hours	
20 NICB series, 1920-41	4.3	4.0	4.2
20 NICB series, 1920-35	4.9	4.4	4.6
14 BLS series, 1935-41	2.9	2.6	2.8
21 BLS series, 1947-56	4.1	3.5	3.8
		Employment	
20 NICB series, 1920-41	2.4	3.7	3.0
20 NICB series, 1920-35	2.7	3.7	3.2
14 BLS series, 1935-41	2.0	0.9	1.4
21 BLS series, 1947-56	5.5	2.8	4.2
		Hours Relative to Employment	
20 NICB series, 1920-41	4.0	4.7	4.4
20 NICB series, 1920-35	4.4	4.7	4.6
14 BLS series, 1935-41	3.6	2.0	2.8
21 BLS series, 1947-56	4.1	3.0	3.6

The measures presented above are the result of successive unweighted averaging. The average deviations, of industry turns from their average at each business cycle turn, were combined without regard to differences of incidence (number of industries registering turns). Similarly, the measures for "peaks and troughs" are unweighted averages of those for the 14 upper and lower turns. (For average deviations at each turn, see Table 20.)

For a description of the basic data and for a list of the industries included, see Appendix and Table 14.

is limited by our decision to include only turns which we considered to be "corresponding" to business cycle reversals. The range is, of course, in any case a highly unstable measure of the dispersion of turns and should be supplemented by others, less dependent on single, possibly erratic, values. We therefore computed the average deviations of turns from their average lead, obtaining the results summarized in Table 16.

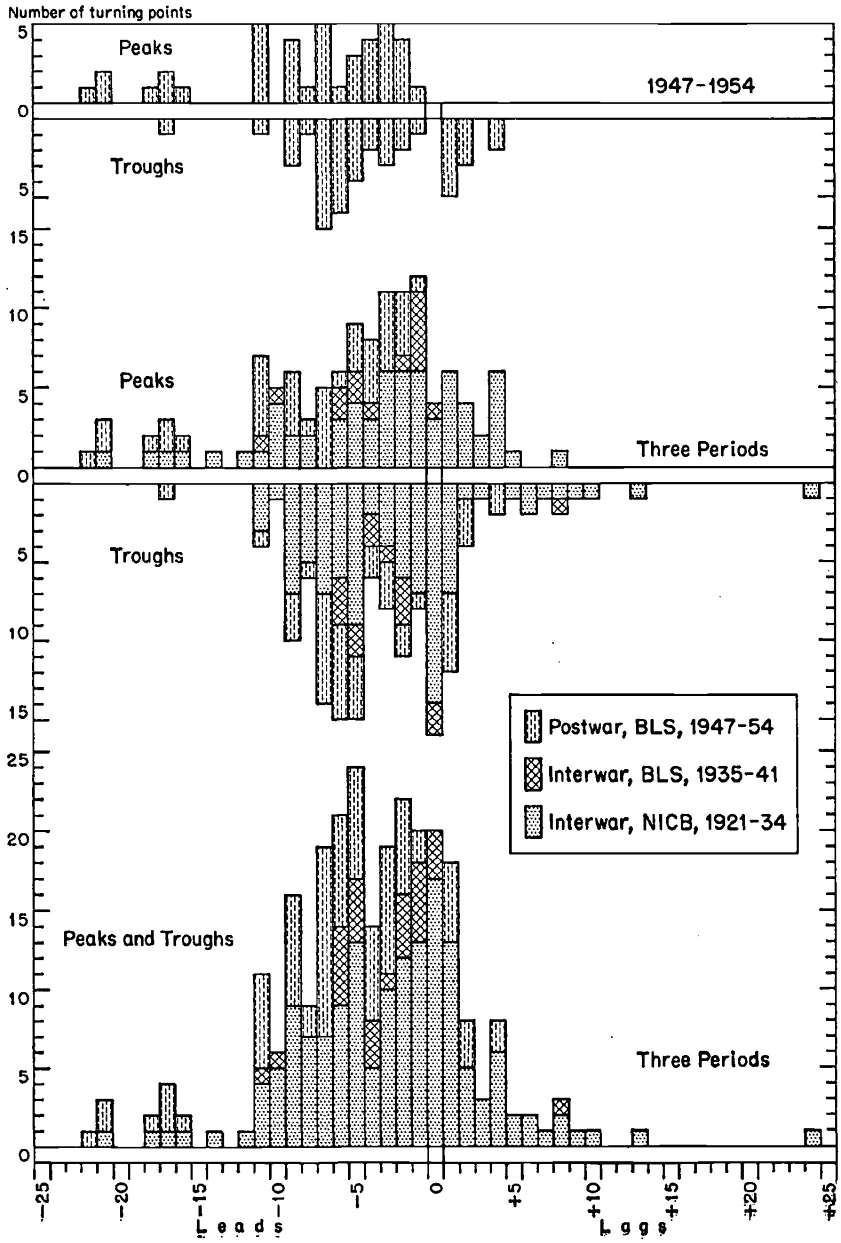
The average deviation for all turning points was about four months—for the brief period covered by the BLS sample during the interwar period, only about three months. The average deviations for the NICB and the postwar BLS sample were similar. There was no tendency for turning points to be clustered more closely at business cycle troughs than at peaks. However, an average dispersion of four months around the longer leads, which are experienced at peaks, has a significance differing from that of the same dispersion around the shorter lead that obtains at troughs. A coefficient of average deviation, relating the dispersion to the average lead, would be smaller for peaks than for troughs—suggesting that the phenomena of leads can be established with greater confidence at peaks than at troughs. Still an average deviation of four months around the average lead of three also establishes the lead at troughs as a phenomenon that recurs with fair consistency.

Table16 also contains average deviations of hours turns from their mean lead over employment. The raw material for this dispersion measure consists of the timing of hours relative to employment in a specific industry for each cyclical turn. On general grounds it might be expected that the timing of hours with respect to corresponding employment turns shows a smaller dispersion than the timing at business cycles dates. In fact, the dispersion is virtually the same in both cases, that is, four months. Changing coverage may explain why the data do not bear out our expectations—not all hours turns related to business cycles could be matched with corresponding employment turns.

The dispersion measures cited provide only limited information on the pattern of the distribution. Are these patterns fairly normal or are they skewed—and if so, in what way? This is a question bearing on the mechanics of cyclical reversals. On general grounds, it might be expected that at peaks the distribution is skewed to the left. A slow cumulation of business reversals may reach a critical point at which business confidence falters over a wide range of industries and leads to closely timed (and perhaps sharp) contractions of labor input. No analogous hypothesis is available for troughs. Thus we might expect characteristic differences of turning point distribution at peaks and troughs. The following tabulation shows indeed some indication of the expected difference. In all four sam-

Chart 12

**Average Weekly Hours in Manufacturing
Frequency Distributions of Industry Turning Points,
Relative to Business Cycle Turns
1921-1954**



ples, at peaks the mean lead is longer than the median lead (indicating skewness), while no similar uniformity can be discerned at troughs.

Weekly Hours in Manufacturing
Average Timing at Peaks and Troughs
(medians and means)

	Peaks		*Troughs*	
	Med.	*Mean*	*Med.*	*Mean*
20 NICB series, 1920-41	−2.1	−3.2	−2.5	−2.4
20 NICB series, 1920-35	−1.3	−3.2	−2.0	−2.2
14 BLS series, 1935-41	−3.0	−3.9	−3.5	−2.6
21 BLS series, 1947-56	−7.0	−8.2	−5.2	−4.2

However, this tendency toward skewness is mild. Chart 12 shows frequency distributions, separately for peaks, troughs and all turning points. The distribution of peaks exhibits the expected asymmetrical contour. The distribution of troughs is fairly symmetrical, but shows pronounced bimodality. The distribution of all turning points combines, of course, the features of the peak and trough contours.

Could dispersion measures be used as standards for testing the significance of the observed leads, and perhaps also the significance of the difference between the timing behavior observed at peaks as compared to troughs? We computed standard errors of the means for the timing measures at peaks, at troughs and at all turns—based on individual turns of hours in each industry. Against these standards, based on 224 observations, the leads appeared uniformly significant at the 99 per cent probability level. The difference between the leads at peaks and troughs was about three times the standard error of the mean for the postwar period, but a little smaller than the standard error for the interwar data. While the nonsignificance of the difference during the interwar period may be accepted with confidence, the affirmative findings cannot. The reason is a bias in favor of "significance," inherent in the approach. If it is true that the timing measures for individual industries at each turn are highly correlated, the treatment of each industry turn as an independent observation creates a spuriously low standard error and thus enhances the chance of finding significant differences.

A test which avoids this danger would treat the average timing (of all industries) at each turning point as a single observation. This reduces the total number of observations to "small-sample size." Significance tests based on these summary data (such as given in Table 20) show the following: Both at peaks and troughs, the average leads exceed three times the standard error of the overall mean and are thus to be regarded as significant at the 99 per cent probability level. The difference between the leads at peaks and at troughs—2.5 months—amounts to only 1.8

times the standard error for this measure. Thus the significance of the difference must remain in doubt—at least until further observations become available.

Similar computations were made for leads of hours over corresponding employment turns. Again, the significance of leads at peaks and at troughs can be regarded as established against the 99 per cent probability standard but the difference between leads at peaks and troughs cannot be thus verified.[6]

Persistence of Sequence, by Industry

Are there industries which typically show early reactions of weekly hours to changes in business climate, and others that are comparative laggards? That is to say, is there any semblance of order in the sequence in which average weekly hours in various industries experience cyclical turns? The existence of such sequence would clarify the role of specific industries or industry groups (such as durable producers' goods, or consumers' luxury items) in the cyclical adustment process. And from a more practical point of view, the existence of definite industrial sequences would enhance the forecasting value of average hours. With hours established as a leading economic variable, an index, and particularly a diffusion index, of hours in characteristically "leading industries" would give even earlier indication of changing business conditions than an index based on hours in all major industries.

On the whole, the evidence shows no consistent sequence of cyclical turns, by industry. As an illustration we present Table 17, giving the average rank, based on sequence of turns, for ten industries for which measures could be computed at each of four interwar cyclical peaks. As would be expected, average rank (based on sequence) is highly correlated with the number of leads and with average lead in the same industries. However, the consistency of sequence—in which we are most interested at this point—is rather low. It is true that Automobiles were first or tied

[6] The significance tests used were designed for normal distributions. Their applicability to the distribution of cyclical turning measures of the average workweek could be questioned. However, the distribution of the data used does not show strong nonnormal characteristics which would suggest the need for nonparametric tests. Moreover, the doubts about the significance of the difference between leads at peaks and at troughs stem more from the dearth of information (the smallness of the sample of turning points) than from the characteristics of any particular test. Inclusion of the recent 1957-1958 contraction — with its long lead of hours at the peak and the considerably shorter lead at the trough — would add to the evidence supporting the thesis that hours tend to lead business cycle turns and employment by longer intervals at peaks than at troughs.

Table 17

Weekly Hours in Manufacturing, Sequence of Industry Turning Points at Four Business Cycle Peaks, 1921-1941

Industries[a]	RANK OF INDUSTRY AT EACH PEAK[b]				Av. Rank 4 Peaks	No. of Leads	Average Timing[c] (months)
	May '23	*Oct. '26*	*June '29*	*May '37*			
Automobiles	1.5	7	1	1	2.6	4	− 9.5
Electrical machinery	1.5	5	3	2.5	3.0	4	− 6.0
Furniture	4	8	5.5	2.5	5.0	2	− 4.5
Silk and rayon	5.5	2	9	4	5.1	2	−10.5
Chemicals	8	3	3	7	5.3	3	− 9.5
Leather tanning	5.5	1	9	7	5.6	2	−11.5
Iron and steel	8	5	5.5	7	6.4	2	− 6.0
Agricultural implements	8	5	3	10	6.5	2	− 6.5
Wool	3	10	7	7	6.8	2	− 1.5
Foundries & machine shops	10	9	9	7	8.8	2	− 1.5

[a] NICB series having matchable specific turns at each of the four reference peaks.

[b] Industry turning first obtains rank 1. Industries listed in order of average rank at the four peaks.

[c] Average timing covers all leads (−), coincidences (0), and lags (+).

for first rank in three of four cases; that Electrical Machinery tended to turn early; and that Foundries and Machine Shops had consistently low ranks. But this exhausts the number of clear-cut cases. In most other industries we find early and late turns fairly well mixed.[7] A formal coefficient of concordance was computed as W=.35. This indicates low concordance. The appropriate test, moreover, shows the concordance to be statistically insignificant, judged against a 90 per cent probability level.[8]

There is a similar pattern at troughs. The formal coefficient equals only .17 and turns out to be insignificant also. Foundries and Machine Shops which turned (on the average) last at peaks, occupy the same position at troughs; and Automobiles react fairly early at both upper and lower turns. Electrical Manufactures, on the other hand, behave differently at peaks and troughs. For analytical and prediction purposes, the important observation is that no industry can be designated as consistently leading the others.

The above discussion was based on the NICB data for the interwar period. The following tabulation supplements these correlation measures by others derived from the two BLS collections:

Consistency of Sequence of Turns, Weekly Hours Related to Business Cycles, by Industry

RANK CORRELATION COEFFICIENTS

	Peaks	*Troughs*	*Peaks and Troughs*
(a) NICB series, 1921-41	0.35	0.17	0.20
(b) BLS series, 1935-41	—	—	+0.14
(c) BLS series, 1947-56	+0.03	+0.44	0.40

Note: The measures given in line (a) and the last measure in line (c) are coefficients of concordance, based on more than two rows of ranks. The measure in line (b) relates the industry ranks at the 1937 peak with those at the 1938 trough, by simple rank correlation. The same simple measure is also used to correlate the ranks (relating to two peaks or two troughs) on which the first two entries of line (c) are based.

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[7] The lack of consistency in the sequence of industry turning points does not, of course, preclude analysis of this sequence in individual cycles. The particularly late turn of hours worked in Automobile production or the very early turn of hours in Leather Tanning, at the 1926 peak, might well be an important characteristic of that peak.

[8] The coefficient of concordance is a measure of the correlation between the ranks of more than two variables, such as height, weight, and volume of individual bodies. In our case we summarize the rank of timing measures, for each industry, at a series of business cycle turns. The coefficient is based on deviations of the actual ranks from the theoretical condition of complete equality of ranks. The coefficient varies between W = 0 and W = 1, with increasing similarity in ranks. W has no sign. The measure is described in Maurice G. Kendall, *Rank Correlation Methods*, London, Hafner Publishing Company, 1955, Chapter 6. The same chapter also presents significance tests for the coefficient of concordance.

Table 18

Weekly Hours in Manufacturing, Sequence of Industries Based on Timing Relative to Employment, at Four Business Cycle Peaks, 1921-1941

Industries[a]	RANK OF INDUSTRY AT EACH PEAK[b]				*Av. Rank 4 Peaks*	*No. of Leads*	*Average Timing*[c] *(months)*
	May '23	*Oct. '26*	*June '29*	*May '37*			
Automobiles	1	4	1	1	1.8	3	−12.0
Electrical equipment	2	3	2	2	2.2	4	− 5.2
Iron and steel	4	1	3.5	3	2.9	4	− 4.0
Wool	3	2	3.5	5	3.4	4	− 1.8
Foundries & machine shops	5	5	5	4	4.8	1	− 4.0

[a] NICB series having matchable specific turns at each of the four business cycle peaks.

[b] Industry with longest lead of hours over employment obtains rank 1. Industries are listed in order of average rank at the four peaks.

[c] Average timing covers all leads (−), coincidences (0), and lags (+).

The measures indicate positive correlation of a generally low order. And the numerical coefficients differ between peaks and troughs, but not in a systematic fashion. The conclusion must be that there exists only a low degree of regularity in the timing sequence of hours, by industry.

A related question concerns the consistency of turns in hours, measured against the corresponding cyclical turns in employment. According to Table 18, there is a fairly high consistency of rank for industries for which we have data over the interwar period. It must be remembered, however, that Automobiles as well as Foundries and Machine Shops—industries with rather stable ranks—showed consistently extreme ranks in Table 17 also, but here constitute 40 per cent of the evidence. For the three samples, the rank correlation coefficients are:

Consistency of Sequence of Turns, Weekly Hours Related to Employment, by Industry
RANK CORRELATION COEFFICIENTS

	Peaks	*Troughs*	*Peaks and Troughs*
(a) NICB series, 1921-41	0.53	0.22	0.08
(b) BLS series, 1935-41	–	–	+0.13
(c) BLS series, 1947-56	+0.36	+0.31	0.39

See note to preceding tabulation.

The conclusion must be similar: there is little consistency in the ranking of individual industries with regard to the timing of hours versus employment. The low coefficient for "peaks and troughs" in the NICB series, in spite of the much higher one for peaks and for troughs separately, is obviously the result of a lack of correlation between sequences at peaks and at troughs.[9]

The previous measures of persistency of sequence over various cycles do not answer the question to what extent the sequences of hours and of employment turns are related at any given business cycle date—regardless of the perpetuation of the same sequence from turn to turn. The direct

[9] We have also investigated whether the timing of turns in hours in the group of durables deviates from that in nondurables. At the five turning points for which such comparisons were possible, nondurables turned earlier than durables in four instances. But the same applies also to the comparable employment series. Measured against employment the leads of weekly hours in nondurables exceeded those in durables in only one out of five cases. We do not think that, at present, the available data can support any generalizations on the differential timing behavior of hours in durables and nondurables. Note, in this context, that also the cyclical timing of profits fails to show consistent differences between the two groups as has been demonstrated by Thor Hultgren in *Cyclical Diversities in the Fortunes of Industrial Corporations,* National Bureau of Economic Research, Occasional Paper 32, 1950, p. 17.

correlation between sequences in hours and in employment reversals is important in our search for possible determinants of the industry sequence of hours at given turns. The simple rank correlations for matchable hours and employment turns are summarized below. The tabulation shows, on the average, a positive correlation between the sequence of turns in hours and in corresponding employment series. Although the averages of the correlation coefficients for individual turns are only +.25 for peaks and +.43 for troughs, the prevalence of a positive association between hours and employment turns is clear. Note that the few inverse coefficients are low—in fact lower than any of the positive coefficients.

Rank Correlation of Turns in Average Weekly Hours and Employment

Peaks			*Troughs*		
Date	*No. of Industries*	*Coefficient r*	*Date*	*No. of Industries*	*Coefficient r*
May 1923	13	−0.27	July 1921	17	+0.80
Oct. 1926	11	+0.41	July 1924	14	+0.68
June 1929	17	+0.76	Nov. 1927	10	−0.08
May 1937	14	−0.16	Mar. 1933	20	+0.29
Nov. 1948	15	+0.79	June 1938	13	+0.30
July 1953	19	−0.02	Oct. 1949	20	+0.34
			Aug. 1954	16	+0.66
Average		+0.25	Average		+0.43

Source: 1923-35 based on NICB data; thereafter on BLS data.

In seeking factors that might influence cyclical changes in average weekly hours, we gave some consideration to new orders. New orders were found, on an aggregative basis, to be a "leading" activity which might contribute to the re-evaluation of business prospects and therefore to reversals of labor input trends. Does the differential behavior of average hours and new orders in different industries support the hypothesis of close interrelation between these variables? We have only limited experience upon which to base an answer to this question. Table 19 contains evidence covering seven industries over four turning points. For these cycles and industries covered, the average lead is about six months—the same for both activities. If new orders are adjusted for price changes, their cyclical turns are occasionally advanced. This, however, would not significantly affect our findings on the average relation between turns in new orders and in average weekly hours. Do new orders turn particularly early in the same industries in which hours show long leads? The rank correlation coefficient for the average ranks at four turns[10] amounts to +.7; it is posi-

[10] This correlation is based on industry averages for the four turning points. The industry averages include only timing measures for turns at which hours and new orders could be matched.

Table 19

Weekly Hours and New Orders in Seven Manufacturing Industries, 1947-1956

Lead (−), Lag (+), or Coincidence (0) at Business Cycle Turns, in Months

Industries[a]		*P* *Nov. '48*	*T* *Oct. '49*	*P* *July '53*	*T* *Aug. '54*	*All* *Turns*[b]
Machinery, excl. Electrical	Hours	−11	+1	−3	+2	−2.8
	Orders	−5	+1	−3	−7	−3.5
Electrical Machinery	Hours	−11	−6	−3	−7	−6.8
	Orders	−4	−6	−3	−9	−5.5
Primary Metals	Hours	−1	+1	−4	−5	−2.2
	Orders	0	−3	−1	−7	−2.8
Fabricated Metal Products	Hours	(−11)	−6	−7	−4	−5.7
	Orders	(—)	−5	−4	−7	−5.3
Transportation Equipment	Hours	(−11)	(−17)	−9	−2	−5.5
	Orders	(—)	(—)	−7	−12	−9.5
Paper and Allied Products	Hours	−6	−5	−3	−7	−5.2
	Orders	−9	−3	−3	−7	−5.5
Leather and Products	Hours	−18	−9	−9	−11	−11.8
	Orders	−13	−3	−8	−6	−7.5
Average						
Hours						−5.7
Orders						−5.7

[a] Industries are those two-digit classifications for which BLS data on Hours and Department of Commerce data on New Orders could be matched.

[b] Averages include only paired measures for Hours and New Orders; timing measures in parentheses are excluded.

tive (between +.6 and +.8) at three turns, and negative but relatively low (−.4) at the remaining one of August 1954. That is, there exists positive correlation between sequence of new order turns and turns in average weekly hours.

What does the evidence on sequence of turning points add up to? We find little consistency of sequence, by industry, from cycle to cycle. We find that the sequence in turning points of average weekly hours in different industries is correlated with that in employment and in new orders, but that the correlation is of a relatively low order. Since the industries do not behave consistently in their timing, economic analysts will have to use approaches which do not depend on such consistency. They may neglect the turning point sequences of identified industries and rely on the cumulative incidence of turns, such as depicted in diffusion indexes. Or they may proceed on a "case study" basis in which the differences between cycles are fully recognized and studied in detail including the historically changing sequences of cyclical turns in labor input and other variables.[11] Both approaches will profit from a review of the degree of consistency and variation in the behavior of the variable—average weekly hours—from cycle to cycle. To such a review we now turn.

Similarities and Differences between Cycles

Table 20 provides summary measures permitting comparison of the average timing behavior of weekly hours, in the industries covered, from cycle to cycle. These show hours leading at every single business cycle turn. Note that this is more consistent behavior than that shown by the aggregate of average hours in All Manufacturing (Table 1). The more consistent showing by the average of individual industries may be due partly to differences in weighting; however, the chance for such consistency may also have been enhanced by the analytic procedure used. Only industries whose turning points could be matched to business cycle turns were included in the average. Furthermore, the selection of specific turns itself contains elements of subjective evaluation.

The largest average lead occurred in November 1948; it amounted to ten months. This is not attributable to a few extreme components, but rather characteristic for the behavior of hours at this turn. It corresponds to a particularly early turn of production worker employment in manu-

[11] We are concerned here only with utilization of sequential patterns. There are, of course, other aspects of cyclical behavior which are used in economic analysis and forecasting.

Table 20

Weekly Hours in Manufacturing, 1927-1956

Leads (−), Lags (+), and Dispersion Measures, at Business Cycle Turns, in Months

	Trough July '21	*Peak May '23*	*Trough July '24*	*Peak Oct. '26*	*Trough Nov. '27*	*Peak June '29*
Average Weekly Hours						
Av. timing	−3.9	−1.9	− .8	−7.9	−1.4	−0.7
Av. deviation	2.2	3.7	2.0	6.5	6.3	4.4
Production Worker Employment						
Av. timing	−2.6	+2.2	+2.0	−5.6	+0.5	+2.1
Av. deviation	2.8	2.3	2.7	3.5	5.1	2.4
Hours vs. Employment						
Av. timing	−1.9	−3.8	−2.3	−3.9	−2.1	−2.7
Av. deviation	1.5	4.3	3.3	5.5	6.1	3.5

	Trough Mar. '33	*Peak May '37*	*Trough June '38*	*Peak Nov. '48*	*Trough Oct. '49*	*Peak July '53*	*Trough Aug. '54*
Average Weekly Hours							
Av. timing	−2.2	−3.9	−2.6	−10.5	−4.2	−6.0	−4.2
Av. deviation	7.3	2.9	2.6	4.5	3.4	3.7	3.6
Production Worker Employment							
Av. timing	−3.5	+0.6	+0.7	− 9.0	−0.1	−3.6	+0.4
Av. deviation	4.2	2.0	0.9	6.9	3.0	4.1	2.5
Hours vs. Employment							
Av. timing	+1.3	−4.5	−4.2	− 1.3	−3.8	−3.1	−5.1
Av. deviation	8.0	3.6	2.0	4.2	3.5	4.0	2.5

NICB data for 20 industries through 1935; BLS data for 14 industries from 1935 to 1941, for 21 industries thereafter.
The timing and dispersion measures, presented in this table, are averages based on the turning points of the individual industry series.

facturing industries. The smallest average leads occurred at the 1924 trough and the 1929 peak; they amounted to a fraction of a month only. The short 1924 lead (coupled with a particularly narrow dispersion) contributed significantly to the bimodality of the distribution of turns at troughs—a feature which can be observed in Chart 12 and was noted earlier. No fewer than 12 of 16 industries reached a trough within a month of the business cycle trough. This reduces the bimodality in the distribution of hours turns largely to the effect of a historically unique situation.

As indicated earlier, the workweek for All Manufacturing, as a whole, showed lags during the 1927-1933 cycle. For the belated turns around 1927 and 1929[12] we have no adequate explanation. A special situation existed at the subsequent low point of the Great Depression. Hours, in fact, experienced a double trough. Historically, average hours as well as some other indicators of business activity began to turn up in mid-1932. After a few months, business activity slackened again, and in March 1933 hours and employment were close to trough levels. From March 1933—the business cycle turning point—business actitvity began to recover more decisively. Hours, however, were affected by the new policies of the Roosevelt Administration. The work sharing program encouraged lowering of average hours worked, and most NRA codes provided explicitly for reduction in full time hours.[13] As a consequence, average hours worked in All Manufacturing declined again from a peak in July 1933 to a trough around September 1934. Chart 1 shows that, during the period from summer 1932 to fall 1934, hours experienced a full cycle. On an aggregative basis, hours as measured by the BLS show a lower trough in 1934; as measured by the NICB, a lower trough in 1932.

Statistically, this situation leads to curious anomalies in the "timing" of hours. In individual industries, hours may experience a clear trough in 1932, or in 1934, or in both years. Thus in relating the turns in hours turns to the business cycle turning point of March 1933, we sometimes obtain considerable leads, sometimes long lags.[14] When hours experienced a full extra cycle, it seemed reasonable to relate the earlier rather than the NRA trough to the business cycle turn. Under the circumstances described we should expect, around 1933, a particularly large average deviation of turning points from their mean. This we find indeed; the average deviation

[12] As previously mentioned, the recent revision of the 1929 business cycle peak, from June to August, reduces the observed lag from four months to two months.

[13] For detail see Leo Wolman's *Hours of Work in American Industry*, National Bureau of Economic Research, Bulletin 71, p. 7.

[14] This situation also contributed somewhat to the bimodality of the distribution of turning points.

of about seven months is greater than corresponding measures for any other turning point during the period under review.

The unusualness of the 1933 trough emerges also from the measures presented in the lowest panel of Table 20. This is the only turning point in the manufacturing sample in which turns in hours, on the average, lag behind those in employment. The average deviation of hours timing, related to employment, is also at its maximum during this period.

With the cited exception, at the 1933 trough, the average dispersion of turns varies, from turn to turn, between two and six months, with an average of about four. Note that there is no consistent tendency for the spread to be smaller when the timing of hours is measured against employment turns. This is, of course, what was reflected in the summary dispersion measure given in an earlier section.