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Chapter 5

Employment during Stages of Industrial Growth and Decline

THE close bond between an industry's output and employment trends is a matter of common observation. The development and successful production of the electric light and motor gave rise to phenomenal increases in employment in these and related branches of industry. As the output of electrical products slowed down somewhat after its initial spurt, the rate of increase in the jobs the industry had to offer slackened to a more moderate pace. And now that the electrical products industry has grown to something like full stature, it resembles most other relatively mature industries in its rather stable volume of employment. Or, to take an enterprise that is now virtually defunct, we can turn to the production of horse-drawn carriages and wagons which ceased its development during the first decade of this century; its peak in output was naturally accompanied at about the same time by a peak in the number of workers this industry employed. With the subsequent decline in the output and use of carriages and wagons, most of the people who had looked to the industry as a source of livelihood had to seek jobs in other fields.

So much is obvious; but it is also rather vague. As soon as we seek to learn exactly how employment changes during the growth and decline of an industry we see the need for more systematic examination of the available facts. Does employment *always* rise with output during the growing phase of an industry's development? How does the tempo of increase in employment usually compare with that in output? In how many manufacturing industries have output and employment already reached a peak? Do the peaks in employ-

ment and output usually coincide or does one precede the other?

PEAKS IN EMPLOYMENT AND OUTPUT

Let us first determine and compare the timing of the peaks reached by employment and output in the manufacturing industries for which we have appropriate data.¹ Peak Census years in employment in all manufacturing industries for which fairly continuous data are available are summarized in Table 9.² The most striking feature of the table is the rather wide

¹It might be thought that these facts could be inferred from information already presented to the reader. However, although we know that employment per unit of product has generally fallen, and can conclude from this earlier finding that maximum points in employment usually precede the corresponding maximum points in output, we do not know in how many industries peaks have actually been reached in these series until we look at them. And even for the industries which have passed the peaks in both employment and output, the validity of any inference as to their timing, if drawn from the declining trend in employment per unit alone, would be open to doubt. For one would have to know, in addition, whether the cycles and random fluctuations impressed on the series for output and employment are so negligible in amplitude as to have little or no effect on the position of the maximum points. This is hardly likely to be the case. Further, since cycles and random movements tend to follow similar time patterns in both output and employment (for obvious reasons), actual peaks in these series, as distinguished from the maxima of smooth primary trend lines, may coincide rather than differ in timing. For these reasons we cannot claim that the discussion of preceding chapters has told us enough about peaks in employment and output to obviate a special analysis.

²It is well to take note of the qualifications to this table. The information gathered there relates to specified years in a circumscribed period. It is possible, therefore, though not very likely, that higher points in employment were reached in some industries in the period preceding 1899. Moreover, it is probable that the industries with peaks in 1939 may go on to greater heights, aside from effects of the current war boom; some peaks even in earlier years may be exceeded after 1939. The table as originally prepared covered 1899-1937, and showed 69 industries with peaks in 1937. Some 19 of these 69 reached new highs in 1939; and 5 industries which, on the basis of data for 1899-1937, had highs in 1904, 1925, 1927, 1929 and 1935, touched even higher points in 1939, according to data for 1899-1939.

The failure to cover all years in the four decades 1899-1939 also limits the value of the results. But a check of the Census data for 30 industries, made by reference to annual series provided by the U. S. Bureau of Labor Statistics for 1919-39, indicates that this is not a serious limitation. No difference was found for 23 industries, and 1 year's difference for 5. The differences for the other 2 industries were 3 and 7 years, respectively.

distribution of high points in employment among the four decades following 1899. Although total factory employment reached its high in 1937 (if we look only at Census years), in no Census year among the 15 listed in Table 9, not even in the severe depressions of 1921, 1931 and 1933, did employ-

TABLE 9
FREQUENCY DISTRIBUTION OF INDIVIDUAL
MANUFACTURING INDUSTRIES BY CENSUS
YEAR OF PEAK EMPLOYMENT AND
OUTPUT, 1899-1939

Peak Census Year	Number of Industries	Employment		Output
		Number Covered by Complete Data for 1899-1939 ^a	Number for Which Indexes of Output are Available for 1925 or Earlier ^b	Number for Which Indexes of Output are Available for 1925 or Earlier ^b
1899	10	8	5	2
1904	12	6	4	2
1909	19	7	5	2
1914	10	6	4	4
1919	73	42	27	4
1921	2	2	1	..
1923	35	16	15	6
1925	12	5	6	4
1927	9	3	4	6
1929	37	19	4	23
1931	1	..	..	2
1933	2	..	..	1
1935	8	4	2	2
1937	50	32	21	15
1939	24	16	5	30
TOTAL	304 ^c	166	103	103 ^d

Source: Based on Appendices B-1 and F.

^a That is, all industries with employment series beginning in 1899 and ending in 1939.

^b In the compilation of the figures given in the last two columns the several printing and publishing industries, treated as separate branches in the first two columns, were combined and counted as one industry.

^c The 51 industries with peak employment in a Census year prior to 1919 are:

ment fail to touch a peak in at least one manufacturing industry. Of the 304 industries represented in the table, two fifths reached their peak employment in 1919 or an earlier Census

Footnotes to Table 9, concluded

Peak in 1899

Chewing and smoking tobacco
Collars, men's
Mats and matting
Gloves, leather
Charcoal
Cooperage
Turpentine and rosin
Nails and spikes
Lead
Umbrellas and canes

Peak in 1904

Malt
Linen goods
Saddlery and harness
Whips
Engraving, wood
Hones
Mirror and picture frames
Boxes, wooden, cigar
Gold leaf and foil
Carriages, wagons and sleighs
Ivory work
Organs

Peak in 1909

Regalia
Hats, fur-felt

Upholstering materials
Type founding
Lime
Marble and granite
Glass products
Lumber-mill products
Silverware
Watchcases
Windmills
Sewing machines
Carriage and wagon materials
Feathers and plumes
Buttons
Combs
Hairwork
Pianos
Pipes, tobacco

Peak in 1914

Liquors, malt
Cigars
Corsets
Flags and banners
Hats, straw, men's
Horse blankets
Jute goods
Nets and seines
Watch and clock materials
Copper

⁴The 10 industries with peak output in a Census year prior to 1919 are:

Peak in 1899

Lumber-mill products
Turpentine and rosin

Peak in 1904

Carriages, wagons and sleighs
Organs

Peak in 1909

Hats, fur-felt
Linen goods

Peak in 1914

Chewing and smoking tobacco
Cigars
Cottonseed products
Liquors, malt

year, and one sixth in 1914 or earlier.³ Among the 51 industries with peaks in employment prior to 1919 appear certain related types of enterprise. We find cigars together with wooden cigar boxes; smoking and chewing tobacco with pipes; carriages and wagons with saddlery and harness, whips, horse blankets, and carriage and wagon materials; combs with hair work.

Table 9 also affords a striking contrast of peaks in employment with those in output. The only pronounced frequencies in the output column are those for 1929, 1937 and 1939; the large frequencies in the employment column are opposite 1919, 1923 and 1937, and there are only small frequencies for 1929 and 1939.⁴ Although seven tenths of the 103 industries attained their peak employment prior to 1929, only three tenths reached peak output before 1929.⁵ And only one tenth of the industries reached peak output prior to 1919, although double that proportion attained maximum employment before that year.

Now that we have counted up the rather imposing number

³ Exclusion of those industries whose employment series end before 1939 or begin after 1899 (cutting out not only industries for which data are inadequate for statistical reasons but also new industries and those now extinct or practically extinct) does not change the picture very much, as the table indicates; nor does restriction of the distribution to industries for which indexes of output are available.

⁴ Comparison with annual data on physical output for 30 industries, 1919-39, reveals no difference between peaks according to Census-year data and peaks according to annual data for 19 industries, and differences of only 1 or 2 years for 6 industries. For the remaining 5 industries the differences are 8 years (2 industries), 10 years (2 industries) and 16 years (1 industry). These differences, it should be noted, are also attributable in part to differences between the methods and data used in constructing the present indexes of physical output and those used for the annual indexes, constructed by the National Research Project (Magdoff, Siegel, and Davis, *Production, Employment and Productivity in 59 Manufacturing Industries, 1919-36*, Philadelphia, 1939) and extended by the Bureau of Labor Statistics.

⁵ Since more output than employment series begin after 1899, there is a greater likelihood that peaks in output in the latter part of the period 1899-1937 will outnumber peaks in employment. But this is not a serious qualification; see the discussion of Table 10, below.

of industries in which, apparently, peaks have already been reached in both output and employment, and have identified the years in which they appear, we see that there is wide discrepancy in the timing of peaks in output and in employment. To determine the interval between these peaks in the same industry we must go on to Table 10. Among 103 industries for which we have information, there were only one tenth in which the peak in employment followed that in output. In almost three tenths the two dates coincided. In the remaining industries—almost two thirds—employment reached a peak and began to fall off while output was still rising. And in as many as half of the latter, output reached its peak more than a decade after employment.⁶

About a third of the 103 industries reached peaks in employment, in output, or in both in 1939. For these, therefore, there is no evidence that a true maximum in one or both series had in fact been attained. If they are excluded from the tabulation, the distribution changes somewhat, although over half of the remaining industries are still characterized by a lead of employment over production.⁷

These comparisons of high points in employment and output deal with employment as measured in terms of number of wage earners. Since hours of labor in factories diminished with the passage of time, peaks in manhours of labor expended must have frequently preceded peaks in average number of workers employed. It is probable, therefore, that

⁶ Annual data are available for the period 1919-39 for 30 industries. For 15 of these there is no difference between the results shown by examination of data for Census years and those obtained from annual data, and for 8 the difference is one or two years. For the other 7 industries the differences are 4, 7, 8, 9, 10, 11, and 16 years, respectively.

⁷ Restriction of the analysis to industries with data covering the entire 4 decades, that is, beginning in 1899 and ending in 1939, also decreases the fraction with employment leading output. But this fraction still exceeds one half, whether we include or exclude industries with one or both peaks in 1939; and no greater proportion of industries is found with output leading employment.

the highest peak in *manhours* leads the highest peak in output in a proportion of industries greater than that shown in Table 10, and that the average lead of the manhour peak over the output peak is longer than the average lead of the employment peak over the output peak. Such data as are available definitely support this statement. Thus in knit

TABLE 10

FREQUENCY DISTRIBUTION OF INDIVIDUAL
MANUFACTURING INDUSTRIES BY DIFFERENCE
BETWEEN CENSUS YEARS OF PEAK
EMPLOYMENT AND OUTPUT, 1899-1939

<i>Difference in Years (peak year of output minus peak year of employment)</i>	<i>All Industries</i>		<i>Industries Covered by Complete Data for 1899-1939^a</i>	
	Total	Excluding Those with Peaks in 1939	Total	Excluding Those with Peaks in 1939
36 to 40	1	1	1	1
31 to 35	1	1	..	..
26 to 30	4	2	..	..
21 to 25	1	1	1	1
16 to 20	18	5	5	1
11 to 15	8	5	3	2
6 to 10	14	14	8	8
1 to 5	17	9	7	3
0	28	23	17	14
-1 to -5	2	2	1	1
-6 to -10	9	9	3	3
TOTAL NUMBER OF INDUSTRIES	103	72	46^b	34

Source: Based on Appendices B-1 and F.

^a That is, all industries with employment and output series beginning in 1899 and ending in 1939.

In the compilation of the figures given in the last two columns, the following industries, treated as separate branches in the first two columns, were

goods the peak in number of wage earners came in 1939, and in paper and pulp, paints and varnishes, petroleum refining, and automobiles, it came in 1937; in all these industries the corresponding peaks in manhours were reached in 1929.⁸

⁸ Leads of peaks in wage earners over peaks in output in these industries were 0, 2, 0, 2, and -8 years, respectively; of peaks in manhours over peaks in output, 10, 8, 8, 8, and 0 years, respectively.

Footnotes to Table 10, concluded.

combined into groups and each group was counted as one industry: the four knit goods industries; industrial chemicals and rayon; copper, lead and zinc.

^b The 46 industries covered in the third column, arranged according to the number of years elapsing between the peak in employment and that in output, are as follows. The date in parentheses is the peak year in employment and in output, if they coincide.

<i>Number of Years</i>	<i>Industry</i>	<i>Number of Years</i>	<i>Industry</i>
36	Gloves	0	Liquors (1914)
23	Jute goods	0	Flour (1919)
20	Meat packing	0	Ice (1929)
20	Tanning and dye materials	0	Rice (1939)
18	Fertilizers	0	Cigars (1914)
16	Cotton goods	0	Carpets and rugs, wool (1923)
16	Shoes, leather	0	Hats, fur-felt (1909)
15	Chewing and smoking tobacco	0	Hats, wool-felt (1939)
14	Silk and rayon goods	0	Knit goods (1939)
12	Beet sugar	0	Woolen and worsted goods (1923)
10	Cordage and twine	0	Paints and varnishes (1937)
10	Explosives	0	Turpentine and rosin (1899)
10	Coke-oven products	0	Carriages, wagons and sleighs (1904)
10	Blast-furnace products	0	Cars, railroad (1923)
10	Copper, lead and zinc	0	Locomotives (1923)
8	Shoes, rubber	0	Glass (1937)
8	Printing and publishing	0	Ships and boats (1919)
6	Salt	0	Cottonseed products
5	Linen goods	0	Steel-mill products
4	Leather	-5	Automobiles, incl. bodies and parts
2	Liquors, distilled	-8	Lumber-mill ^c products
2	Fruits and vegetables, canned	-8	
2	Paper and pulp	-8	
2	Chemicals, industrial, incl. rayon and gases	-10	
2	Petroleum refining		

EMPLOYMENT DURING GROWTH AND DECLINE OF OUTPUT

The preceding discussion has brought out one aspect of the development of manufacturing, namely, that peaks in employment and output have been reached in many industries. We shall now consider how employment and output have climbed to their peaks, and how they have descended.

A sample of the full series on employment and output is presented in Chart 18 (pp. 130-37), which gives some of the longer indexes (those beginning in 1899 or earlier) and a few interesting shorter series. The reader will note certain striking parallels between growth in output and employment even if he merely glances at the successive pages of this chart. There are, for example, the very rapid increases in both employment and output in automobile manufacture during the two decades 1899-1919, and the declines in cigar manufacturing production and employment after 1914. But closer examination will reveal noteworthy differences also: the far more rapid rate of increase in steel production than in steel-mill employment, up to 1914, and the decline in the number of coke-oven workers during the 1920's, while coke production continued to rise at a fairly rapid pace. These differences indicate the need for a precise statement of the rates of change in each decade. This is provided by the collection (Table 11) of average annual rates of growth, during successive decades, in output and employment.

Table 11 points to three conclusions: first, that in most industries output has grown at a decelerating rate; second, that during specific periods employment has tended to increase less rapidly than output; and third, that growth of employment, too, has usually suffered retardation. That employment has commonly fallen in relation to output we already know;⁹ but the first and third points demand rather extended attention.

⁹ See Chapter 3, above.

TABLE 11
INDIVIDUAL MANUFACTURING INDUSTRIES

Physical Output and Wage-Earner Employment:
Average Annual Percentage Changes

Industry		1869- 1879	1879- 1889	1889- 1899	1899- 1909	1909- 1919	1919- 1929	1929- 1937
<i>Foods</i>								
Meat packing	OUTPUT		6.1	1.8	2.5	2.6	0.7	-0.7
	EMPLOYMENT		5.8	5.8	2.5	6.2	-2.7	0.5
Oleomargarine	OUTPUT						8.6 ^a	2.9
	EMPLOYMENT						-1.5 ^a	-2.9
Flour	OUTPUT	3.9	1.5	2.9	0.9 ^o	1.1	-1.3	-1.9
	EMPLOYMENT	0.0	0.9	3.7	2.0	1.4	-4.9	-0.2
Cereals	OUTPUT						9.3 ^a	-3.2
	EMPLOYMENT						1.2 ^a	2.8
Rice	OUTPUT				9.8	5.4	1.2	0.7
	EMPLOYMENT				6.6	5.5	-2.9	4.3
Bread and cake	OUTPUT						4.9 ^b	-0.5
	EMPLOYMENT						4.6 ^b	2.9
Biscuits and crackers	OUTPUT						3.5 ^b	0.7
	EMPLOYMENT						-0.7 ^b	-2.0
Fish, canned	OUTPUT				3.5 ^o	0.9	1.7	0.5
	EMPLOYMENT				3.5 ^o	2.3	1.0	3.7
Fruits and vege- tables, canned	OUTPUT				5.4	6.7	6.2	5.3
	EMPLOYMENT				1.2	4.5	2.7	4.2
Milk, canned	OUTPUT				10.4 ^o	16.7	1.8	3.1
	EMPLOYMENT				4.2 ^o	12.7	-6.3	3.0
Butter	OUTPUT				4.1 ^o	4.2	5.3	0.6
	EMPLOYMENT				3.9 ^o	4.3	0.8	0.2
Cheese	OUTPUT				-0.2 ^o	4.6	1.5	3.2
	EMPLOYMENT				0.4 ^o	4.0	-1.5	3.5
Ice cream	OUTPUT						4.6 ^b	1.1
	EMPLOYMENT						-0.5 ^b	-2.3
Beet sugar	OUTPUT				20.0	4.0	4.0	2.3
	EMPLOYMENT				13.8	5.1	-4.4	2.8
Cane sugar, not elsewhere made	OUTPUT					-3.0	-2.2	8.5
	EMPLOYMENT					4.0	-9.2	7.8
Cane-sugar refining	OUTPUT					3.8	2.3	-1.5
	EMPLOYMENT					6.9	-2.7	0.1
Confectionery	OUTPUT						-2.4 ^a	1.3
	EMPLOYMENT						0.0 ^a	-2.0
Chocolate	OUTPUT						3.4 ^b	2.7
	EMPLOYMENT						-1.6 ^b	2.1
Corn products	OUTPUT					4.0	3.7	-2.2
	EMPLOYMENT					5.0	-1.5	0.5
Ice	OUTPUT				11.8	7.2	5.3	-3.5
	EMPLOYMENT				8.9	6.5	0.8	-6.6

TABLE 11 (continued)

INDIVIDUAL MANUFACTURING INDUSTRIES

Physical Output and Wage-Earner Employment:
Average Annual Percentage Changes

<i>Industry</i>		1869- 1879	1879- 1889	1889- 1899	1899- 1909	1909- 1919	1919- 1929	1929- 1937
<i>Beverages</i>								
Liquors, malt	OUTPUT				4.4	-6.8		
	EMPLOYMENT				3.3	-4.5		
Liquors, distilled	OUTPUT				2.7	-29.6	-0.8	79.3
	EMPLOYMENT				5.6	-14.2	0.8	26.0
Malt	OUTPUT						4.7 ^a	11.8
	EMPLOYMENT						1.0 ^a	13.7
Liquors, vinous	OUTPUT						-3.5 ^b	34.6
	EMPLOYMENT						-15.7 ^b	41.6
<i>Tobacco products</i>								
Cigarettes	OUTPUT				14.9 ^c	22.6	8.8	3.7
	EMPLOYMENT				13.1 ^c	10.8	-0.6	2.7
Cigars	OUTPUT	7.5	6.1	3.3	3.3	0.1	-1.2	-2.7
	EMPLOYMENT	7.4	6.3	2.7	2.6	-1.3	-3.0	-5.0
Chewing and smoking tobacco	OUTPUT				3.9	-0.2	-2.4	-2.3
	EMPLOYMENT				-0.7	-3.9	-5.1	-0.8
<i>Textile products</i>								
Cotton goods	OUTPUT	5.7	4.1	4.3	3.3	1.4	2.5	-0.1
	EMPLOYMENT	2.6	2.4	3.9	2.3	1.5	-0.2	-0.1
Lace goods	OUTPUT					3.4 ^d	1.4	5.5
	EMPLOYMENT					-2.7 ^d	0.6	2.1
Woolen and worsted goods	OUTPUT		1.3	2.6	3.7	-0.5	0.3	1.7
	EMPLOYMENT		1.6	1.5	2.6	0.2	-1.3	1.0
Silk and rayon goods	OUTPUT		10.9	4.6	6.0	4.9	4.6	3.8
	EMPLOYMENT		5.0	3.7	4.3	2.5	0.3	-1.3
Knit goods	OUTPUT	6.2	9.9	7.7	5.6	5.3	6.1	1.9
	EMPLOYMENT	6.9	7.8	4.9	4.5	2.9	1.9	1.3
Carpets and rugs, wool	OUTPUT				2.6	-2.3	4.9	-1.1
	EMPLOYMENT				1.6	-3.6	3.6	-0.8
Asphalted-felt- base floor covering	OUTPUT						10.0 ^b	4.7
	EMPLOYMENT						5.7 ^b	4.3
Linoleum	OUTPUT						0.2 ^b	-2.3
	EMPLOYMENT						-2.0 ^b	-1.7
Oilcloth	OUTPUT				11.6	-4.8	10.2	-5.0
	EMPLOYMENT				13.1	1.5	2.3	-1.3
Cordage and twine	OUTPUT				2.1	1.2	0.8	-1.1
	EMPLOYMENT				1.1	1.8	-2.0	-0.4

Industry	1869-1879		1879-1889		1889-1899		1899-1909		1909-1919		1919-1929		1929-1937	
<i>Textile products (continued)</i>														
Jute goods	OUTPUT						5.9	0.7	-1.5	4.6				
	EMPLOYMENT						4.0	0.7	-3.6	3.5				
Linen goods	OUTPUT						3.9	-8.1	1.5	-3.2				
	EMPLOYMENT						0.9	-6.1	1.5	-2.0				
Hats, fur-felt	OUTPUT						4.8	-2.9	0.6	0.0				
	EMPLOYMENT						2.9	-3.0	-1.2	-0.5				
Hats, wool-felt	OUTPUT	-3.5	-2.0				-2.9	-2.3	2.3	12.4				
	EMPLOYMENT	-4.1	-2.5				-0.6	-3.1	3.5	9.0				
Artificial leather	OUTPUT								-0.3 ^b	2.1				
	EMPLOYMENT								0.8 ^b	-0.2				
Wool shoddy	OUTPUT			0.5	2.2	3.7	0.2							
	EMPLOYMENT			0.4	0.6	2.9	-3.6							
<i>Leather products</i>														
Leather	OUTPUT			0.6	2.5	1.6	-0.4	1.4						
	EMPLOYMENT			2.7	1.8	1.5	-3.6	0.3						
Shoes, leather	OUTPUT	4.4	3.8	1.8	2.7	1.3	1.1	1.4						
	EMPLOYMENT	1.9	2.3	1.5	2.6	1.3	-0.2	0.6						
Gloves, leather	OUTPUT				1.5	0.7	0.6	-0.2						
	EMPLOYMENT				-2.2	-0.6	0.2	2.9						
<i>Rubber products</i>														
Shoes, rubber	OUTPUT				1.0 ^e	10.9 ^d	-1.4	-0.6						
	EMPLOYMENT				1.8 ^e	12.0 ^d	-2.5	-4.0						
Tires and tubes	OUTPUT						6.5 ^b	-2.6						
	EMPLOYMENT						2.1 ^b	-3.4						
<i>Paper products</i>														
Paper and pulp	OUTPUT		7.5	8.6	6.5	3.7	6.6	2.3						
	EMPLOYMENT		2.4	5.6	4.3	4.1	1.2	1.0						
<i>Printing and publishing</i>														
Total	OUTPUT				7.6	4.3	6.3	0.3						
	EMPLOYMENT				2.9	1.1	2.0	-0.1						
<i>Chemical products</i>														
Chemicals, industrial, incl. rayon and com-	OUTPUT				6.6	11.2	10.7	7.0						
	pressed gases ^f				4.0	11.5	3.1	3.5						
Cottonseed products	OUTPUT				3.8	4.2	-1.1	-2.3						
	EMPLOYMENT				4.5	4.6	-5.1	0.6						

TABLE 11 (continued)
 INDIVIDUAL MANUFACTURING INDUSTRIES
 Physical Output and Wage-Earner Employment:
 Average Annual Percentage Changes

Industry	1869-1879-		1889-		1899-		1909-		1919-		1929-	
	1879	1889	1889	1899	1909	1919	1919	1929	1929	1937		
<i>Chemical products (continued)</i>												
Linseed products	OUTPUT								3.1 ^b		-1.9	
	EMPLOYMENT								0.5 ^b		-0.4	
Carbon black	OUTPUT						18.0 ^d		15.9		3.6	
	EMPLOYMENT						14.8 ^d		11.0		1.7	
Soap	OUTPUT				6.1 ^o		3.9		1.1		1.1	
	EMPLOYMENT				3.4 ^o		4.6		-3.5		-0.3	
Wood-distillation products	OUTPUT				6.7		3.3		3.0		0.1	
	EMPLOYMENT				5.8		6.2		-0.7		-0.5	
Charcoal	OUTPUT								-4.5 ^b		-10.0	
	EMPLOYMENT								-9.0 ^b		-2.3	
Explosives	OUTPUT		8.8		9.3		4.3		0.7		-0.9	
	EMPLOYMENT		7.6		3.3		3.9		-4.8		-0.4	
Fertilizers	OUTPUT				7.0		3.0		2.2		0.7	
	EMPLOYMENT				4.7		3.7		-2.2		0.0	
Paints and varnishes	OUTPUT				5.4		3.3		6.7		1.1	
	EMPLOYMENT				3.9		4.2		3.1		1.0	
Salt	OUTPUT		5.4	5.8	3.9	2.3	2.7	1.2			-0.4	
	EMPLOYMENT		3.8	0.3	4.5	0.3	2.8	-1.7			-2.0	
Tanning and dye materials	OUTPUT				7.6		4.3		2.0		0.1	
	EMPLOYMENT				3.9		6.1		-5.6		1.9	
<i>Petroleum and coal products</i>												
Petroleum refining	OUTPUT		8.7		4.1		6.4		12.0		11.4	
	EMPLOYMENT		2.4		1.3		1.4		15.4		3.2	
Coke-oven products	OUTPUT		13.8		7.3		7.7		4.8		5.0	
	EMPLOYMENT		11.3		9.2		5.6		0.0		-3.5	
Fuel briquettes	OUTPUT						10.3		16.9		-2.9	
	EMPLOYMENT						6.9		9.5		0.8	
<i>Stone, clay and glass products</i>												
Cement	OUTPUT				18.0 ^o		2.8		5.8		-4.7	
	EMPLOYMENT				8.9 ^o		-0.5		2.7		-2.9	
Lime	OUTPUT				2.5 ^o		-1.6		2.7		0.3	
	EMPLOYMENT				4.6 ^o		-2.0		-2.7		1.7	
Concrete products	OUTPUT								7.4 ^a		-1.1	
	EMPLOYMENT								2.9 ^a		-3.0	
Sand-lime brick	OUTPUT						-2.5 ^d		6.7		-5.0	
	EMPLOYMENT						-2.1 ^d		1.1		-3.8	
Clay products	OUTPUT						-5.3 ^d		4.6		-5.0	
	EMPLOYMENT						-5.1 ^d		2.0		-4.3	
Glass	OUTPUT				6.1		3.6		4.5		6.3	
	EMPLOYMENT				2.7		1.2		-1.4		2.0	

Industry	1869-1879		1879-1889		1889-1899		1899-1909		1909-1919		1919-1929		1929-1937	
<i>Forest products</i>														
Lumber-mill products	OUTPUT						-0.2	-0.7	0.3				-4.0	
	EMPLOYMENT						2.8	-1.3	-1.1				-3.2	
Planing-mill products	OUTPUT								-4.2 ^a				-5.4	
	EMPLOYMENT								-5.1 ^a				-3.7	
Excelsior	OUTPUT								0.3 ^a				-4.3	
	EMPLOYMENT								-1.3 ^a				-3.2	
Turpentine and rosin	OUTPUT						-2.7	-1.7	2.8				-2.6	
	EMPLOYMENT						-0.6	-3.4	3.7				-2.6	
<i>Iron and steel products</i>														
Blast-furnace products	OUTPUT			5.1	6.0			1.8	3.6				-1.6	
	EMPLOYMENT			3.0	-0.2			1.2	-5.3				-1.0	
Steel-mill products	OUTPUT	8.6	9.2	8.4	6.3			3.9	4.7				-0.4	
	EMPLOYMENT	7.1	3.6	4.7	2.7			4.5	0.5				2.5	
Wire	OUTPUT							0.4	3.8				-1.3	
	EMPLOYMENT							0.9	1.3				1.1	
Wrought pipe	OUTPUT								6.8 ^a				-1.2	
	EMPLOYMENT								1.2 ^a				2.7	
Cast-iron pipe	OUTPUT							-6.6 ^d	8.6				-4.7	
	EMPLOYMENT							0.2 ^d	4.5				-1.5	
Firearms	OUTPUT								4.5 ^b				0.8	
	EMPLOYMENT								1.6 ^b				0.0	
<i>Nonferrous-metal products</i>														
Copper	OUTPUT						8.0	2.5	5.3				-2.7	
	EMPLOYMENT						3.3	1.1	-1.7				0.0	
Lead	OUTPUT						5.1	0.0	4.8				-6.6	
	EMPLOYMENT						-1.2	-1.3	-2.9				-2.2	
Zinc	OUTPUT						7.1	6.2	3.0				-1.9	
	EMPLOYMENT						3.2	7.6	-1.8				-0.4	
Secondary metals, non-precious	OUTPUT								6.4 ^a				2.7	
	EMPLOYMENT								8.8 ^a				2.3	
Collapsible tubes	OUTPUT								1.5 ^a				2.7	
	EMPLOYMENT								-1.8 ^a				1.1	
Nonferrous-metal products, not elsewhere classified	OUTPUT								9.1 ^a				-1.6	
	EMPLOYMENT								5.1 ^a				0.6	

TABLE 11 (concluded)

INDIVIDUAL MANUFACTURING INDUSTRIES

Physical Output and Wage-Earner Employment:
Average Annual Percentage Changes

Industry	1869-1879-1889-1899		1899-1909		1909-1919		1919-1929		1929-1937	
	1879	1889	1899	1909	1919	1919	1929	1929	1937	
<i>Machinery</i>										
Phonographs	OUTPUT			13.4	20.0		-5.8			
	EMPLOYMENT			15.1	18.6		-6.7			
Typewriters	OUTPUT						5.1 ^b		1.8	
	EMPLOYMENT						3.4 ^b		2.9	
<i>Transportation equipment</i>										
Automobiles, incl. bodies and parts	OUTPUT			43.1	31.7		13.5		-1.3	
	EMPLOYMENT			42.3	16.3		2.6		0.8	
Carriages, wag- ons and sleighs	OUTPUT	2.0		0.1	-7.1		-17.0		-4.2	
	EMPLOYMENT	1.7		-0.9	-11.1		-15.8		-4.5	
Cars, railroad	OUTPUT			-0.5	4.1		-5.1		-0.9	
	EMPLOYMENT			2.3	1.7		-3.2		0.1	
Locomotives	OUTPUT	1.8		0.7	1.3		-11.0		-7.2	
	EMPLOYMENT	2.5		-2.4	6.0		-8.5		-2.5	
Ships and boats	OUTPUT			-2.7	22.2		-15.8		-2.7	
	EMPLOYMENT			-1.4	25.3		-17.8		1.5	
Motorcycles and bicycles	OUTPUT			-7.6	10.9		-5.6			
	EMPLOYMENT			-12.9	9.4		-8.8			
Carriages and sleds, children's	OUTPUT						2.0 ^a		-1.5	
	EMPLOYMENT						0.7 ^a		-3.7	
<i>Miscellaneous products</i>										
Organs	OUTPUT			-5.8 ^c	-3.0		0.8			
	EMPLOYMENT			-8.0 ^c	-2.0		2.1			
Pianos	OUTPUT			6.5 ^c	1.9		-6.1		-5.0	
	EMPLOYMENT			3.9 ^c	-1.1		-8.1		-6.8	
Buttons	OUTPUT				4.8 ^d		-2.0		2.9	
	EMPLOYMENT				1.4 ^d		-5.3		3.6	

Source: Appendix F.

^a 1925-1929.^b 1923-1929.^c 1904-1909.^d 1914-1919.^e 1899-1914.

^{*} The figures for rayon alone are available only for 1923-29 and 1929-37. The corresponding rates for output are 23.4 and 15.2; and for employment, 18.2 and 4.4.

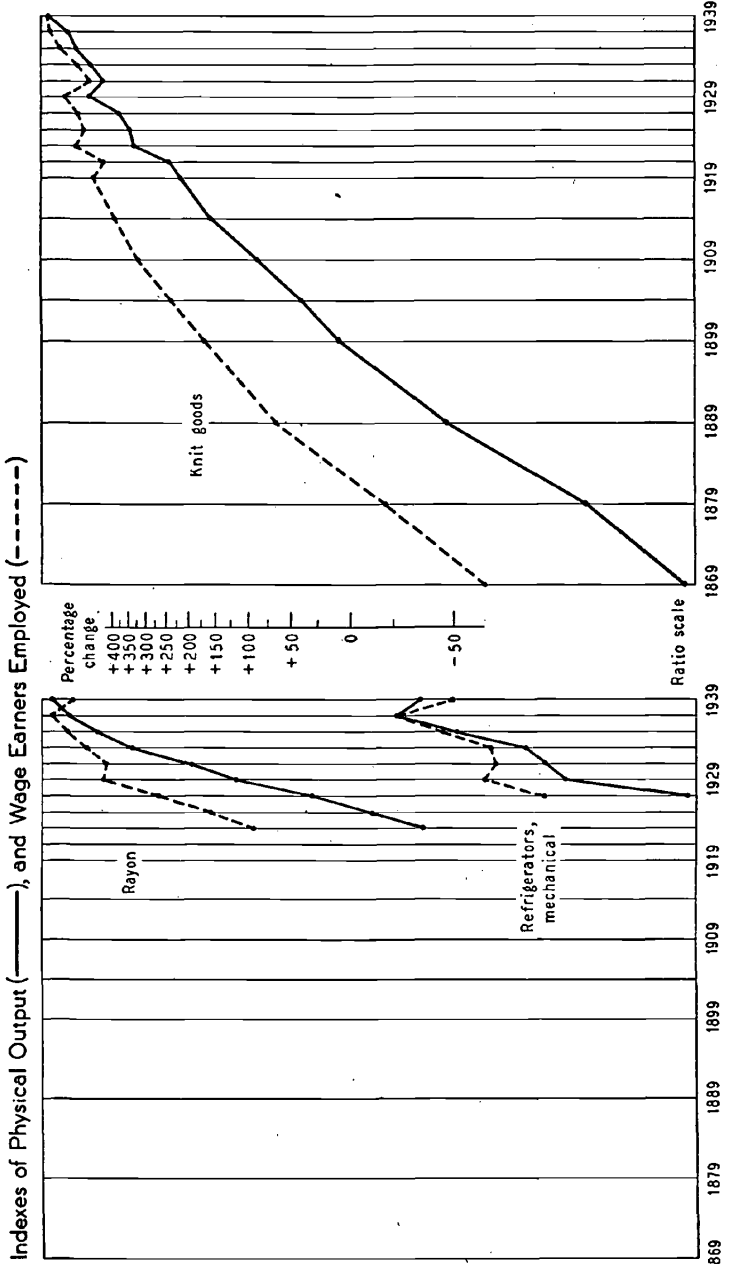
The tendency toward retardation in growth of output is apparent even from a crude analysis of the direction of change in the growth rate of output between successive decades.¹⁰ Of the 271 possible comparisons between contiguous decades, almost two thirds reveal such declines. A similar preponderance in number of declines over number of increases (including zero changes among the latter) is found in all but one pair of contiguous decades considered singly, and for over two thirds of the 99 separate industries listed.¹¹ The rate at which output increased declined progressively in every decade in 9 of the industries for which we have data for four or more decades: rice, ice, cordage and twine, leather gloves, wood-distillation products, fertilizers, tanning and dye materials, zinc and automobiles. In the automobile industry output rose less rapidly during the second decade of the twentieth century than during the first, lost speed again during the third decade, and again during the fourth.

The preceding comparisons between contiguous decades not only indicate the presence of retardation in growth but serve to measure its continuity. In one respect, however, such comparisons tend to underestimate the actual extent to which retardation exists. For example, in the flour industry the rate of growth of output fell from the decade 1869-79 to the decade 1879-89, rose to 1889-99, fell to 1899-1909, rose to 1909-19, fell to 1919-29, and fell again to 1929-37. There were two rises and four declines. Yet both rises stopped at

¹⁰ For other evidence of retardation in growth of output, somewhat differently presented, see Simon Kuznets, *Secular Movements in Production and Prices* (Houghton Mifflin, 1930), and Arthur F. Burns, *Production Trends in the United States since 1870* (National Bureau of Economic Research, 1934).

¹¹ Exclusion of the comparison of 1919-29 with 1929-37, because of the generally low rate of change in output between the latter pair of years, reduces the total number of comparisons to 177, 105 of which are negative. Exclusion of industries with but one comparison (usually 1919-29 with 1929-37) lowers the total number of industries to 75; in 48 of these there were more negative changes than positive and zero combined. (Combining zero changes with positive changes makes, of course, for a conservative conclusion concerning retardation.)

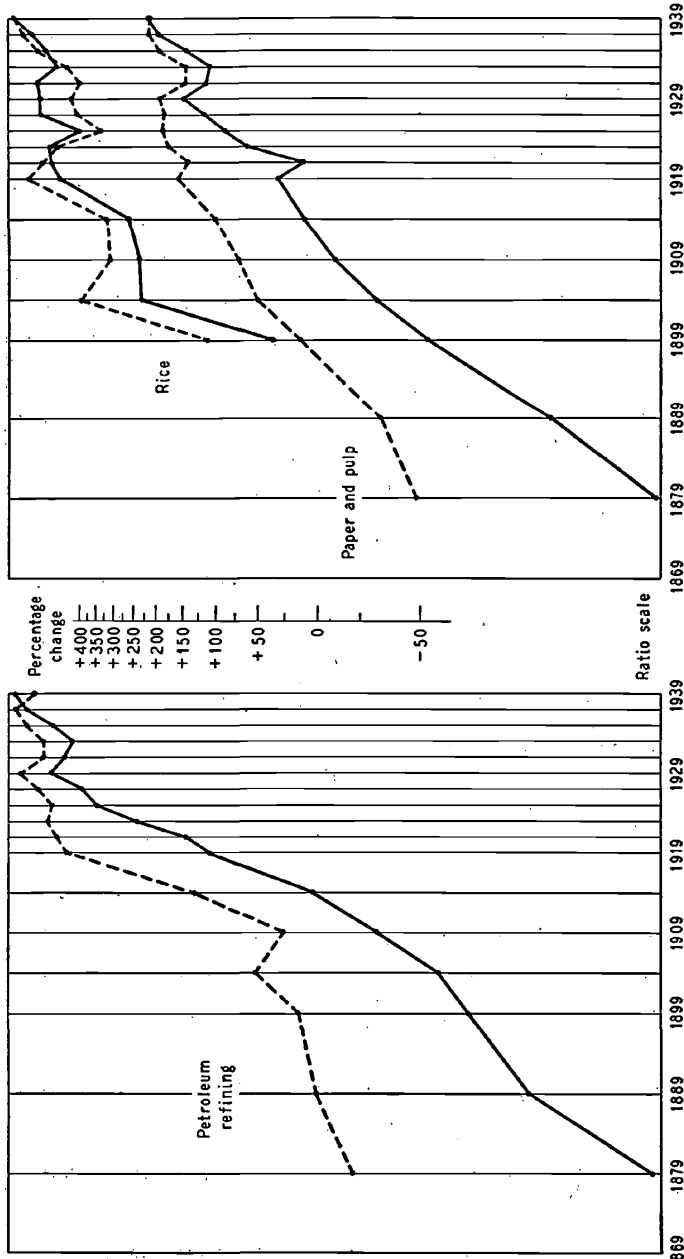
Chart 18
 SELECTED MANUFACTURING INDUSTRIES
 Indexes of Physical Output (————), and Wage Earners Employed (-----)



Based on Table F-1

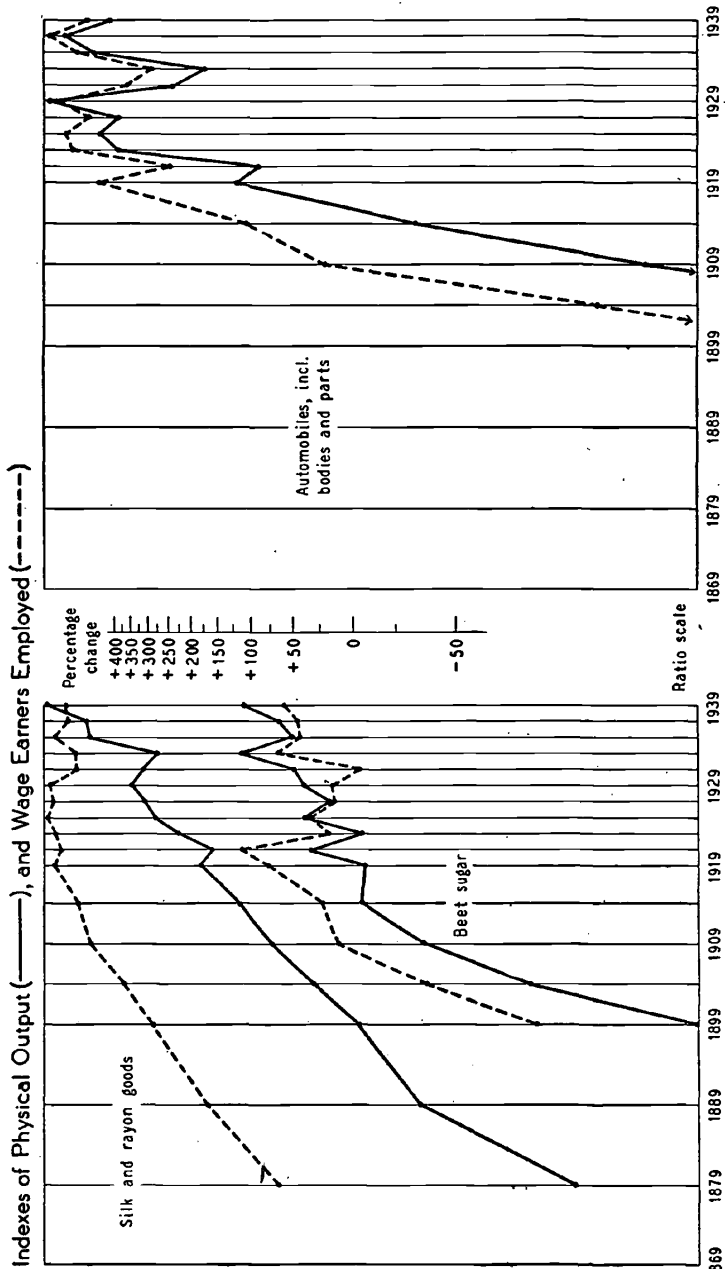
Chart 18 (cont.)
 SELECTED MANUFACTURING INDUSTRIES

Indexes of Physical Output (—), and Wage Earners Employed (-----)



Based on Table F-1

Chart 18 (cont.)
 SELECTED MANUFACTURING INDUSTRIES
 Indexes of Physical Output (—), and Wage Earners Employed (---)

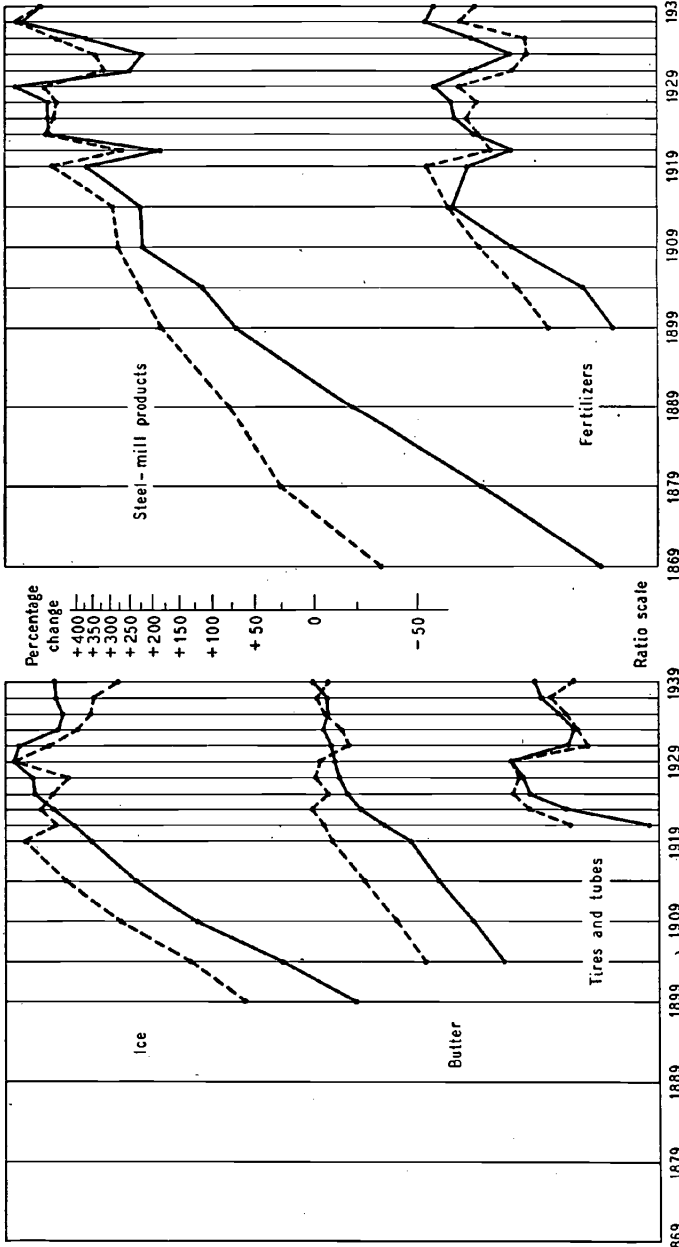


Based on Table F-1

Chart 18 (cont.)

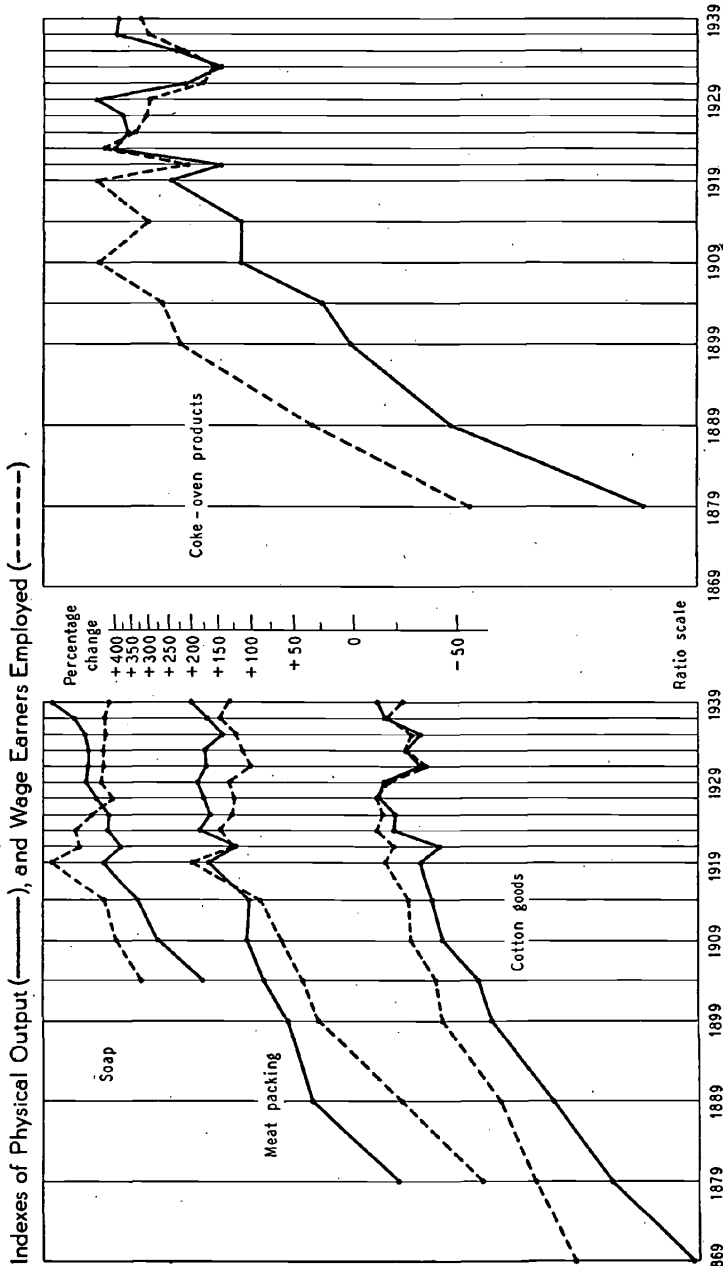
SELECTED MANUFACTURING INDUSTRIES

Indexes of Physical Output (————), and Wage Earners Employed (-----)



Based on Table F-1

Chart 18 (cont.)
 SELECTED MANUFACTURING INDUSTRIES
 Indexes of Physical Output (—), and Wage Earners Employed (-----)

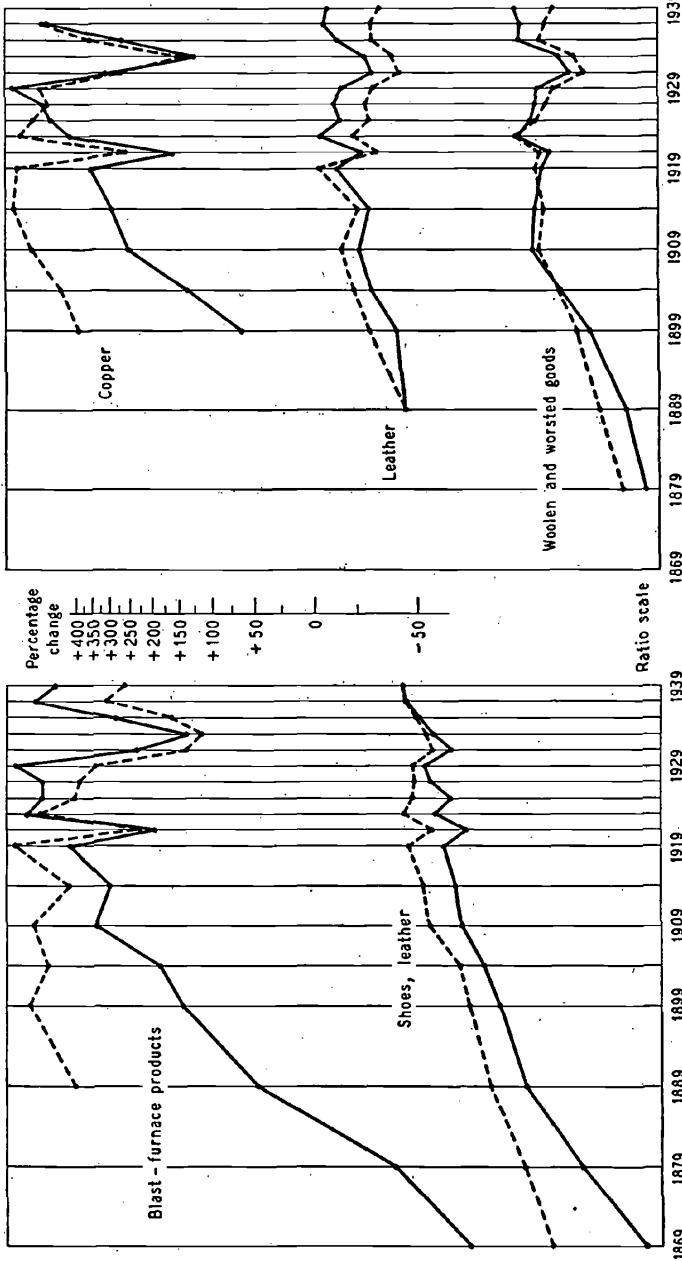


Based on Table F-1

Chart 18 (cont.)

SELECTED MANUFACTURING INDUSTRIES

Indexes of Physical Output (—), and Wage Earners Employed (---)

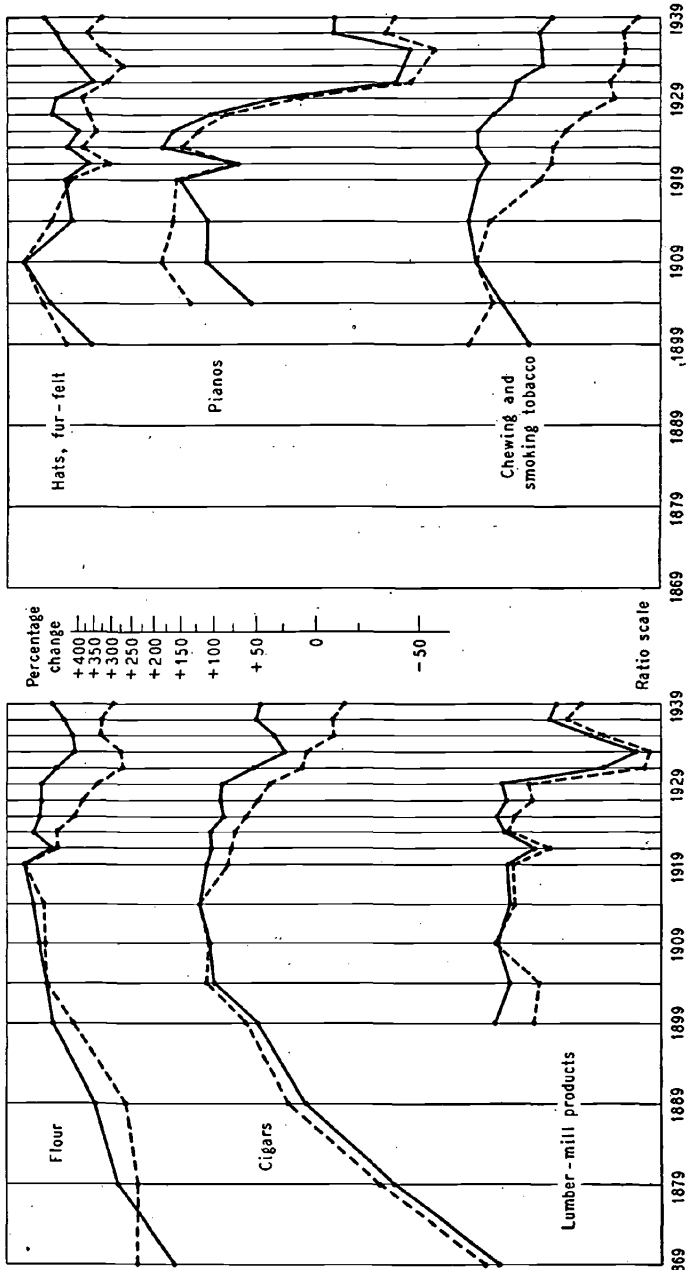


Based on Table F-1

Chart 18 (cont.)

SELECTED MANUFACTURING INDUSTRIES

Indexes of Physical Output (—), and Wage Earners Employed (-----)

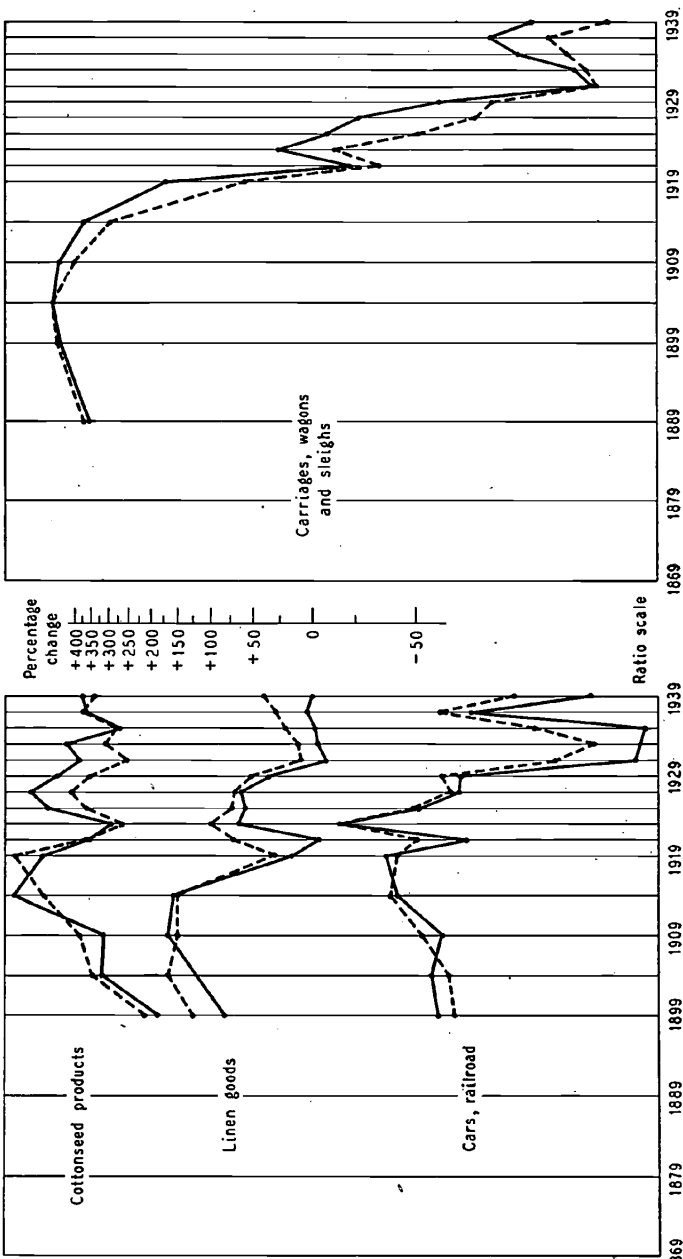


Based on Table F-1

Chart 18 (concl.)

SELECTED MANUFACTURING INDUSTRIES

Indexes of Physical Output (—), and Wage Earners Employed (-----)



1869 1879 1889 1899 1909 1919 1929 1939

Based on Table F-1

levels lower than the previous high points. If the heights of the succeeding levels are taken into account, as well as the direction of movement between them, a pronounced downward trend is discernible in the rate of growth of output.

That the phenomenon of retardation is widespread is indicated in Table 12; here the average rate, per decade, of change in the rate of growth is specified by the measure of retardation. Ninety-nine industries are included in the table. In over eight tenths of these output grew at a progressively slower rate. Exclusion of the period 1929-37 reduces both the number of industries and the proportion affected by retardation, yet over seven tenths of the 74 industries for which figures are available are still to be classed in that category. Further restriction to industries for which there are long series (that is, at least back to 1899) hardly modifies this picture. Some of the exceptional industries, it is interesting to note, were powerfully influenced by external events. Among these are three liquor industries, which, after serious curtailment of their production by the prohibition amendment, revived dramatically upon its repeal. Again, several industries producing construction materials—sand-lime brick, clay products (brick), lumber, and cast-iron pipe—benefited substantially from the great building boom of the 1920's. Petroleum refining is another industry characterized by acceleration in growth of output, in this case because of the development of the motorcar during the last three of the six decades covered by the series for this industry.

With these exceptions, then, the rate of change in manufacturing output has tended to decline with the passage of time. Rapid rates of increase in output have usually been followed by slower rates, and the latter by actual decreases. Put somewhat differently, the output of individual industries has tended to rise less and less rapidly from decade to decade, eventually becoming zero (at peak output) and then negative.

TABLE 12

SELECTED MANUFACTURING INDUSTRIES

Physical Output and Wage-Earner Employment:
Measures of Retardation in Growth

Industry	Period Covered by Series	Measure of Retardation, Full Period		Measure of Retardation, Period excl. 1929-37	
		Physical Number Out- put	of Wage Earners	Physical Number Out- put	of Wage Earners
<i>Percent per decade</i>					
<i>Foods</i>					
Meat packing	1879-1937	-1.0	-1.3	-0.9	-1.6
Oleomargarine	1925-1937	-5.2	-1.4		
Flour	1869-1937	-0.9	-0.5	-0.8	-0.7
Cereals	1925-1937	-11.4	1.6		
Rice	1899-1937	-3.0	-1.5	-4.0	-4.5
Bread and cake	1923-1937	-5.1	-1.6		
Biscuits and crackers	1923-1937	-2.7	-1.3		
Fish, canned	1904-1937	-0.8	0.0	-0.9	-1.2
Fruits and vegetables, canned	1899-1937	-0.1	0.7	0.4	0.7
Milk, canned	1904-1937	-3.4	-2.2	-3.8	-4.9
Butter	1904-1937	-0.9	-1.4	0.6	-1.5
Cheese	1904-1937	0.7	0.4	0.8	-0.9
Ice cream	1923-1937	-3.3	-1.8		
Beet sugar	1899-1937	-4.9	-4.0	-7.1	-8.3
Cane sugar, not elsewhere made	1909-1937	5.8	1.9	0.8	-12.7
Cane-sugar refining	1909-1937	-2.5	-3.3	-1.4	-9.0
Confectionery	1925-1937	3.8	-2.0		
Chocolate	1923-1937	-0.7	3.8		
Corn products	1909-1937	-3.0	-2.2	-0.3	-6.2
Ice	1899-1937	-4.4	-4.9	-3.0	-3.8
<i>Beverages</i>					
Liquors, malt	1899-1919	-10.7	-7.6	-10.7	-7.6
Liquors, distilled	1899-1937	26.2	7.6	-1.9	-2.4
Malt	1925-1937	6.8	12.6		
Liquors, vinous	1923-1937	39.5	22.4		
<i>Tobacco products</i>					
Cigarettes	1904-1937	-4.1	-4.0	-2.6	-6.2
Cigars	1869-1937	-1.7	-2.1	-1.7	-2.1
Chewing and smoking to- bacco	1899-1937	-2.1	-0.2	-3.1	-2.2
<i>Textile products</i>					
Cotton goods	1869-1937	-0.8	-0.6	-0.7	-0.5
Lace goods	1914-1937	1.0	2.5	-1.9	3.4

TABLE 12 (continued)
 SELECTED MANUFACTURING INDUSTRIES
 Physical Output and Wage-Earner Employment:
 Measures of Retardation in Growth

Industry	Period Covered by Series	Measure of Retardation, Full Period		Measure of Retardation, Period excl. 1929-37	
		Physical Output	Number of Wage Earners	Physical Output	Number of Wage Earners
<i>Percent per decade</i>					
<i>Textile products (concluded)</i>					
Woolen and worsted goods	1879-1937	-0.3	-0.4	-0.5	-0.7
Silk and rayon goods	1879-1937	-1.0	-1.2	-1.2	-1.0
Knit goods	1869-1937	-0.8	-1.1	-0.4	-1.1
Carpets and rugs, wool	1899-1937	-0.4	0.0	1.1	1.0
Asphalted-felt-base floor covering	1923-1937	-4.8	-1.3		
Linoleum	1923-1937	-2.5	0.3		
Oilcloth	1899-1937	-3.3	-4.0	-0.7	-5.0
Cordage and twine	1899-1937	-1.0	-0.8	-0.6	-1.6
Jute goods	1899-1937	-0.6	-0.6	-3.6	-3.7
Linen goods	1899-1937	-1.2	0.0	-1.2	0.3
Hats, fur-felt	1899-1937	-1.1	-0.8	-2.1	-2.1
Hats, wool-felt	1879-1937	2.7	2.4	1.1	1.5
Artificial leather	1925-1937	2.4	-1.0		
Wool shoddy	1889-1929	0.1	-1.0	0.1	-1.0
<i>Leather products</i>					
Leather	1889-1937	-0.1	-1.0	-0.4	-1.9
Shoes, leather	1869-1937	-0.5	-0.3	-0.6	-0.4
Gloves, leather	1899-1937	-0.5	1.6	-0.4	1.2
<i>Rubber products</i>					
Shoes, rubber	1899-1937	-1.7	-3.1	-1.2	-2.1
Tires and tubes	1923-1937	-8.5	-5.4		
<i>Paper products</i>					
Paper and pulp	1879-1937	-0.9	-0.6	-0.6	-0.4
<i>Printing and publishing</i>					
Total	1899-1937	-1.9	-0.8	-0.6	-0.4
<i>Chemical products</i>					
Chemicals, industrial, incl. rayon and compressed gases ^a	1899-1937	0.1	-0.9	1.9	-0.4
Cottonseed products	1899-1937	-2.3	-2.1	-2.3	-4.7
Linseed products	1923-1937	-4.8	-0.9		
Carbon black	1914-1937	-6.2	-5.8	-1.8	-3.3

TABLE 12 (continued)

Industry	Period Covered by Series	Measure of Retardation, Full Period		Measure of Retardation, Period excl. 1929-37	
		Physical Output	Number of Wage Earners	Physical Output	Number of Wage Earners
<i>Percent per decade</i>					
<i>Chemical products (concluded)</i>					
Soap	1904-1937	-1.7	-1.9	-2.3	-3.4
Wood-distillation products	1899-1937	-2.0	-2.4	-1.8	-3.1
Charcoal	1923-1937	-5.8	7.4		
Explosives	1889-1937	-2.6	-2.3	-2.7	-3.5
Fertilizers	1899-1937	-1.9	-2.0	-2.2	-3.3
Paints and varnishes	1899-1937	-0.9	-1.0	0.6	-0.4
Salt	1869-1937	-1.0	-0.8	-0.9	-0.7
Tanning and dye materials	1899-1937	-2.3	-1.8	-2.6	-4.6
<i>Petroleum and coal products</i>					
Petroleum refining	1879-1937	-0.1	0.3	1.2	1.5
Coke-oven products	1879-1937	-2.3	-2.7	-1.9	-3.7
Fuel briquettes	1909-1937	-5.9	-2.8	6.0	2.4
<i>Stone, clay and glass products</i>					
Cement	1904-1937	-6.0	-3.1	-5.5	-2.9
Lime	1904-1937	-0.2	-0.9	0.1	-3.6
Concrete products	1925-1937	-7.9	-5.7		
Sand-lime brick	1914-1937	-1.3	-0.9	9.4	3.3
Clay products	1914-1937	0.2	0.4	10.5	7.5
Glass	1899-1937	0.2	-0.5	-0.8	-2.1
<i>Forest products</i>					
Lumber-mill products	1899-1937	-1.1	-1.8	0.3	-2.0
Planing-mill products	1925-1937	-1.3	1.5		
Excelsior	1925-1937	-4.6	-1.9		
Turpentine and rosin	1899-1937	0.5	0.1	2.8	2.1
<i>Iron and steel products</i>					
Blast-furnace products	1889-1937	-1.5	-1.3	-0.8	-2.3
Steel-mill products	1869-1937	-1.4	-0.7	-1.0	-0.9
Wire	1909-1937	-0.8	0.1	3.4	0.4
Wrought pipe	1925-1937	-7.5	1.5		
Cast-iron pipe	1914-1937	1.0	-0.8	16.3	4.3
Firearms	1923-1937	-3.5	-1.6		

TABLE 12 (concluded)
 SELECTED MANUFACTURING INDUSTRIES
 Physical Output and Wage-Earner Employment:
 Measures of Retardation in Growth

Industry	Period Covered by Series	Measure of Retardation, Full Period		Measure of Retardation, Period excl. 1929-37	
		Physical Output	Number of Wage Earners	Physical Output	Number of Wage Earners
<i>Percent per decade</i>					
<i>Nonferrous-metal products</i>					
Copper	1899-1937	-2.8	-1.3	-1.3	-2.4
Lead	1899-1937	-3.0	-0.5	-0.2	-0.9
Zinc	1899-1937	-2.9	-2.0	-2.0	-2.4
Secondary metals, non-precious	1925-1937	-3.5	9.8		
Collapsible tubes	1925-1937	1.2	3.0		
Nonferrous-metal products, not elsewhere classified	1925-1937	-9.8	-4.3		
<i>Machinery</i>					
Phonographs	1899-1929	-8.4	-9.5	-8.4	-9.5
Typewriters	1923-1937	-3.8	-0.5		
<i>Transportation equipment</i>					
Automobiles, incl. bodies and parts	1899-1937	-11.7	-11.3	-10.8	-15.3
Carriages, wagons and sleighs	1889-1937	-3.0	-2.9	-6.5	-6.5
Cars, railroad	1899-1937	-1.1	-1.2	-2.2	-2.7
Locomotives	1889-1937	-3.0	-1.6	-3.8	-2.4
Ships and boats	1899-1937	-3.8	-3.3	-6.3	-7.7
Motorcycles and bicycles	1899-1929	1.0	2.1	1.0	2.1
Carriages and sleds, children's	1925-1937	-3.3	-4.4		
<i>Miscellaneous products</i>					
Organs	1904-1929	3.4	5.4	3.4	5.4
Pianos	1904-1937	-4.7	-3.9	-6.8	-5.9
Buttons	1914-1937	-0.9	1.1	-6.5	-6.6

Source: Based on the rates of change in Table 11. The measure of retardation equals $100(b-1)$, b being given by the equation $1 + \frac{r}{100} = ab^t$, fitted to the rates of change by Glover's method; r = the percentage rate of change in output (or employment) in Table 11, and t = the number of rates in each row (i.e., the number of decades covered, counting periods of less than a decade as equal to a full one).

* The measures of retardation for the rayon branch, covering the period 1923-1937, are -6.6 percent per decade for output and -11.7 percent per decade for employment.

The extensive data in Tables 11 and 12 thus confirm the findings of Kuznets and Burns.¹²

In many of the industries whose output was characterized by a decelerating rate of growth the degree of diminution was quite substantial. The rate of gain in output in one third of the industries listed in Tables 11 and 12 fell off by more than 3 percent per decade. At a 3 percent per decade rate of retardation, an industry's output would slow down in growth from around 10 percent per annum to zero in a period of only four decades.

As for the rate of growth in employment, the evidence in Table 11 shows that it too is subject to retardation. Just as output in most individual industries has tended to expand less and less rapidly with the passage of time, so the percentage change in number of workers employed has usually diminished from period to period. Reductions in hours of labor have modified this pattern, to be sure, and for this reason retardation of growth in number of workers, when measured by direction of change between rates in contigu-

¹² Both Dr. Kuznets' and Dr. Burns' findings relate mainly to the production of single commodities rather than to groups of related commodities. On the other hand, our series cover industries as defined by the Census, that is, they usually apply to groups of commodities. For example, Dr. Burns deals with wheat flour production, whereas we present figures for the entire flour industry, which produces not only wheat flour, but also cornmeal, buckwheat flour, some feed, and so on. The trends in these products have differed from one another; according to the Census the peak of wheat flour production came in 1919, of buckwheat flour in 1909, and of cornmeal in 1899 or earlier. Because of these differences it may be expected that our series for industries would be less extreme in their behavior than Dr. Burns' series for individual products. The Census industrial categories sometimes bring together establishments manufacturing diverse products, such as Portland and non-Portland cements, merely to lessen the total number of separate industries, and to that extent statistics based on the industrial categories yield results less illuminating than those based on individual products. However, many, if not most, of the Census industries do combine establishments producing commodities related through their process of manufacture (such as cottonseed oil and cottonseed cake and meal) and in such cases the trend of employment and output revealed by the Census data is somewhat more significant than the trend that would be shown for the separate products if data were available for them.

ous decades, is far less pronounced than in the case of output. But in terms of the measures in Table 12, the evidence of retardation in growth of employment is almost as substantial as for output. Of the 99 industries listed in Table 12, over seven tenths were characterized by retardation in growth of employment, and if the period 1929-37 is excluded, the proportion is even higher, eight tenths. Undoubtedly trends in manhours would show even more pronounced rates of retardation than trends in employment.

Although rates of retardation in employment are not identical with corresponding rates of retardation in output, they show a distinct resemblance. The data assembled in Table 12 reveal a substantial degree of correlation between pairs of columns. Industries whose output has grown at a rapidly declining rate—automobiles, tires and tubes, and carbon black (a basic material for rubber products)—are outstanding also for speedy decline in rate of growth in employment. Again, industries at the bottom of the list in one respect are usually at the bottom in the other. The liquor industries are worth noting in this connection.¹³

Similarity in degree of retardation in both output and employment does not mean, of course, that the graph of employment is superimposed exactly on that of output. Chart 18 does reveal a marked affinity between the lines for employment and output, but as we already know, peaks in employment frequently precede peaks in output; and at any given time the rate of growth in employment is usually slower than the corresponding rate for output. Both these facts are brought out in Table 11. As a rule (to which there are exceptions), the rate of growth of output is algebraically greater than the corresponding rate for employment. Both rates tend to fall with time, but the difference in levels

¹³ For all the industries in Table 12 the coefficient of rank correlation between the rates of retardation in output and those in employment for the full period is .65.

seems to persist. As the rates decline, they may turn negative, and in this transformation the rate for employment usually precedes that for output.

The time pattern of employment can be inferred, of course, from the time pattern of output and of employment per unit, and there is some value in tracing this connection. For example, in an industry in which output has grown at a rate that has declined progressively, and in which employment per unit has decreased at an approximately constant percentage rate, one should expect to find that the growth of employment has also been characterized by retardation. Indeed, the rate of retardation in employment would exactly equal the rate of retardation in output if the rate of decline in employment per unit were quite constant. Further, under the circumstances stated, the maximum level of employment would precede the maximum level of output by a determinate period. And finally, the rate of increase in employment at any specified time would be equal to a determinate fraction of the corresponding rate of increase in output.¹⁴

¹⁴ The algebraic expression of the reasoning in the text is as follows: Under the circumstances stated, output will be defined by the function

$$\log Q = a + bt + \frac{c}{2}t^2;$$

employment per unit of product, by

$$\log \frac{N}{Q} = A + Bt;$$

and employment, by

$$\log N = \log Q + \log \frac{N}{Q} = (a + A) + (b + B)t + \frac{c}{2}t^2;$$

in which Q = output, N = employment, t = time, and the other symbols represent constants. The rate of growth in output is derived from the equation

$$\frac{d \log Q}{dt} = b + ct;$$

it is the antilog of $b + ct$. The rate of growth in employment is derived from the equation

$$\frac{d \log N}{dt} = (b + B) + ct;$$

INDUSTRIAL FLUX AND CHANGES IN EMPLOYMENT

Against this background of growth and decline in individual industries, during the period ending with the year 1939, it is well to re-examine certain conclusions brought out in the preceding chapter. Employment appears to move in the same direction as output, but contrary to employment per unit of product, during the early stages of an industry's career; during the middle stages its movement seems to correspond with employment per unit rather than with output; and during the late stages all three tend to follow the same direction. In young industries, whose output characteristically shoots up quickly, the enormous gains in production apparently tend to outweigh the decline in the labor-output ratio; as a consequence employment too expands, most often rather rapidly. During the mature phase of an industry's development output expands slowly, if at all, and the gain is usually more than counterbalanced by the declining trend in the labor-output ratio; as a result jobs decrease unless the length of the working week is reduced sufficiently to offset the decline. During the period between the peak in output and the peak

it is the antilog of $(b + B) + ct$. B , which is the log of the rate of decline in N/Q , is, of course, negative. The maximum in Q is reached when

$$b + ct = 0, \text{ or } t = \frac{-b}{c}.$$

The maximum in N is reached when

$$(b + B) + ct = 0, \text{ or } t = \frac{-(b + B)}{c}.$$

The difference between the dates of the two maxima is B/c .

If the rate of decline in the employment-output ratio is correlated with the rate of increase in output, as was suggested though not established in Chapter 3, the inference concerning employment becomes more complex though it is not seriously modified. Then, as compared with the preceding case, employment will reach a maximum earlier; will reach a lower maximum; will rise less rapidly to the maximum; will fall less rapidly from the maximum; and finally, will not be symmetrical about the vertical passing through the maximum.

in employment, if the two differ, there will naturally be a decline in employment while output is still rising. The length of this period will depend on the particular rate of decline in employment per unit in the industry. Often, of course, business cycles and random perturbations will cause the peaks of employment and output to coincide, as we have seen. But in the vicinity of these peaks there may still be differences in direction of movement as between employment and output. In old and waning industries, falling output offers no counterpoise to diminishing labor requirements per unit of product, and even substantial cuts in weekly hours of work fail to stem reductions in the number employed.

These conclusions, based on the period bounded mainly by 1899 and 1939, would have to be modified somewhat if it were found that the labor-output ratio not only shrinks but does so at a rate that changes regularly from stage to stage.¹⁵ But whether or not there does exist a typical pattern of development in employment per unit of product, there can be no question that there has been continuous flux in the industrial distribution of employment. In almost all prosperous years, and in many years of poor business as well, to judge from what has happened during the Census years 1899-1939, the employment offered by one or another industry has reached a maximum. Jobs grow in number in some branches

¹⁵ If unit labor requirements shrink at a declining rate, their sharpest drops must occur in precisely the stages at which output is expanding most rapidly; and since the rise of the latter overcompensates for the shrinkage in the former, presumably the number employed mounts most rapidly in the same period. In that case, also, the change in labor per unit would become less and less noticeable just when employment is expanding but slowly or actually receding, for in this period output is either lagging behind that of most other industries or definitely sagging. If deceleration of change in unit labor requirements could be proven, one would have to conclude, then, that an industry's labor force usually expands most rapidly when its reductions in labor per unit are most drastic, and least rapidly or not at all when it has ceased substantially to cut its unit labor requirements. All this is by way of conjecture, however. We cannot state, from the data gathered in this study, that the labor-output ratio has changed at other than a fairly constant rate during the life of an industry.

of industry while they decline in others, even though the aggregate for all industry may show scarcely a ripple.

Something of this industrial ebb and flow was perceptible in earlier tables of this chapter. A different view is provided by Table 13.¹⁶ In the first decade of the century there was a

TABLE 13

INCREASES AND DECREASES IN WAGE-EARNER
EMPLOYMENT IN MANUFACTURING
INDUSTRIES, SELECTED PERIODS

Period	Total Number of Separate Industries	Average Number of Wage Earners ^a	Increases in Employment		Decreases in Employment	
			Number of Industries with Increases	Sum of Job Increases	Number of Industries with Decreases	Sum of Job Decreases
1899-1909	266	5,370,685	225	1,773,601	41	80,320
1909-1919	290	7,350,597	221	2,443,313	69	372,490
1919-1929	307	8,382,720	144	994,693	163	1,051,019
1929-1937	289	8,472,662	150	834,525	139	629,122

Source: Based on an analysis of the data in Appendix B-1.

^a Average of numbers employed in the two years compared.

net decline in employment in 41 manufacturing industries, a loss amounting in all to some 80 thousand wage-earner jobs; but during the same period there was an increase in employment in 225 industries, amounting to 1.8 million jobs. In the decade 1909-19 decreases in employment occurred in 69 industries, a loss of close to 400 thousand jobs; and increases in 221 industries, a gain of almost 2.5 million jobs. In the next two periods job losses exceeded or came close to equaling job increases. Between 1919 and 1929 more than half our manufacturing industries registered net losses in employment; during these years over one million, or one in eight, jobs were eliminated, while about a million new ones

¹⁶ This table follows closely one published by Frederick C. Mills in *Economic Tendencies in the United States* (National Bureau of Economic Research, 1932), p. 420.

were created. In the last period covered, 1929-37, there were 600 thousand losses and 800 thousand increases.¹⁷

This incessant shifting of employment among industries bears upon certain aspects of the problem of technological labor displacement. The connections between advance in technology and the aggregate volume of employment and unemployment are, of course, exceedingly complex, and one could scarcely claim that the preceding discussion of one aspect of change, secular trends, in one sector of the economy, manufacturing, disentangles them. Nevertheless the findings, limited though they are, at least help to explain employment changes in individual industries, and to indicate the kinds of influence exerted upon these changes by technological developments.

Technological change, which is usually held to comprise also changes in efficiency and other factors connected only remotely if at all with technology proper, plays a part not only in the decline of employment in mature and decadent industries but in the emergence of new sources of employment as well. The founding of new industries, their solution of basic production problems and their subsequent rapid growth are largely matters of technological progress. And the sustenance of growth in mature industries, or the postponement of decline in older ones, has been due frequently to the technological advances made under the stress of competition for markets, materials, labor and capital. Even reductions in hours of labor, which lessen or offset the effect of factors making for reductions in employment, constitute one of the important fruits of general technological progress, distributed even to workers in laggard or stagnant industries. Technological development thus leads not only to loss of work but to new jobs and to long tenure.

The relationships involved even in a single industry are far

¹⁷ This summary takes no account of the violent changes in employment in the interval between the two terminal years.

from simple. When employment in an industry is contracting, and its technological level is rising at the same time, we cannot always state unequivocally that technological development is the factor responsible for the reduction in jobs. In the cigar industry, for example, production was 20 percent less in 1937 than in 1929, and aggregate manhours were 52 percent lower, but because of a shorter working week only 33 percent fewer workers were employed. Workers per unit fell almost 20 percent and manhours per unit 40 percent. Can we say that this reduction in unit labor requirements led to an equivalent labor displacement? Is it not possible that output, and with it employment, might have fallen still more had mechanization not been instituted and costs and prices cut? All this is not to deny that the trend of employment is downward in many industries and that a painful process of adjustment is continually going on. Yet *technological* unemployment in an industry, i.e., the fraction of unemployment that may be ascribed to a particular set of the several sets of factors making for unemployment, remains so complex a quantity that it can scarcely be estimated with existing statistics.

When employment and output are not falling, but rather rising, it is more readily apparent that declines in employment per unit do not necessarily mean labor displacement. Yet even in this case changes in the ratio of employment to production have been interpreted as measures of the displacement of labor. The volume of manufacturing output in 1929 was 64 percent greater than it had been in 1919, but the number of wage earners employed had not increased at all. It was 8.4 million in both 1919 and 1929. In these ten years, therefore, the number of workers engaged in producing a unit of output fell by almost 40 percent. It has sometimes been inferred from this evidence of stagnation of employment that post-war advances in technology and related developments prevented 5.4 million workers (i.e., 64 percent of 8.4) from

finding employment in manufacturing. But it is also relevant that the 64 percent advance in output could not have occurred if costs had not been cut; and that employment in other branches of industry, such as trade and service, expanded at the same time, contributing, incidentally, to the advance in factory output.

On the question of technological unemployment, viewed as a problem of the individual industry, one may make a few summary observations, though these do not rest entirely on the statistics considered here. First, the amount of "unemployment" in a specific industry is rather meaningless. There is constant shifting of labor among industries. Many workers, for example carpenters, are members of crafts or trades, rather than of industries. For this reason the total number of persons attached to a particular industry (including the unemployed) is not a significant one; and the difference between the number of persons attached and the number actually employed, i.e., the number unemployed, also is without meaning. It is preferable, therefore, to concentrate on *labor displacement*, i.e., the net decline in the number employed in a given industry during a specified time period.¹⁸ This leads

¹⁸ It must be stressed that we are dealing with but one element in labor turnover. Shifts of employment between regions and occupations are also significant, as is the movement of workers from one establishment to another. Thus, a change in occupation even within the same plant, often attributable to technological development, requires adjustment and imposes a burden on the persons affected. Nor is industrial turnover necessarily more important than the other types. As statements in the Census volumes attest, establishments frequently shift from one industry to another (i.e., change the nature of their main product) without a drastic change in personnel.

Furthermore, we are measuring *net* changes. Employment in an industry may show no net change whatever or may change but slightly, yet every worker in it may have been discharged and replaced. The considerable rate of turnover that may be involved in this sort of shift is illustrated by the course of events in a large cigar company when its operations were mechanized. The 626 hand workers employed by the company in 1931 (more than half of whom were men) had been replaced by 1936 by 13 hand workers on part time, 202 machine operators (mostly women) and 20 machinists. Few of the machine operators were retrained hand workers. (Daniel Creamer and Gladys V. Swackhamer, *Cigar Makers—After the Lay-Off*, National Research Project, Philadelphia, 1937, pp. 23-24.)

us to our second comment. The labor displacement associated with any event or complex of events in an industry cannot be measured by study of that industry alone. For one thing, there are such secondary effects as the displacement of labor in other industries in the community. The shutdown of a large local industry affects retail trade and other local activity. "Ghost towns" stand as tragic monuments to this sort of industrial collapse. Perhaps more important are the secondary effects of changes in a particular industry upon competing or complementary industries. The displacement of workers by machines may be accompanied by increased employment in the mechanical trades. Decline in carriage manufacture was associated with growth in motor-vehicle production. Technological displacement of labor thus often has its counterpart in technological "expansion of labor," as Carroll Wright has called it. In the third place, neither technology nor any other single factor can, as a rule, be set apart as *the* factor making for a given change in employment. Except in the rare cases when technological development is clearly the predominant element, its effect cannot be determined.

Finally, there is a hard kernel of truth in the contention that technological changes—and all the other developments characteristic of a dynamic economy—frequently create serious needs for adjustment. But it is true too that the separation of workers from their jobs has not always meant forced or prolonged unemployment, for growing industries have often attracted labor from other sectors of the economy by offering higher wages and better working conditions.