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CHAPTER 6

The Supply and Condition of Equipment

STOCK OF VEHICLES POORLY OR INVERSELY RELATED TO TRAFFIC

The preceding two chapters show that the number of cars and locomotives with which the railroads handle their business did not increase as much as traffic when the latter was growing or decline as much when it was diminishing. They tell nothing, however, about the direction of change in the size of the equipment stock itself. In expansions the stock may, for all we have yet said, have increased (although not in proportion to traffic) or may have decreased. In contractions it may have been reduced (although not proportionately) or augmented.

As a matter of fact the stock sometimes became larger and sometimes smaller in expansion, and likewise in contraction. Up to the first World War, the railroads made net additions to their supply of every kind of equipment for which we have information in phases of rising and in those of falling traffic alike (Table 33). Beginning in the early or middle 1920's (depending on the type of vehicle) stocks of every variety diminished in phases of both kinds. In the intermediate period (marked off by horizontal lines in the table) most of our observations for locomotives and freight cars indicate increases in stocks, regardless of phase; but two show falls in expansions, and two in contractions of traffic. (The number of passenger cars was reduced in all rising phases of travel except one, augmented in all the falling phases.)

Even when allowance is made for changes in the rate of growth or decline as well as for direction of change, the number of vehicles does not appear to have conformed positively to the fluctuations in traffic (Table 34). In the case of total stocks, instances counting toward an inverse are more numerous than those counting toward a positive relation, on the whole. For freight locomotives before the war, however, the margin is very close, and for freight cars afterward the data suggest positive conformity by a fair preponderance. In the case of serviceable stocks margins are so narrow that they indicate little conformity of either type.

Table 33

Direction of Change in Stocks of Locomotives and Cars during Cycles in Ton-miles and Passenger-miles

Level of traffic	Approx. date[a]	Direction of change from preceding date						
		Freight service				Passenger service		
		Locomotives		Cars		Locomotives		Cars
		All (Tables 35, 36)	Serviceable (Table 36)	All (Tables 37, 36)	Serviceable (Table 36)	All (Tables 38, 39)	Serviceable (Table 39)	All (Table 40)
Peak	1876							
Trough	1877			+				
Peak	1884			+				
Trough	1885			+				
Peak	1893			+				
Trough	1894	+		+				
Peak	1903	+		+				
Trough	1904	+		+				
Peak	1907	+		+				
Trough	1908	+		+				
Peak	1910	+		+		+		+
Trough	1911	+		+		+		+
Peak	1913	+		+		+		+
Trough	1914	+		+				+
Peak	1918			+				−
Trough	1919			+				+
Peak	1920			−				−
Trough	1921	+	+	−	−			+
Peak	1923	−	+	+	+	−	+	−
Trough	1924	+	+	+	+	−	+	+
Peak	1926	−	−	+	+	−	−	+
Trough	1927	−	−	−	−	−	−	b
Peak	1929	−	−	−	−	−	−	b
Trough	1932	−	−	−	−	−	−	−[c]
Peak	1937	−	−	−	−	−	−	−
Trough	1938	−	−	−	−	−	−	−

[a] For exact dates and annual or monthly nature of figures see tables indicated.
[b] No corresponding phases.
[c] From 1925 to 1932.

What data we have on capacity rather than number do not suggest that the aggregate load-carrying ability of freight cars varies directly with ton-miles: 13 comparisons score inverse, only 4 positive conformity (Table 41). Between 1921 and 1938 the aggregate number of seats in passenger cars was inversely related to travel in all instances except two (Table 42). (Data on the tractive effort of locomotives are not adequately subdivided by services.)

Table 34

Number of Comparisons suggesting Positive, and Number suggesting Inverse, Conformity of Equipment Stocks to Cycles in Ton-miles or Passenger-miles

Branch of service	Kind of vehicle	Period	All vehicles		Serviceable vehicles		Source table
			Positive	Inverse	Positive	Inverse	
Freight	Locomotives	1893–1914	3	4	...	...	35
Freight	Locomotives	1921–38	1	7	4	4	36
Freight	Cars	1876–1921	6	10	...	...	37
Freight	Cars	1920–38	6	2	5	3	36
Passenger	Locomotives	1908–13	0	2	...	...	38
Passenger	Locomotives	1922–38	1	6	4	3	39
Passenger	Cars	1908–38	1	12	...	...	40

Table 35

Freight Locomotives: Change per Year between End-quarter Peaks and Troughs in Ton-miles, 1893–1914

	Level of end-quarter ton-miles[a]	Years from prec. date	No. of locomotives[b]	Change from preceding date			Conformity suggested[c]
				Total	Per year: To peak from trough	Per year: To trough from peak	
1893	Peak	...	19,603	...	...	...	...
1894	Trough	1	20,090	397	...	397	...
1903	Peak	9	25,444	5,444	605	...	Positive
1904	Trough	1	27.029	1,585	...	1,585	Inverse
1907	Peak	3	32,079	5,050	1,683	...	Positive
1908	Trough	1	33,840	1,761	...	1,761	Inverse
1908	Trough	...	33,655	...	...	...	...
1910	Peak	2	34,992	1,337	668	...	...
1911	Trough	1	36,405	1,413	...	1,413	Inverse
1913	Peak	2	38,493[d]	2,088	1,044	...	Inverse
1914	Trough	1	39,333[d]	840	...	840	Positive

[a] Quarter ended June 30. Level in other than end-quarters ignored in determining peaks and troughs.

[b] June 30.

[c] By comparison with preceding rate, e.g., 605 with 397.

[d] Class I plus II plus III railways assumed to bear same ratio to I plus II as in 1912

Table 36

Number of Locomotives assigned to Road Freight Service, and Number of Freight Cars on Line
Change per Month between Peaks and Troughs in Revenue Ton-miles, 1920–1938

Turn in ton-miles		Months from prec. date	All vehicles					Serviceable vehicles				
				Change from prec. date					Change from prec. date			
					Per month					Per month		
Date	Level		Number[a]	Total	To peak from trough	To trough from peak	Conformity suggested by comparison with preceding rate	Number[a]	Total	To peak from trough	To trough from peak	Conformity suggested by comparison with preceding rate
Locomotives												
Feb. 1920	Peak	...	[b]					[b]				
July 1921	Trough	17	33,129	...	...	Rise	...	25,208	...	...	Rise[c]	...
Apr. 1923	Peak	21	32,973	−156	−7.4	...	Inverse	25,227	19	0.9	...	Inverse
June 1924	Trough	14	33,238	265	...	18.9	Inverse	27,021	1,794	...	128.1	Inverse
July 1926	Peak	25	31,686	−1,552	−62.1	...	Inverse	26,526	−495	−19.8	...	Inverse
Dec. 1927	Trough	17	30,618	−1,068	...	−62.8	Positive	25,800	−726	...	−42.7	Positive
Aug. 1929	Peak	20	28,908	−1,710	−85.5	...	Inverse	24,198	−1,602	−80.1	...	Inverse
July 1932	Trough	35	27,984	−924	...	−26.4	Inverse	20,437	−3,761	...	−107.5	Positive
Apr. 1937	Peak	57	24,096	−3,888	−68.2	...	Inverse	17,854	−2,583	−45.3	...	Positive
May 1938	Trough	13	23,947	−149	...	−11.5	Inverse	17,060	−794	...	−61.1	Positive
Cars (thousands)												
Feb. 1920	Peak	...	2,500	...	...	...	...	2,322	...	...	...	...
July 1921	Trough	17	2,434	−66	...	−3.9	...	2,084	−238	...	−14.0	...
Apr. 1923	Peak	21	2,463	29	1.4	...	Positive	2,248	164	7.8	...	Positive
June 1924	Trough	14	2,477	14	...	1.0	Positive	2,295	47	...	3.4	Positive
July 1926	Peak	25	2,521	44	1.8	...	Positive	2,365	70	2.8	...	Inverse
Dec. 1927	Trough	17	2,496	−25	...	−1.5	Positive	2,348	−17	...	−1.0	Positive
Aug. 1929	Peak	20	2,471	−25	−1.2	...	Positive	2,325	−23	−1.2	...	Inverse
July 1932	Trough	35	2,357	−114	...	−3.3	Positive	2,109	−216	...	−6.2	Positive
Apr. 1937	Peak	57	1,968	−389	−6.8	...	Inverse	1,768	−341	−6.0	...	Positive
May 1938	Trough	13	1,935	−33	...	−2.5	Inverse	1,714	−54	...	−4.2	Inverse

[a] Three-month average; date of turn is middle month.

[b] Not known, because certain roads failed to report; but even with these included, figure would be lower than that for July 1921; see Charts 69 and 70.

Table 37

Freight Train-cars: Change per Year between End-quarter Peaks and Troughs in Ton-miles, 1876–1921

	Level of end-quarter ton-miles[a]	Years from prec. date	Freight-train cars[b]	Change from prec. date: Total	Per year: To peak from trough	Per year: To trough from peak	Conformity suggested[c]
			(thousands of cars)				
1876	Peak	...	385	...	...	...	...
1877	Trough	1	392	7	...	7	...
1884	Peak	7	798	406	58	...	Positive
1885	Trough	1	806	8	...	8	Positive
1893	Peak	8	1,206	400	50	...	Positive
1894	Trough	1	1,229	23	...	23	Positive
1893	Peak	...	1,013	...	...	...	...
1894	Trough	1	1,205	192	...	192	...
1903	Peak	9	1,654	449	50	...	Inverse
1904	Trough	1	1,692	38	...	38	Positive
1907	Peak	3	1,992	300	100	...	Positive
1908	Trough	1	2,101	109	...	109	Inverse
1910	Peak	2	2,148	47	24	...	Inverse
1911	Trough	1	2,209	61	...	61	Inverse
1913	Peak	2	2,298	89	44	...	Inverse
1914	Trough	1	2,350	52	...	52	Inverse
1918	Peak	4.5	2,398	48	11	...	Inverse
1919	Trough	1	2,427	29	...	29	Inverse
1920	Peak	1	2,388	−39	−39	...	Inverse
1921	Trough	1	2,379	−9	...	−9	Inverse

[a] Quarter ended June 30, 1876–1914; December 31, 1918–21. Level in other quarters ignored.

[b] On last day of quarter.

[c] By comparison with preceding rate; e.g., 58 with 7.

Table 38

Passenger Locomotives: Change per Year between End-quarter Peaks and Troughs in Passenger-miles, 1908–1913

	1908	1910	1911	1913
Level of passenger-miles, quarter ended June 30[a]	Trough	Peak	Trough	Peak
Years from preceding date	...	2	1	2
Passenger locomotives on June 30				
Number	13,185	13,660	14,301	14,612[b]
Change in number from preceding date	...	475	641	311
Total				
Per year				
To peak from trough	...	238	...	156
To trough from peak	...	...	641	...

[a] Level in other than end-quarters ignored.

[b] Class I plus II plus III assumed to bear same ratio to Class I plus II as in 1912.

Table 39

Number of Locomotives assigned to Road Passenger Service

Change per Month between Peaks and Troughs in Revenue Passenger-miles, 1922–1938

Turn in passenger-miles		Months from prec. date	All locomotives[a]	Change from prec. date			Conformity suggested[b]	Serviceable locomotives[a]	Change from prec. date			Conformity suggested[b]
					Per month					Per month		
Date	Level			Total	To peak from trough	To trough from peak			Total	To peak from trough	To trough from peak	
Feb. 1922	Trough	...	15,089	...	...	...	...	11,746	...	...	...	...
Oct. 1923	Peak	20	14,432	−657	−33	...	...	11,766	20	1	...	...
Apr. 1925	Trough	18	14,425	−7	...	0	Inverse	11,816	50	...	3	Inverse
Aug. 1925	Peak	4	14,325	−100	−25	...	Inverse	11,779	−37	−9	...	Inverse
Dec. 1928	Trough	40	12,664	−1,661	...	−42	Positive	10,588	−1,191	...	−30	Positive
Mar. 1929	Peak	3	12,435	−229	−76	...	Inverse	10,417	−171	−57	...	Inverse
Mar. 1933	Trough	48	10,475	−1,960	...	−41	Inverse	7,620	−2,797	...	−58	Positive
Mar. 1937	Peak	48	8,166	−2,309	−48	...	Inverse	6,490	−1,130	−24	...	Positive
Aug. 1938	Trough	17	7,953	−213	...	−13	Inverse	6,023	−467	...	−27	Positive

[a] Three-month average; date of turn is middle month.

[b] By comparison with preceding rate; e.g., 0 with −33 or 3 with 1.

Table 40

Passenger-carrying Cars: Change per Year between End-quarter Peaks and Troughs in Passenger-miles, 1908–1938

	Level of end-quarter passenger-miles[a]	Years from prec. date	Passenger-carrying cars[b]	Change from preceding date		
				Total	Per year	
					To peak from trough	To trough from peak
				(number of cars)		
1908	Trough	...	31,278[c]	...	...	...
1910	Peak	2	32,702[c]	1,424	712	...
1911	Trough	1	34,233[c]	1,531	...	1,531
1910	Peak	...	37,908[d]	...	...	...
1911	Trough	1	40,081[d]	2,173	...	2,173
1913	Peak	2	42,278[d]	2,197	1,098	...
1911	Trough	...	37,676	...	...	...
1913	Peak	2	39,815	2,139	1,070	...
1915	Trough	2	42,003	2,188	...	1,094
1917	Peak	2.5	41,589	−414	−166	...
1918	Trough	1	41,922	333	...	333
1919	Peak	1	41,699	−223	−223	...
1921	Trough	2	41,838	139	...	70
1923	Peak	2	41,509	−329	−164	...
1924	Trough	1	41,719	210	...	210
1925	Peak	1	41,821	102	102	...
1932	Trough	7	37,059	−4,762	...	−680
1937	Peak	5	29,678	−7,381	−1,476	...
1938	Trough	1	28,791	−887	...	−887

[a] Quarter ended June 30, 1908–15; December 31, 1917–38. Level in other quarters ignored.

[b] On last day of quarter. Class I line-haul roads plus Pullman Co., except as noted.

[c] All line-haul roads, only.

[d] All line-haul roads plus Pullman Co.

Changes in a stock of equipment are the net result of two processes—installation and retirement.[1] If installations during a phase

[1] Installations include, among other subdivisions, "Used units acquired", "Leased units returned to service", "Leased from others—used units". These categories may represent to some degree transfers among Class I railways rather than additions to the supply available to them as a class. Retirements included "Leased to others" and "Returned to lessors—not known to have been permanently withdrawn for sale or demolition", which may represent transfers rather than group losses. Installations and retirements by "reclassifications" of cars likewise may not be real gains and losses. In the case of freight cars, however, reclassifications appear to be largely shifts to and from "company service equipment", i.e., real additions to and deletions from the freight fleet. Subdivisions of the installation and retirement figures have been published for 1932 and subsequent years. For freight cars they suggest that the dubious categories are unimportant. "New

Table 41

Aggregate Capacity of Railway-owned Freight Cars

Change per Year between Peaks and Troughs in End-quarter Ton-miles, 1903–1938

	Level of end-quarter ton-miles[a]	Years from prec. date	Aggregate capacity[b]	Change from preceding date: Total	Per year: To peak from trough	Per year: To trough from peak	Conformity suggested by comparison with prec. rate
			(millions of tons)				
1903	Peak	...	48.6	...	...	...	...
1904	Trough	1	50.9	2.3	...	2.3	...
1907	Peak	3	67.3	16.4	5.5	...	Positive
1908	Trough	1	73.3	6.0	...	6.0	Inverse
1910	Peak	2	77.1	3.8	1.9	...	Inverse
1911	Trough	1	81.5	4.4	...	4.4	Inverse
1913	Peak	2	88.0	6.5	3.2	...	Inverse
1914	Trough	1	91.9	3.9	...	3.9	Inverse
1914	Trough	...	88.8[c]	...	...	...	...
1918	Peak	4.5	96.8	8.0	1.8	...	...
1919	Trough	1	99.0	2.2	...	2.2	Inverse
1920	Peak	1	98.3	−0.7	−0.7	...	Inverse
1921	Trough	1	98.5	0.2	...	0.2	Inverse
1922	Peak	1	98.8	0.3	0.3	...	Positive
1923	Trough	1	101.3	2.5	...	2.5	Inverse
1926	Peak	3	106.0	4.7	1.6	...	Inverse
1927	Trough	1	105.8	−0.2	...	−0.2	Positive
1928	Peak	1	105.3	−0.5	−0.5	...	Inverse
1932	Trough	4	100.9	−4.4	...	−1.1	Positive
1936	Peak	4	85.7	−15.2	−3.8	...	Inverse
1938	Trough	2	84.0	−1.7	...	−0.8	Inverse

[a] Quarter ended June 30, 1903–14; December 31, 1918–38. Level in other quarters ignored.

[b] On last day of quarter. All railways, 1903–14; Class I line-haul railways, 1914–38.

[c] Figure for all roads, 1914, multiplied by 1915 ratio, .966, of Class I to all.

are higher than retirements the stock will increase; if they are lower it will decline. If average monthly (or annual) installations exceed average monthly (or annual) retirements by a wide margin, the stock will increase more rapidly than if there is only a narrow excess. If they fall short of average retirements by a wide margin,

units acquired" and "Rebuilt and re-written into property accounts" include a great majority of installations, "Permanently withdrawn for sale or demolition" and "Retired for purpose of rebuilding" a great majority of retirements.

Chiefly because of changes in the list of Class I carriers, the net balance of installations and retirements during a year will not exactly equal the net change in stocks between year-ends.

Table 42

Aggregate Seating Capacity of Passenger Cars (thousands of seats)
Change per Year between Peaks and Troughs in End-quarter Passenger-miles, 1921–1938

Date	1921	1923	1924	1925	1932	1937	1938	1932	1937	1938
Level of end-quarter passenger miles	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Trough	Peak	Trough
Years from preceding date	. . .	2	1	1	7	5	1		5	1
Aggregate capacity[a]	2,184	2,213	2,227	2,198	1,965	1,583	1,543	2,208	1,782	1,739
Change from preceding date										
Total	. . .	29	14	−29	−233	−382	−40	. . .	−426	−43
Per year										
To peak from trough	. . .	14	. . .	−29	. . .	−76	. . .	. . .	−85	. . .
To trough from peak	. . .	. . .	14	. . .	−33	. . .	−40	. . .	. . .	−43
Conformity suggested[b]	. . .	. . .	None	Inverse	Positive	Inverse	Inverse	. . .	. . .	Inverse

[a] Class I line-haul railways only, 1921–38 section. Same plus Pullman Co., 1932–38 section. Prior to 1935 railway-owned sleeping cars were counted as having a capacity of two persons per seat or berth; beginning in 1935 only one. We deducted one-half the railway-owned sleeping car capacity from the *Statistics of Railways* figures before 1935.

[b] By comparison with preceding rate; e.g., 14 with 14.

Table 43

Freight-train Cars Installed and Retired per Year between End-quarter Peaks and Troughs in Ton-miles, 1907–1938

Date[a]	Level of end-quarter ton-miles[b]	Years from prec. date	Number of cars installed			Conformity suggested[c]	Number of cars retired			Conformity suggested[c]
			Total since prec. date	Per year			Total since prec. date	Per year		
				In expansion	In contraction			In expansion	In contraction	
1907	Peak									
1908	Trough	1	171,556	...	171,556	...	70,976	...	70,976	...
1910	Peak	2	202,518	101,259	...	Inverse	158,875	79,438	...	Inverse
1911	Trough	1	125,532	...	125,532	Inverse	68,031	...	68,031	Inverse
1913	Peak	2	260,642	130,321	...	Positive	166,701	83,350	...	Inverse
1914	Trough	1	150,813	...	150,813	Inverse	96,985	...	96,985	Positive
1918	Peak	4[d]	356,725[d]	89,181	...	Inverse	318,620[d]	79,655	...	Positive
1919	Trough	1	76,019	...	76,019	Positive	43,274	...	43,274	Inverse
1920	Peak	1	36,044	36,044	...	Inverse	75,197	75,197	...	Inverse
1921	Trough	1	63,406	...	63,406	Inverse	69,245	...	69,245	Inverse
1922	Peak	1	105,394	105,394	...	Positive	126,471	126,471	...	Inverse
1923	Trough	1	232,060	...	232,060	Inverse	213,789	...	213,789	Positive
1926	Peak	3	389,024	129,675	...	Inverse	350,315	116,772	...	Positive
1927	Trough	1	73,254	...	73,254	Positive	96,991	...	96,991	Inverse
1928	Peak	1	62,945	62,945	...	Inverse	90,707	90,707	...	Positive
1932	Trough	4	199,439	...	49,860	Positive	350,192	...	87,548	Inverse
1936	Peak	4	132,251	33,063	...	Inverse	500,394	125,098	...	Inverse
1938	Trough	2	116,849	...	58,424	Inverse	175,559	...	87,780	Inverse

[a] Year ended June 30, 1907–14; December 31, 1918–38.

[b] Level in other quarters ignored.

[c] By comparison with preceding date; e.g., 101,259 with 171,556 or 79,438 with 70,976. The 'conformity suggested' is that which each comparison of figures suggests would have occurred in the stock of freight cars. For example, since installations were more frequent in 1907–08 than in 1908–10, they tended to build up stock more rapidly in the contraction than in the expansion; i.e., to cause inverse conformity of stock. Since retirements were less frequent in 1907–08 than in 1908–10, they tended to pull down the stock less rapidly in the contraction than in the expansion; i.e., they too, in this instance, tended to cause inverse conformity.

[d] No data for June 30 to December 31, 1916 available; hence 4 years instead of 4.5 used as divisor.

Table 44

Passenger-train Cars Installed and Retired per Year between End-quarter Peaks and Troughs in Passenger-miles, 1908–1938

Date[a]	Level of passenger-miles, quarter ended on date[b]	Years from prec. date	Number of cars installed			Conformity suggested[c]	Number of cars retired			Conformity suggested[c]
			Total since prec. date	Per year			Total since prec. date	Per year		
				In expansion	In contraction			In expansion	In contraction	
1908	Trough									
1910	Peak	2	5,291	2,646	...	...	3,505	1,752	...	...
1911	Trough	1	4,250	...	4,250	Inverse	1,701	...	1,701	Inverse
1913	Peak	2	5,883	2,942	...	Inverse	3,229	1,614	...	Positive
1915	Trough	2	6,293	...	3,146	Inverse	3,239	...	1,620	Positive
1917	Peak	2[d]	3,796[d]	1,898	...	Inverse	3,827[d]	1,914	...	Inverse
1918	Trough	1	1,817	...	1,817	Positive	1,051	...	1,051	Inverse
1919	Peak	1	435	435	...	Inverse	670	670	...	Positive
1921	Trough	2	2,302	...	1,151	Inverse	1,814	...	907	Positive
1923	Peak	2	3,986	1,993	...	Positive	3,646	1,823	...	Inverse
1924	Trough	1	2,755	...	2,755	Inverse	2,295	...	2,295	Positive
1925	Peak	1	3,230	3,230	...	Positive	3,569	3,569	...	Inverse
1932	Trough	7	14,464	...	2,066	Positive	19,574	...	2,796	Inverse
1937	Peak	5	4,237	847	...	Inverse	12,904	2,581	...	Positive
1938	Trough	1	642	...	642	Positive	1,592	...	1,592	Inverse

[a] Year ended June 30, 1908–15; December 31, 1917–38.

[b] Level in other quarters ignored.

[c] By comparison with preceding rate; e.g., 4,250 with 2,646 or 1,701 with 1,752. For the special meaning of positive or inverse conformity here, which may seem puzzling in the column for retirements, see note c to Table 43.

[d] No data for June 30 to December 31, 1916 available, hence 2 years instead of 2.5 used as divisor.

the stock will decline more rapidly than if the deficiency is small. We may analyze separately the effect of each upon the conformity of the stock. If the average rate of installation is higher in expansion than in contraction, for example, the stock must conform positively, provided the rate of retirement is the same in both phases. If the average rate of retirement is higher in expansion than in contraction, the stock must conform inversely, provided installations proceed at the same rate in both.

In fact, neither corresponded very closely to fluctuations in traffic. More often than not, installations of freight cars proceeded more rapidly in contractions than in expansions of ton-miles. Eleven comparisons of adjoining phases indicate greater annual gross additions to car supply when the movement of freight was diminishing than when it was increasing. Five indicate the contrary (Table 43). In most cases installations tended to produce inverse conformity of car stocks. Retirements, on the other hand, were, if anything, more frequent in expansion. Eleven comparisons indicate more rapid gross reductions in expansion than in contraction; only 5 indicate the reverse. Retirements, like installations, tended to produce inverse conformity of stocks. Neither majority, however, is very impressive.

Installations and retirements of passenger-train cars were even less consistently responsive to cyclical variations in traffic than those of freight cars (Table 44).[2] In 5 comparisons, cars were added to supply more rapidly when travel was gaining; but in 8, additions were more frequent in contraction. Retirements proceeded faster in expansion in 7 pairs of phases, but slower in 6.[3]

POSITIVE RELATION OVER LONG PERIODS

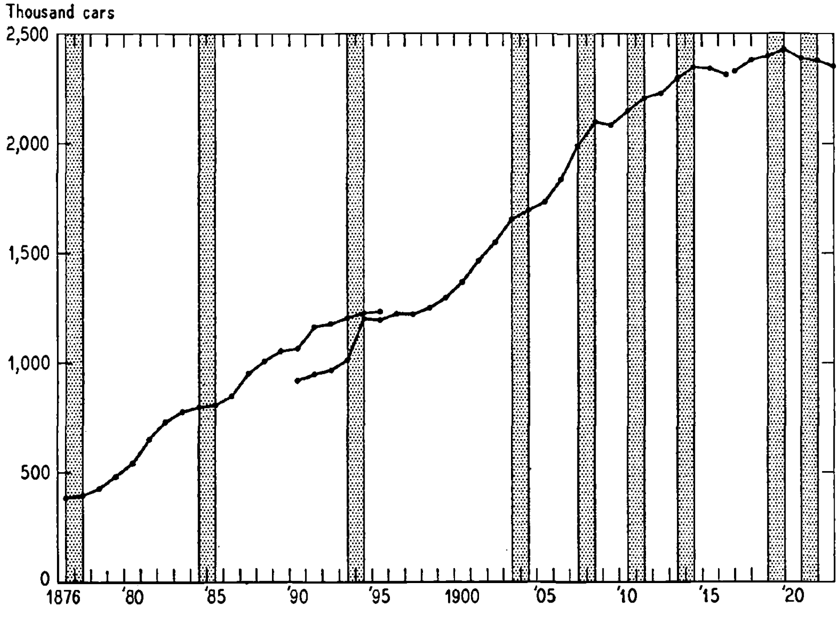
Although the size of stocks bore little relation to cyclical fluctuations in traffic, the history of the two looks similar when viewed in longer perspective. The era during which ton-miles and passenger-miles in each expansion usually rose well above the previous peak

[2] The figures, however, are not nearly as satisfactory. They include non-passenger-carrying cars and do not include Pullmans. "Used units acquired", lease items and reclassifications between passenger-train categories seem to be important, at least in some years.

[3] Data on installations and retirements of locomotives are not subdivided by services.

Chart 63

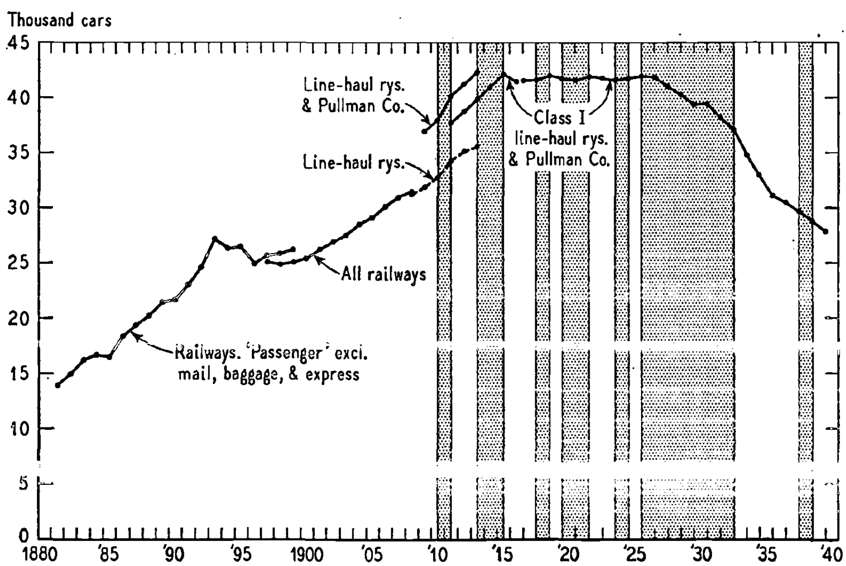
Freight-train Cars Owned by Railways at End of Year, 1876–1922



Shaded periods are contractions in end-quarter ton-miles.

Chart 64

Passenger-carrying Cars Owned at End of Year, 1881–1939



Shaded periods are contractions in end-quarter passenger-miles (not available before 1908, which, however was a trough).

CHART 65

Locomotives Owned by Railways at End of Year, 1876–1942

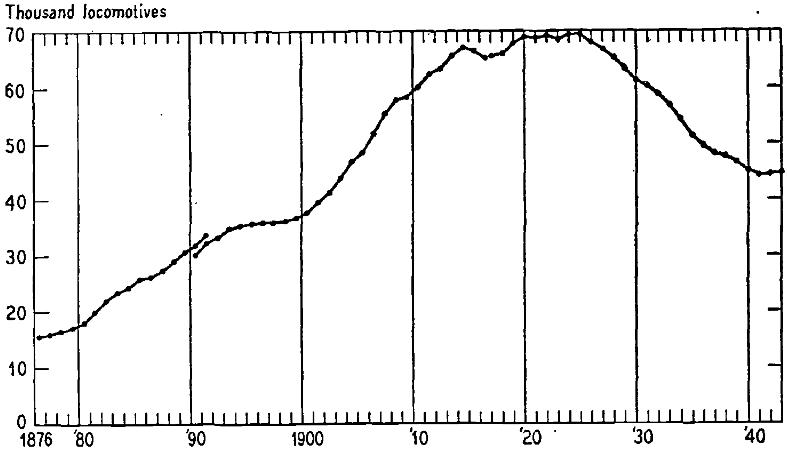
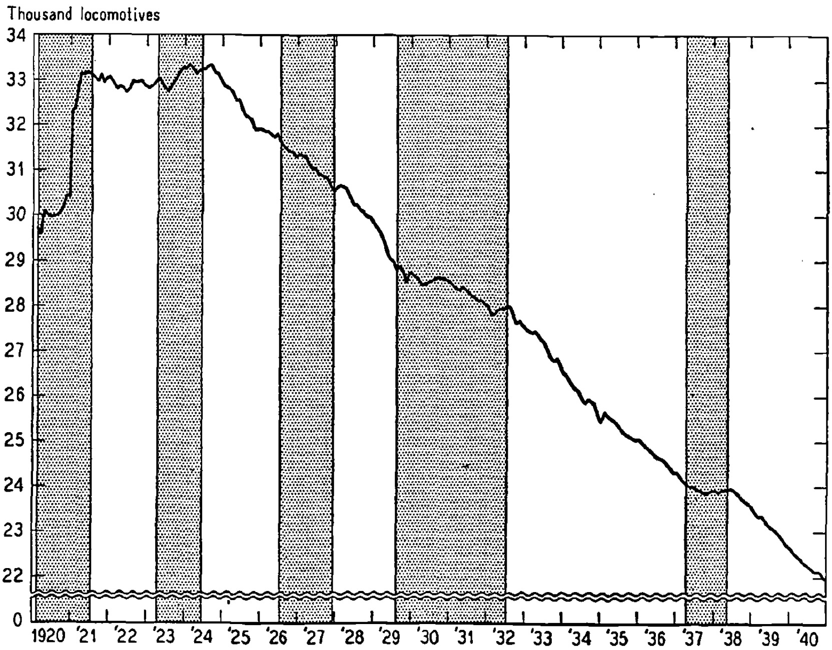


CHART 66

Total Locomotives Assigned to Road Freight Service, February 1920—December 1940



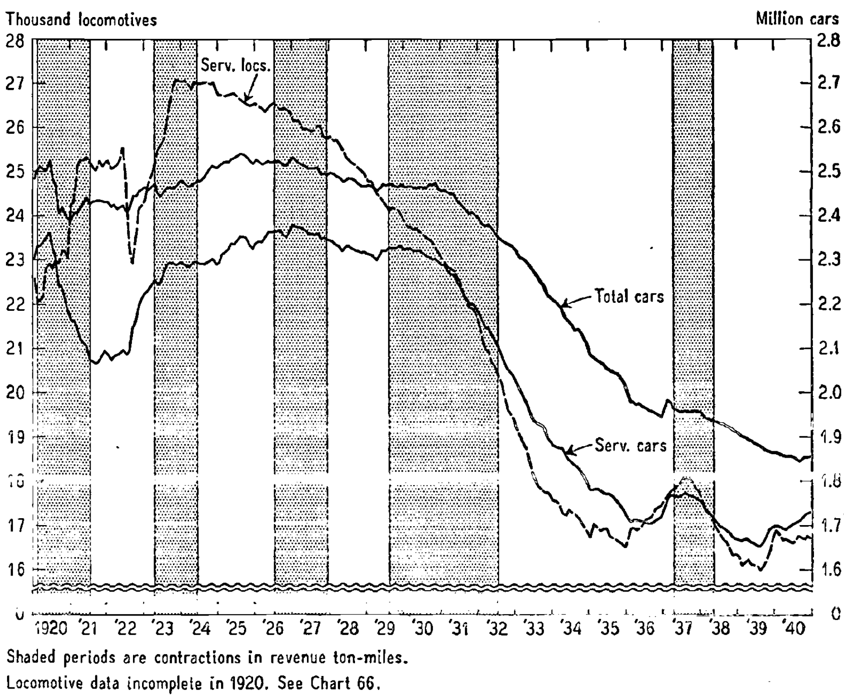
Shaded periods are contractions in revenue ton-miles.

1920 figures do not include: New York Central, February-December; Missouri Pacific, February, March; Fort Smith and Western, March.

level was one of rather steadily increasing supplies of cars and locomotives (Charts 63, 64, and 65). The period in which each high point little exceeded or did not even equal its predecessor was one of persistently diminishing stocks (Charts 66, 67, 68, and 64).[4] It is true that the transition was somewhat more diffused in the case of equipment. We can place the critical point in traffic fairly well at 1920. But there were minor choppy waves in stocks, with little net change, from about 1914 to the middle 1920's, generally speaking. Wartime difficulties may account for the early disappearance of rapid growth. After the war perhaps the railroads tried to eliminate the long-standing problem of car shortages. Such an endeavor would explain the belated downturn in stocks; and car shortages did become negligible after 1924 (they reappeared in World War II).

CHART 67

Serviceable Locomotives Assigned to Road Freight Service; Total and Serviceable Freight Cars on Line: January 1920—December 1940

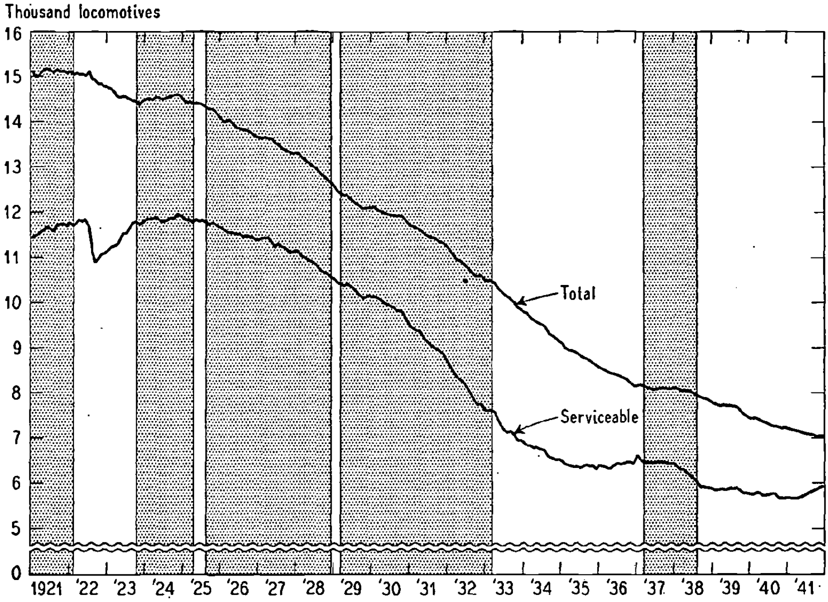


Shaded periods are contractions in revenue ton-miles.
Locomotive data incomplete in 1920. See Chart 66.

[4] Data in Charts 66–68 and 72–74 are daily averages through January 1935, averages of beginning and end of month thereafter. Class I switching and terminal companies included 1937 and thereafter.

CHART 68

Total and Serviceable Locomotives Assigned to Road Passenger Service, January 1921—December 1941



Shaded periods are contractions in passenger-miles.

In the middle 1890's, when the sharp cumulative growth of traffic from cycle to cycle was temporarily interrupted, the situation was rather like that which prevailed after the early 1920's. The 1896 peak in ton-miles was only slightly higher than the one in 1893 according to annual data, lower according to monthly estimates. Annual figures indicate that the later high point in passenger-miles was lower than the earlier. The curve of freight car stocks is quite flat for several years after the sharp rise in 1893–94. Passenger equipment diminished or increased little in most years, 1893–99. The supply of locomotives in all services combined grew at a conspicuously retarded rate during about the same period.

CAR BUYING AND THE GROWTH OF TRAFFIC

More frequent orders in expansion

Reverting to the shorter, cyclical periods of rising and those of falling traffic, we find that railroad managers did make a greater effort to build up their stock of equipment in the former than in the latter. In 20 of 27 pairs of neighboring phases in ton-miles, freight car orders per quarter were higher in expansion than in contraction (Table 45). Some of the exceptions, moreover, occurred under rather peculiar circumstances. Purchases in 1915–18 averaged slightly lower than in 1913–14. But the imminence of federal control in 1917 may have discouraged the roads from buying equipment. By the end of that year, moreover, cars were hard to get. "Car and locomotive builders are largely engaged in producing equipment needed abroad, both by our allies and our own forces . . . ", the ICC reported on December 1. "The steel and other materials needed for such construction, as well as the labor, are also needed in other phases of the conflict."[5] Railway profits took an unusually unfavorable turn toward the end of private operation (Ch. 10). Even the mammoth order placed by the Director-General in the very last quarter of the traffic expansion would not necessarily offset the effect of these influences. Quarterly average orders were substantially lower in the brief expansion of 1919–20 than in 1920–21. Here the situation as to control was reversed: the Director-General, faced with the prospect that the railroads would soon be given back to their owners, was unwilling to buy more equipment.[6] Purchases were made in 1929–32 at a higher average rate than in either the preceding or the following expansion. In this case, however, our system of marking off phases may be at fault. Ton-miles were greater in the last quarter of 1928 than in subsequent quarters; accordingly we took that quarter as the end of the expansion. But the first three quarters of 1929 were almost as high and even the fourth not much lower. The rapid decline began in 1930. Successive figures, beginning with the fourth quarter of 1928, in billions of ton-miles, are 113.93; 112.02; 113.54; 113.52; 108.04. Orders were much higher in 1929 than in 1928 or 1930–32. If we assign the first 9 months of 1929 to the expansion, we get averages of 17,501 cars per quarter for I 28–III 29 inclusive and only 7,141 for IV 29–III 32. The new figure for the expansion is higher not only than that for the following contraction but also than the figure for 1926–27. Three of our 7 exceptions are eliminated by this re-dating. Altogether, 5 are somewhat questionable.

[5] 47 ICC 757, 759.

[6] Hines, *War History . . .*, p. 125.

Table 45

Freight Cars Ordered per Quarter during Phases of Ton-miles, 1877–1938

Quarters included		No. of quarters	Number of cars ordered		
First[a]	Last		Total[b]	Per quarter	
				In expansion	In contraction
I 77	II 77	2	5,080	...	2,540
III 77	II 84	28	316,820	11,315	...
III 84	III 85	5	26,890	...	5,378
IV 85	II 93	31	542,370	17,496	...
III 93	III 94	5	29,720	...	5,944
IV 94	I 96	6	97,630	16,272	...
II 96	III 96	2	25,680	...	12,840
IV 96	II 03	27	930,870	34,477	...
III 03	I 04	3	43,030	...	14,343
II 04	II 07	13	787,080	60,545	...
III 07	II 08	4	34,530	...	8,632
III 08	I 10	7	235,220	33,603	...
II 10	I 11	4	72,440	...	18,110
II 11	II 13	9	323,660	35,962	...
III 13	IV 14	6	161,960	...	26,993
I 15	II 18	14	365,230	26,088	...
III 18	II 19	4	1,000	...	250
III 19	I 20	3	14,640	4,880	...
II 20	III 21	6	57,470	...	9,578
IV 21	II 23	7	244,250	34,893	...
III 23	II 24	4	93,350	...	23,338
III 24	III 26	9	193,240	21,471	...
III 24	III 26	9	217,430	24,159	...
IV 26	IV 27	5	76,300	...	15,260
I 28	IV 28	4	42,880	10,720	...
I 29	III 32	15	165,320	...	11,021
IV 32	II 37	19	164,640	8,665	...
III 37	II 38	4	17,240	...	4,310

[a] First after trough in expansion, after peak in contraction.
[b] 1877–1926 from *Railroad Purchasing and the Business Cycle*, John E. Partington (Brookings Institution, 1929), pp. 219–26; 1924–38 from the *Iron Trade Review*. NBER seasonal adjustment made to nearest 10 cars.

In 12 of 15 pairs of phases in travel, passenger car orders per quarter were higher when traffic was gaining than when it was declining (Table 46). One of the three exceptions involved the brief (one quarter long) expansion of 1928–29 and one the war phase 1914–18. But orders were also more frequent in the long contraction of 1929–33 than in the long rise of 1933–37.

The time consumed in construction, we infer, prevented these differences in rates of ordering from being reflected in rates of installation.

Table 46

Passenger-cars Ordered per Quarter during Phases of Passenger-miles, 1908–1938

Quarters included		No. of quarters	Number of cars ordered		
				Per quarter	
First[a]	Last		Total[b]	In expansion	In contraction
III 08	II 10	8	5,856	732	...
III 10	I 12	7	3,319	...	474
II 12	IV 13	7	4,075	582	...
I 14	IV 14	4	1,009	...	252
I 15	II 18	14	3,496	250	...
III 18	IV 18	2	0	...	0
I 19	III 20	7	1,101	157	...
IV 20	I 22	6	582	...	97
II 22	IV 23	7	3,752	536	...
I 24	II 25	6	2,951	...	492
III 25	III 25	1	574	574	...
III 25	III 25	1	489	489	...
IV 25	IV 28	13	4,996	...	384
I 29	I 29	1	120	120	...
II 29	I 33	16	1,701	...	106
II 33	I 37	16	1,021	64	...
II 37	III 38	6	265	...	44

[a] First after trough in expansion, after peak in contraction.
[b] 1908–25 from Partington; 1925–38 from *Railway Age*.

Purchases often declined before traffic

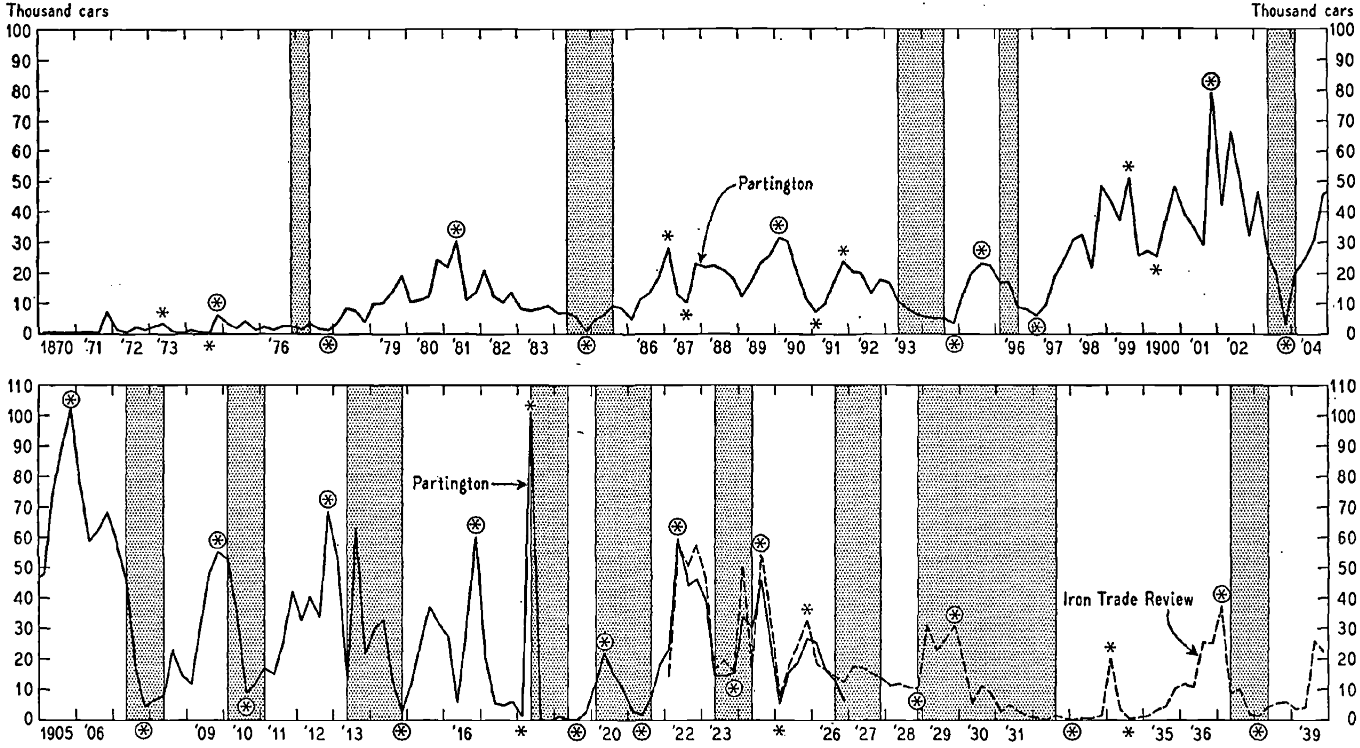
The curve of freight car orders contains many wild fluctuations (Chart 69). The business cycle staff of the National Bureau recognizes many more peaks and troughs in orders than in traffic. On Chart 69 we indicate them, as usual, by asterisks. For every peak in ton-miles, however, we can pick out one supremely high quarter in orders; we encircle its asterisk. (In doing so, we disregard the needle-like rise in the second quarter of 1918, when, because of government action, orders shot up from practically nothing to 100,000 cars, then relapsed to absolutely nothing. Instead we choose an earlier peak more like those usually encountered.)[7] In every instance except two (1920 and 1929) the high point in orders preceded the peak of traffic—sometimes by a long interval.

During the first six expansions of travel, orders for passenger

[7] The propriety of calling the 1918 needle-point a peak is discussed in *Measuring Business Cycles*, p. 492.

CHART 69

Freight Car Orders, First Quarter 1870—Fourth Quarter 1939

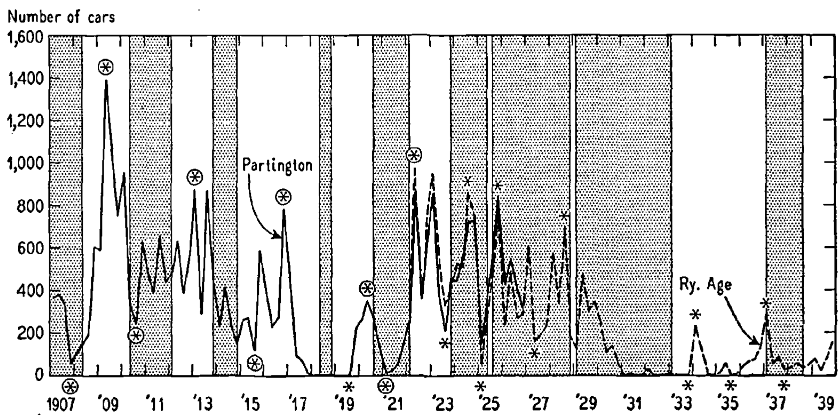


Shaded periods are contractions in ton-miles.

cars likewise declined before passenger-miles reached their climax (Chart 70). The early recession of purchases in 1914–18 may be attributable to war conditions, but that in 1920–21 cannot be explained by anticipation of return to private operation, for the transfer of control was made before the decline in orders. Since the seventh and eighth expansion each lasted only one quarter, orders could not reach a peak within either. Supreme high and low points in orders are indeed hard to select after 1923, and we have not tried. But certainly there was no peak of purchases at the initial trough of traffic in either expansion. In the 1933–37 phase the high points in orders and traffic coincided, although a subsidiary rise in purchases reached almost as high a level in 1934.

CHART 70

Passenger Car Orders, First Quarter 1907—Fourth Quarter 1939



Shaded periods are contractions in passenger-miles.

Rate of traffic growth does not explain early peaks in orders

John Maurice Clark has suggested that the earliness of the decline in orders may be a response to retardation in the growth of traffic.[8] When railway business increases, his argument runs, more equipment is needed to handle it, and more is ordered. When it increases rapidly orders must be frequent; if, although it continues

[8] See 'Business Acceleration and the Law of Demand', reprinted from the *Journal of Political Economy*, March 1917, in his *Preface to Social Economics* (Farrar and Rinehart, 1936) and his further discussion cited on p. 349 of the latter volume.

Table 47

Increase per Quarter in Ton-miles; Freight Cars Ordered per Quarter During Segments of Expansions in Ton-miles

Expansion and segment[a]	Increase in ton-miles: Billion ton-miles per quarter[b] (1)	Increase in ton-miles: Direction of change from prec. segment (2)	Cars ordered: Thousands per quarter[c] (3)	Cars ordered: Direction of change from prec. segment (4)	Relation between signs in col. (2) & (4) (5)	Cars ordered, lagged: Thousands per quarter (6)	Cars ordered, lagged: Direction of change from prec. segment (7)	Relation between signs in col. (2) & (7) (8)
II 77–II 84								
First	.35†	...	4.85	...	...	6.24	...	...
Second	.32	−	13.09	+	Unlike	14.04	+	Unlike
Third	.12	−	14.82†	+	Unlike	13.93	−	Like
Fourth	.17	+	8.28	−	Unlike	7.58	−	Unlike
III 85–II 93								
First	.49†	...	13.04	...	...	14.58	...	...
Second	.40	−	19.58†	+	Unlike	20.01	+	Unlike
Third	.45	+	18.45	−	Unlike	18.10	−	Unlike
Fourth	.45	0	16.43	−	d	14.70	−	d
III 94–I 96								
First	.73†	...	6.32	...	...	14.77	...	...
Second	.73†	0	17.31	+	d	21.81	+	d
Third	.69	−	22.73†	+	Unlike	20.66	−	Like
Fourth	.47	−	18.73	−	Like	16.83	−	Like
III 96–II 03								
First	.71	...	16.09	...	...	19.74	...	...
Second	.83	+	33.64	+	Like	34.84	+	Like
Third	.76	−	41.52	+	Unlike	42.57	+	Unlike
Fourth	1.14†	+	43.50†	+	Like	38.46	−	Unlike
I 04–II 07								
First	.58	...	32.93	...	...	43.00	...	...
Second	1.62	+	69.64	+	Like	77.83	+	Like
Third	1.12	−	71.74†	+	Unlike	65.85	−	Like
Fourth	2.64†	+	55.70	−	Unlike	38.79	−	Unlike
II 08–I 10								
First	3.80	...	19.89	...	...	13.30	...	...
Second	0.85	−	16.96	−	Like	30.20	+	Unlike
Third	2.85	+	45.52	+	Like	52.83	+	Like
Fourth	4.27†	+	53.62†	+	Like	41.11	−	Unlike
I 11–II 13								
First	1.00	...	22.78	...	...	32.02	...	...
Second	2.56†	+	35.66	+	Like	37.12	+	Like
Third	1.76	−	46.90†	+	Unlike	50.18	+	Unlike
Fourth	1.90	+	35.86	−	Unlike	44.72	−	Unlike
IV 14–II 18								
First	2.65	...	22.62	...	...	30.13	...	...
Second	3.20	+	28.11	+	Like	26.88	−	Unlike
Third	1.82	−	17.30	−	(Like)	18.01	−	(Like)
Fourth	4.93†	+	41.73†	+	(Like)	30.64	+	(Like)
II 19–I 20[e]								
First	6.70	...	0.00	...	...	2.64	...	...
Second	0.40	−	2.64	+	(Unlike)	12.00	+	(Unlike)
Third	16.70†	+	12.00†	+	(Like)	22.04	+	(Like)

Table 47—*Concluded*

Expansion and segment[a]	Increase in ton-miles: Billion ton-miles per quarter[b] (1)	Increase in ton-miles: Direction of change from prec. segment (2)	Cars ordered: Thousands per quarter[c] (3)	Cars ordered: Direction of change from prec. segment (4)	Relation between signs in col. (2) & (4) (5)	Cars ordered, lagged: Thousands per quarter (6)	Cars ordered, lagged: Direction of change from prec. segment (7)	Relation between signs in col. (2) & (7) (8)
III 21–II 23								
First	4.29	...	19.71	...	...	35.45	...	...
Second	−.66	−	46.57†	+	(Unlike)	48.39	+	(Unlike)
Third	10.44†	+	43.82	−	(Unlike)	34.64	−	(Unlike)
Fourth	7.53	−	22.61	−	Like	14.35	−	Like
II 24–III 26								
First	2.14	...	38.78†	...	...	21.20	...	...
Second	2.32	+	19.25	−	Unlike	22.26	+	Like
Third	1.35	−	25.12	+	Unlike	20.11	−	Like
Fourth	3.16†	+	15.73	−	Unlike	13.80	−	Unlike
IV 27–IV 28								
First	2.23	...	10.91	...	...	11.48	...	...
Second	−.08	−	11.48†	+	(Unlike)	10.47	−	(Like)
Third	2.38	+	10.47	−	(Unlike)	10.02	−	(Unlike)
Fourth	6.15†	+	10.02	−	(Unlike)	30.86	+	(Like)
III 31–II 37								
First	2.99	...	1.28	...	...	2.49	...	...
Second	.74	−	4.03	+	Unlike	3.86	+	Unlike
Third	2.76	+	10.20	+	Like	12.95	+	Like
Fourth	3.30†	+	21.38†	+	Like	18.67	+	Like

† Highest rate of growth, col. (1); highest orders, col. (3).
Parentheses indicate that, for reasons given in the text, the value of a comparison is doubtful.
[a] Dates are trough and peak quarters in ton-miles.
[b] Computed from Babson estimates, 1877–1907, 1914–18; ARA data, 1908–13; ICC net ton-miles, 1919–20; ICC revenue ton-miles, 1921–38.
[c] Computed from Partington data, 1877–1923; *Iron Trade Review* data, 1924–38.
[d] No change in traffic.
[e] This expansion lasted only three quarters and cannot be divided into more than three segments without arbitrary allocation.

to grow, it does so less rapidly than before, the railroads will place fewer orders. A mere retardation in the rise in ton-miles should lead to an actual diminution of purchases. Contraction will affect the equipment-producing industry before it appears in railway traffic.[9]

If the suggested explanation of early declines in orders is realistic, traffic, in those of its expansions in which purchases diminished before the end of the phase, must have grown most

[9] Because of the time consumed in filling orders, however, employment and deliveries may continue to increase after new orders begin to wane.

rapidly at some time before its peak. Indeed its most rapid growth must have accompanied or preceded the highest orders. To test whether this was true of freight traffic, we divide each expansion of ton-miles into four segments, compute the average rate of growth and the average orders in each, and compare their changes from segment to segment (Table 47, col. 1 and 3; other columns, not pertinent here, are explained later[10]).

[10] Our plan for dividing a phase is explained in Chapter 7, where we encounter a problem requiring the segmentation of contractions as well as expansions.

The proper method of determining the number of cars ordered corresponding to the growth of traffic between any two successive stages is not obvious. It can be explained with the aid of the following code of symbols.

	Earlier stage	Later stage	
Month numbers, in chronological order	$1, 2, \cdots m$	$m + 1, m + 2 \cdots$	$m + n$
Traffic	$s_1, s_2, \cdots s_m$	$t_1, t_2, \cdots$	t_n
No. of orders	$o_1, o_2, \cdots o_m$	$p_1, p_2, \cdots$	p_n
Cumulative orders, beginning with first month of earlier stage, or any preceding month	$c_1, c_2, \cdots c_m$	$k_1, k_2 \cdots$	k_n

Our formula for computing the rate of growth of traffic is

$$\frac{\frac{\Sigma t}{n} - \frac{\Sigma s}{m}}{0.5(m + n)}$$

The number of orders should be computed similarly. When two months are separated by intervening months, the response, if any, to the growth of traffic is not to be sought in the orders placed during the last month only, but in all the orders placed after the first month. For example, the response to the change from s_1 to t_1 is not p_1, but more properly $o_2 + o_3 + \cdots + o_m + p_1$. But this is equal to $k_1 - c_1$. Likewise, the orders corresponding to the change in traffic between any two months equal the cumulative orders for the later month minus the cumulative orders for the earlier month. The orders corresponding to the average change in traffic from the first group of months to the second group are

$$\frac{\Sigma k}{n} - \frac{\Sigma c}{m}$$

and the rate of ordering corresponding to the rate of growth in traffic is

$$\frac{\frac{\Sigma k}{n} - \frac{\Sigma c}{m}}{0.5(m + n)}$$

Accordingly, we compute the orders corresponding to any segment of a traffic phase by this formula. We do *not* follow either of two formulas that at first thought might seem to be proper, viz:

$$\frac{\Sigma p - \Sigma_o}{m + n} \quad \text{or} \quad \frac{\Sigma p}{n}$$

Table 48

Increase per Quarter in Passenger-miles; Passenger Cars Ordered per Quarter During Segments of Expansions in Passenger-miles, 1908–1938

Expansion and segment[a]	Increase in passenger-miles		Cars ordered		Relation between signs in col. (2) & (4)	Cars ordered, lagged		Relation between signs in col. (2) & (7)
	Million passenger-miles per quarter (1)	Direction of change from prec. segment (2)	No. of cars per quarter[b] (3)	Direction of change from prec. segment (4)	(5)	No. of cars per quarter (6)	Direction of change from prec. segment (7)	(8)
II 08–II 10								
First	146	...	327	...	...	599	...	...
Second	189	+	868	+	Like	1,056	+	Like
Third	155	−	957†	+	Unlike	787	−	Like
Fourth	211†	+	534	−	Unlike	270	−	Unlike
I 12–IV 13								
First	139	...	550	...	...	444	...	...
Second	208†	+	597†	+	Like	652	+	Like
Third	18	−	580	−	Like	621	−	Like
Fourth	58	+	597†	+	Like	303	−	Unlike
IV 14–II 18								
First	153	...	267	...	...	297	...	...
Second	156	+	377†	+	Like	382	+	Like
Third	322	+	248	−	(Unlike)	171	−	(Unlike)
Fourth	484†	+	7	−	(Unlike)	0	−	(Unlike)
IV 18–III 20								
First	586†	...	0	...	...	0	...	...
Second	188	−	55	+	(Unlike)	176	+	(Unlike)
Third	−129	−	275	+	(Unlike)	308	+	(Unlike)
Fourth	417	+	294†	+	(Like)	173	−	(Unlike)
I 22–IV 23								
First	237†	...	700†	...	...	454	...	...
Second	222	−	621	−	Like	681	+	Unlike
Third	129	−	454	−	Like	308	−	Like
Fourth	107	−	368	−	Like	443	+	Unlike
I 33–I 37								
First	283	...	39	...	...	63	...	...
Second	55	−	54	+	Unlike	42	−	Like
Thirp	171	+	33	−	Unlike	55	+	Like
Fourth	284†	+	156†	+	Like	132	+	Like

† Highest rate of traffic growth, col. (1); highest orders, col. (3).
Parentheses indicate that, for reasons given in the text, the value of a comparison is doubtful.
[a] Dates are trough and peak quarters in passenger-miles. The 1925 and the 1928–29 expansions each lasted only one quarter and cannot be divided into segments.
[b] Computed from Partington data, 1908–23; *Railway Age* data, 1933–37.

The results do not support the theory under consideration. In all there were 8 phases in which the number of cars ordered per quarter was greatest in some segment earlier than the fourth. In exactly half of these phases (1904–07, 1921–23, 1924–26, 1927–28) the most rapid growth of traffic followed the highest level of orders, instead of coinciding with or preceding it. In the other four phases, maximum purchases lagged behind maximum growth; but in one, 1877–84, an expansion that lasted more than seven years, the highest rate of increase in ton-miles pertains to the first segment; the heaviest purchases did not occur until the third. Coming after so long an interval, they can hardly be regarded as a deferred reaction to the initial spurt in the movement of tonnage. A majority of the 8 observations are incompatible with the supposed explanation.

In the comparisons before 1908, it is true, we rely on the Babson estimates of ton-miles. Although the latter were constructed with great care and ingenuity, the materials on which they rest may prevent them from accurately reflecting differences in rate of growth.[11] But if we exclude the 5 earlier cycles from our count, we get even less convincing results. Orders were at their highest before the end of the traffic expansion in 4 instances after 1908. In three of these, maximum purchases preceded the most rapid growth of ton-miles.

Orders for passenger cars attained their top level during an earlier segment than the last in three expansions of passenger-miles for which we have data on traffic (Table 48, col. 1 and 3[12]). In another, 1912–13, they were practically as high in the second as in the final segment. Of these four phases, two support the theory. Maximum orders either coincided with or came after the most rapid increase of travel in 1912–13. Both came in the first segment of 1922–23. But the other two, 1908–10 and 1914–18, contradict the theory. War conditions, discussed previously, help explain the premature decline in purchases.

From our consideration of both freight and passenger data we conclude that fluctuations in the rate of growth of traffic did not at all consistently account for early high levels of orders.

So far we have confined ourselves to asking whether an early high level of orders, when it occurred, can be explained by a decelerating growth of traffic. But we can approach the subject from the other end by inquiring in how many expansions of traffic did

[11] We use them for 1914–18 also; but here they are founded on much more adequate data.

[12] Average orders computed from differences of cumulatives; see note 10.

the highest rate of growth occur before the fourth segment? And when it did, how often did maximum orders occur in the same segment as maximum growth, or somewhat later, but not in the last segment? The quickest increase of ton-miles came before the last segment in only 5 of the 13 expansions between 1877 and 1938. In the remaining 8, tapering off cannot have reduced orders. In 2 of the 5, it did not in fact reduce them. In 1921–23 maximum orders preceded maximum growth; and the lag of orders in 1877–84, as already noted, was too long to interpret in terms of traffic. Only 3 phases (1885–93, 1894–96, and 1911–13) fulfill both conditions specified in our two questions.

If we omit phases before 1908, our general conclusion becomes stronger. The most rapid growth came before the end in only one expansion, 1921–23, and in that instance the highest level of orders preceded it.

Rate of growth in general not linked with orders

Leaving behind us the particular question whether decelerations in the increase of business to be handled account for the early decline in orders, we may ask a more general question. Variations in the growth of traffic, even when averaged over several months, obviously do occur, although they are not consistent from cycle to cycle. Are they matched by corresponding changes in orders? Is an acceleration of growth from one segment to the next usually accompanied by multiplying orders, and a deceleration by diminishing orders? To answer this question we have labeled each case of more rapid growth in ton-miles plus, and each case of slackened growth minus (see Table 47, col. 2). Likewise we marked each case of increased freight car orders plus, and each case of diminished orders minus (col. 4). If the answer to our question is 'yes', the sign for traffic should agree with that for orders in a substantial majority of cases. This it fails to do (Table 49, line 1, last two columns). Of all comparisons from 1877 to date, the signs are alike in only 15. In the other 21, acceleration of traffic was accompanied by deceleration of orders, or vice versa.

But some of these comparisons should perhaps be regarded with suspicion. Those for segments of expansions before 1908 involve traffic estimates which, as previously noted, may not be equal to the relatively delicate task of measuring changes in rate of growth.

The data on orders, moreover, are very incomplete for the earliest phases. But if we omit comparisons drawn from the five earlier phases, unlike signs are still a trifle more numerous than like signs (line 2). War conditions may account for the retardation of orders in the third segment of 1914–18 and certainly account for the high acceleration produced by the Director-General's 100,000 car order in the fourth. Prospective re-transfer of operations affects the entire 1919–20 expansion. In 1921–25 ton-miles actually diminished in the second segment; in comparing the latter with the first or third we are not doing strictly what we set out to do—investigate the changes in orders that correspond to different rates of *increase* in traffic. Each segment of 1927–28 was only one quarter long. But deletion of all these doubtful cases does not reveal any striking majority among the few that remain (line 3); there are 8 instances of like, 6 of unlike changes.

Table 49

Car Orders and Rates of Traffic Growth

Number of Like and of Unlike Signs of Change

	From first to second segment		From second to third segment		From third to fourth segment		Total	
	Like	Unlike	Like	Unlike	Like	Unlike	Like	Unlike
Ton-miles and freight car orders								
1 1877–1938	5	7	4	9	6	5	15	21
2 1908–38	3	5	4	4	4	3	11	12
3 1908–38, omitting doubtful comparisons	3	2	2	2	3	2	8	6
4 1877–1938, orders lagged	5	7	8	5	5	6	18	18
5 1908–38, orders lagged	3	5	5	3	4	3	12	11
6 1908–38, orders lagged, omitting doubtful comparisons	2	3	3	1	2	3	7	7
Passenger-miles and passenger car orders								
7 1908–38	4	2	2	4	4	2	10	8
8 1908–38, omitting doubtful comparisons	4	1	2	2	3	1	9	4
9 1908–38, orders lagged	4	2	4	2	1	5	9	9
10 1908–38, orders lagged, omitting doubtful comparisons	4	1	4	0	1	3	9	4

Computed from Tables 47 and 48, col. (5) and (8).

Similar comparisons for passenger traffic and orders fail to disclose any consistent relation (line 7). Ten times the signs are alike; but 8 times they are unlike. Once more some of the comparisons should perhaps be ignored. In the war expansion sharply falling profits and transfer of operations may have disturbed the placement of orders in the third and fourth segments. The first segment of 1918–20 falls within the period of government operation; traffic declined during the third. When instances involving these segments are eliminated, the percentage of pairs of like signs rises (line 8). In 9 cases the signs are alike, in only 4 unlike. Even so, the number of like pairs against which unlike pairs cannot be offset is only 5 out of 13, or 38 per cent.

Table 50

Freight Car Orders and Increase in Ton-miles

Illustrative Computations for Table 47, Col. (1), (3), and (6), Second Segment of 1877–84

		Column (1) Ton-miles	Column (3) Orders	Column (6) Orders
1	Quarters in stage II	III 77–III 79	III 77–III 79	IV 77–IV 79
2	Quarters in stage III	IV 79–IV 81	IV 79–IV 81	I 80–I 82
		(billions)	(thousands)	(thousands)
3	Av. per quarter, stage II	7.13	27.60†	32.86†
4	Av. per quarter, stage III	10.03	145.40†	159.26†
5	Line 4 − line 3	2.90	117.80	126.40
6	Number of quarters, Stage II	9	9	9
7	Number of quarters, Stage III	9	9	9
8	Av. interval between stages, in quarters (line 6 + line 7) ÷ 2	9	9	9
9	Av. change in ton-miles, or av. orders, second segment, line 5 ÷ line 8	.32	13.09	14.04

† Average of cumulatives; see text, note 10.

The foregoing computations were made on the assumption that the response, if any, of management to a particular increase in traffic begins in the first quarter of the rise and ends in the last. But perhaps some little time elapses before railway officials realize that a rise has begun, or before they can frame specifications and place contracts. With that possibility in mind we have recomputed the average freight car orders, using data for stages each of which begins and ends one quarter later than the corresponding stage of ton-miles. The new procedure, which allows for an average lag of three months, is contrasted with the old in Table 50. The new figures fail to support the view that orders are positively related to growth (Table 49, last two columns, lines 4 to 6). If we review all comparisons from 1877 onward we find unlike signs in exactly half. From 1908 to 1938 similar changes exceeded dissimilar changes by a margin of only one. Omitting the doubtful items in the later period leaves an equal division. Recomputing passenger car orders in the same way, we get the same number of like and unlike signs after 1908; when we exclude doubtful comparisons, however, the 9 to 4 majority yielded by our previous calculations remains.

These findings are based on some rather rough figures.[13] And in the case of passenger car orders they do include a fair positive score for selected comparisons. Nevertheless they should lead us to reconsider the reasons for expecting a positive relation. If an increase in traffic does ever lead to larger purchases, it must do so because railway managers fear that the existing stock may soon prove inadequate. Orders are of no value whatsoever in coping with traffic already tendered; their usefulness lies in the future. After they are filled, whatever transportation may then be called for can more certainly and promptly be provided. If there are times when the equipment on hand is considerably more than adequate to the current volume of business, traffic can increase materially without prompting any increase in orders. Our analysis suggests strongly that there are such times. In contractions the number of cars did not decline in proportion to traffic; sometimes, indeed, it actually increased. It is fairly clear that near the beginning of expansions the supply of vehicles, on most roads and perhaps excepting specialized varieties, was commonly more than sufficient. Quite possibly even the previous peak may not have fully tested the capacity of the equipment then on hand.

While traffic is climbing toward, but is still quite far from, the shadowy limit imposed by existing stocks, we should not expect its growth to have any great effect on orders. If it does rise close

[13] On the inevitable limitations of the order figures see Chapter II of Partington's book. We found them difficult to adjust for seasonality and feel uncertain of our results.

to that level, on the other hand, we should not suppose that the railroad companies will provide merely for a slight further increment, only to have the same problem come up again a few months later. Frequent reconsideration would be time-consuming and inconvenient. If borrowing were necessary, underwriters and investors would not welcome a multiplicity of equipment trust issues, each secured by a small block of rolling stock. No one railroad typically buys cars in continuous driblets; or at any rate, small repetitive purchases can hardly account for any large part of total orders. On the contrary, orders for hundreds or thousands of freight cars, depending on the size of the road, are often placed at one time. On any one road, large increases in traffic may have little effect on orders up to some critical point; then a relatively small further increase may be accompanied by a burst of purchases, after which orders may again fall to a low level. No doubt this point is reached at different dates on different roads; in the national totals, the effect may be distributed over a considerable period. But it does not follow that the grand total of orders will be closely related throughout expansion to the rate of growth. Little response to growing traffic at first, then progressively increasing response, then a tapering off as needs for some time in the future are deemed to be provided for—this interpretation fits the pattern of orders reasonably well, without presupposing any special pattern in the growth of traffic.

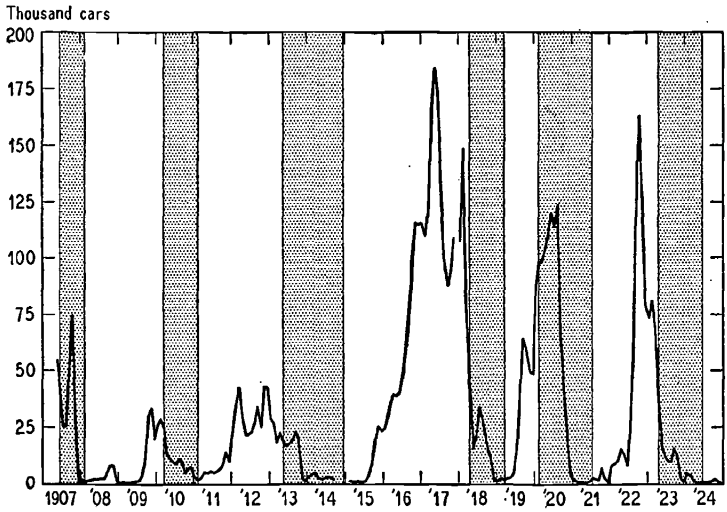
Prospective traffic in uncertain quantities, rather than the proximity of current volume to capacity, must often have stimulated buying intended to increase the stock of equipment. In the earlier expansions, extensive new mileage was under construction. Until a new line is opened, those in charge of it have experienced no growth of traffic at all; yet they must be ready to provide loading when they begin to do business. The projection and construction of new roads tended to multiply orders regardless of the current rate of growth on lines already in operation.

On the other hand, there is an alternative to increasing the supply of equipment even when traffic is at a critical level. The amount needed to handle any specified volume of business depends on the quality of service to be provided. A larger supply is required to handle tonnage promptly than to handle it with some delay. In a pinch the standard of service can be reduced. Between

1908, or perhaps some earlier time, and 1924, large freight car shortages developed near peaks in ton-miles (Chart 71[14]). It should not be inferred that many intended shipments were never actually made. The figures show only that many cars were not placed for loading on the day for which they were requested. Probably most of the shipments actually did move, but somewhat later than the consignors desired. Of course, this was not a satisfactory solution of the problem; but for a long while it was the one railroad managers adopted, perhaps involuntarily.

CHART 71

Daily Average Freight Car Shortages, May 1907—December 1924



Shaded periods are contractions in ton-miles.
No data, October 1914-January 1915, December 1917.

Another method by which the supply of cars can sometimes be stretched is to increase the amount of empty movement. While shortages threaten on some parts of a line there are often surpluses on others. If management is willing to haul empties from remote points, increasing its transportation costs in the process, it can raise the effective capacity of its equipment.

[14] Sources of data: May 1907–Nov. 1916, American Railway Association, *Bulletin* 6, Feb. 6, 1917. Dec. 1916–Nov. 1917, C. O. Ruggles, Railway Service and Regulation, *Quarterly Journal of Economics*, Vol. 33, 1919, p. 129. Jan. 1918–Dec. 1921, American Railway Association, *Annual Bulletin, 1922*. Jan. 1922–Dec. 1930,

Many factors other than current or prospective traffic can, of course, influence purchases. Among them are the prices equipment builders ask, what they are likely to ask in the future, the antiquity of the existing stock, the evolution of more economical types or of vehicles better adapted to the needs of shippers, the intensity of competition in service among railroads or with other means of transport, and the financial condition of the railroads.[15]

MAINTENANCE DEFERRED IN CONTRACTION

The unserviceable portion of the equipment supply tended to grow when traffic was falling off and to diminish when traffic was rising. This is clearest in the case of freight cars (Chart 72). Some months after each peak in traffic, cars in bad order, which had been decreasing in number, began to accumulate and continued to do so throughout the remainder of the contraction and part way into the next expansion. At some time after the trough, the number began to decline and continued to do so until the next peak of traffic had been passed. In the three last phases, in which the amplitude of fluctuation in traffic was more severe than anything since 1921, the unserviceable stock of locomotives, both freight and passenger, also behaved in this manner (Charts 73 and 74). Before that, however, similar variations are difficult or impossible

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Survey of Current Business. No data for Oct. 1914–Jan. 1915, Dec. 1917. Shortages after 1924 were small and are not shown.

The following general description of the figures is suggested by the instructions on the back of Association of American Railroads (new name), Car Service Division, *Form CS-44, Revised 1-1-36*. On each railway operating division, cars available at the close of a business day for loading the next day are compared with cars ordered for loading the next day (orders too large for shippers' loading capacity are adjusted downward). Excess of available over ordered is reported to central office of railway as surplus; excess of ordered over available as shortage. Each railway system totals separately the figures from its divisions reporting surpluses and those from divisions reporting shortages. Daily system totals of each kind are averaged over roughly half a month and reported to the Association. Shortages and surpluses, therefore, can be and frequently are reported simultaneously.

To estimate daily averages for monthly periods we combined daily averages for bi-weekly periods, 1907–12, or for semi-monthly periods, 1913–14, and averaged figures for one day at the beginning and one at the end of each month, 1915–17. The *Survey of Current Business* data are averages for only the last 7 or 8 days of a month.

[15] Arthur F. Burns is conducting a comprehensive National Bureau study of cyclical variations in the construction of plant and equipment on the railroads and in other industries.

to discern. The shopmen's strike in the summer of 1922 caused a sudden piling up of unusable motive power, which was liquidated, somewhat less rapidly, in the following months. Apart from this disturbance, the stock in bad order declined fairly continuously from the beginning of 1921 to late 1929 or early 1930.[16] But in the case of locomotives assigned to passenger service the decline proceeded more rapidly in expansions (Table 51). There was unbroken inverse conformity to travel. The story for locomotives intended for freight service when repaired is less consistent. Five comparisons of phases indicate inverse, but three positive conformity.[17] The average decline per month was greater in 1923–24 than in 1921–23 or 1924–26. In 1926–27 the companies reduced the unserviceable stock at the rate of about 20 locomotives per month; in 1927–29, only 5.4. Computation of the average net change, however, hardly gives us a fair indication of what went on in 1921–23 or 1923–24, since the rate altered sharply within each phase. If the strike had not occurred, it seems likely that the mechanical departments of the roads, which had already begun to work down the bad-order supply, would have persisted in that course, that the number would have been much smaller at the end of the expansion, and that it might have increased in the following contraction. (Actually there was a sharp fall in the first part of that contraction but a slight rise during the remainder and for a few months after.) There would have been a fall in 1921–23 and a rise in 1923–24, and there would have been a similar contrast between 1923–24 and 1925–26. The only other exceptional comparison involves the mildest contraction and expansion in the period for which we have data. In such phases the effect of cyclical fluctuation in traffic can most readily be obscured by accidental circumstances.

Variations in an unserviceable stock are the net result of two opposite sets of influences. On the one hand, wear and tear in use is constantly making some units of equipment unusable. On the other, the railroads are constantly removing some units from the unserviceable group either by repairing them or by writing them off the books. During a month in which the number of units becoming disabled exceeds the number repaired or retired, the un-

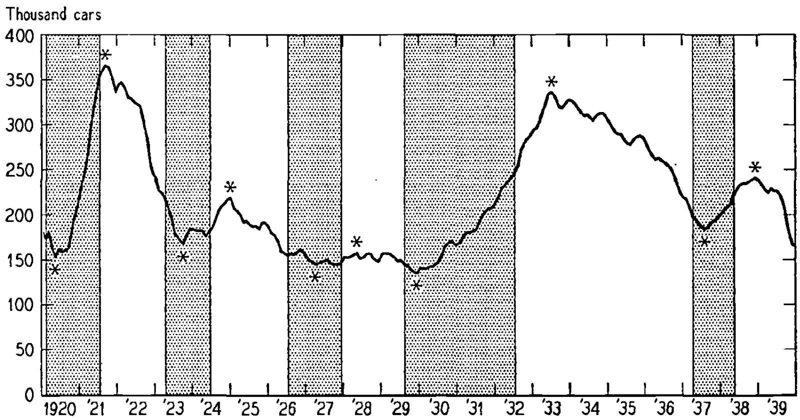
[16] There are no comparable data for 1920 because some roads failed to report.
[17] No comparison of 1920–21 with the following phase can be made; we cannot tell what the nature of the change indicated by complete figures for 1920 would have been.

serviceable stock increases. When repairs and retirements exceed disablements, it diminishes.

Since the stock increased, after the first few months, in 1929–32 (or 1929–33 in passenger service) and in 1937–38, the amount of equipment rendered unserviceable must have exceeded the amount repaired or retired. This means that it exceeded the amount repaired alone. The railroads did not recondition equipment as fast as it became unusable. Instead they allowed unserviceable stocks to accumulate.

CHART 72

Unserviceable Freight Cars on Line, January 1920—December 1939



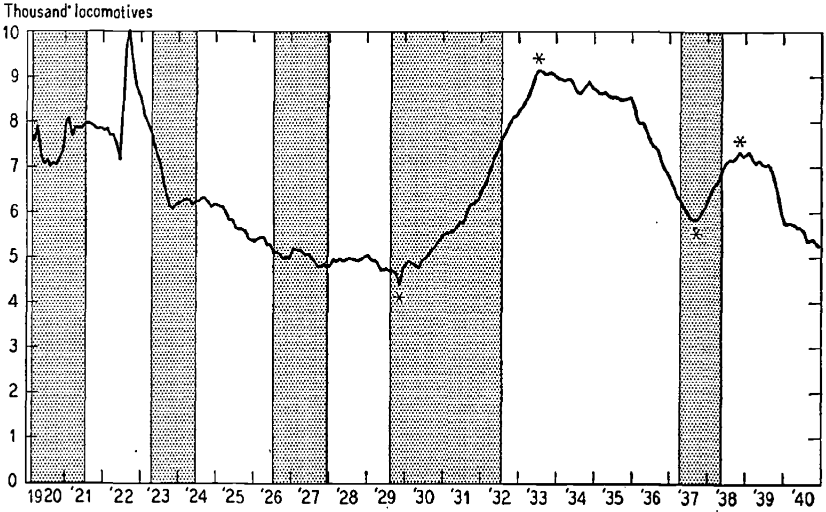
Shaded periods are contractions in ton-miles.

Maintenance work must have been reduced considerably. Presumably the number of vehicles becoming 'bad order' each month diminishes as the amount of use diminishes during a contraction of traffic. Consequently repairs could be reduced somewhat without any accumulation. But in practice maintenance of equipment was reduced even more, since cars and locomotives in disrepair actually did accumulate.

There are several reasons why railroad managers should fail, during a contraction, to maintain the stock of serviceable equipment at its previous peak level. Cutting maintenance expense improves the immediate financial showing of the company. Operating profits tend to decline out of proportion to traffic anyhow, as we shall demonstrate in Chapter 10. The showing would be still worse if the sum required to maintain the stock at its initial level

CHART 73

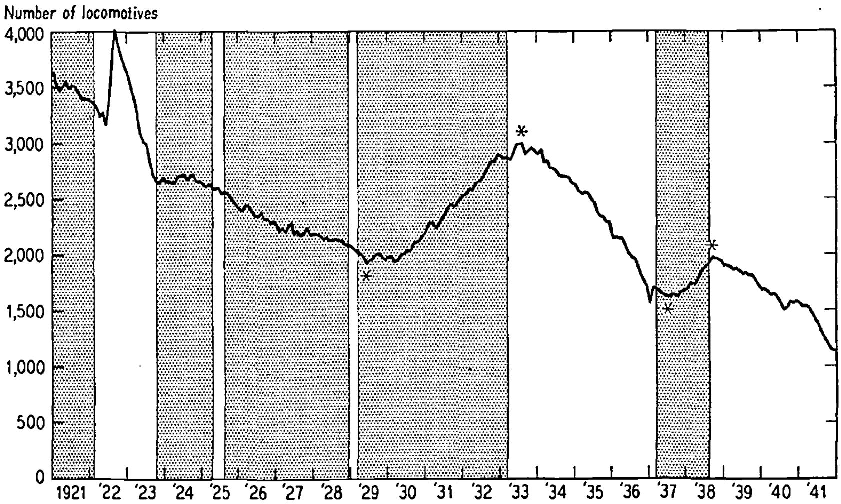
Unserviceable Locomotives Assigned to Road Freight Service, February 1920—December 1940



Shaded periods are contractions in ton-miles.
1920 incomplete. See Chart 66.

CHART 74

Unserviceable Locomotives Assigned to Road Passenger Service, January 1921—December 1941



Shaded periods are contractions in passenger-miles.

Table 51

Unserviceable Locomotives assigned to Road Passenger Service

Change per Month between Peaks and Troughs in Passenger-miles, 1922–1938

Date of turn	Feb. 1922	Oct. 1923	Apr. 1925	Aug. 1925	Dec. 1928	Mar. 1929	Mar. 1933	Mar. 1937	Aug. 1938
Level of passenger-miles	Trough	Peak	Trough	Peak	Trough	Peak	Trough	Peak	Trough
Months from preceding date	...	20	18	4	40	3	48	48	17
Number of unserviceable locomotives†	3,345	2,669	2,606	2,547	2,073	2,019	2,859	1,687	1,929
Change from preceding date									
Total	...	−676	−63	−59	−474	−54	840	−1,172	242
Per month									
To peak from trough	...	−34	...	−15	...	−18	...	−24	...
To trough from peak	...	...	−4	...	−12	...	18	...	14

† Three-month average; date of turn is middle month.

were charged to operating expenses. Probably, however, this is not the main consideration; by itself it might be a little shortsighted. The companies may also feel uncertain whether the peak stock will again be needed. As the contraction of 1929–32 developed, and as the inroads of motor competition became more and more obvious, many railroad officials must have doubted that their traffic would ever regain its 1929 level. Meanwhile improvements in what new equipment was being purchased as well as in the layout of fixed plant and in operating practices made it somewhat unlikely that a stock as large as before would be required even for a completely restored volume of traffic. It would be foolish to spend money on repairing cars and locomotives that might never be utilized; better to leave untouched the poorest part of the disabled stock—the part most likely to be discarded if the total supply should ultimately prove excessive. Then, too, designers may evolve better types before the next boom; delay may permit a wiser choice between buying new vehicles and reconditioning old ones. Moreover, even if managers could be certain that all the old rolling stock would come in handy, interest on the cost of repairs would be lost by making them too far in advance of need. Finally, as is apparent from preceding chapters, it is possible to neglect repairs to some extent when traffic is declining, and yet preserve a serviceable supply large enough to accommodate the current traffic with ease. Although unusable vehicles multiplied and the serviceable number declined in 1929–32 (or –33) and 1937–38, traffic declined even more rapidly than the usable supply, and the average serviceable vehicle was not required to do as much work at the end of the phase as at the beginning.

If there are good reasons for not offsetting disablements by repair, there are also good reasons for not offsetting them by retirement. Although in a contraction like 1929–32 the suspicion may arise that lost volume will not be recovered, nothing is certain. In case it should come back in large measure it will be convenient to have a reserve that can fairly quickly be added to the active supply by reconditioning rather than purchase. Only the eventual recovery, great or small, will tell with some finality how much of the disabled stock will be needed. Apparently this possibility, in these two instances, outweighed the immediate scrap value and the cost of storing equipment in bad order.

As expansion develops, on the other hand, it becomes more obvious either that an increase in the serviceable stock by means of repairs will soon be needed or that much of the equipment has no future and retiring it is preferable to expenditure on reconditioning. Consequently, the unserviceable stock is likely to be reduced in the one way or the other, even though gross additions to it are presumably increasing as a result of greater wear and tear in the growing movement of traffic. In 1932–37 (or 1933–37) retirement in fact played an important role, for the serviceable supply also decreased. Change in that supply is the net result of acquisitions of new cars and repairs of old ones, on the one hand, and disablements, plus perhaps retirement of cars not first transferred to the unserviceable group, on the other. Obviously the latter two items exceeded the former. Disablements (plus any retirements made without first transferring the vehicles to the bad order category) were more numerous than repairs and new acquisitions, and hence than repairs alone.

That the rises in bad orders did not begin promptly at the recession in traffic, nor the reductions promptly at its revival, may be accounted for by a combination of three factors. When traffic turns upward, the number of units becoming unserviceable must begin to increase. But railroad managers may not promptly realize that there has been an upturn. What we designate in retrospect as a trough or a peak may not have been recognized at the time. Consequently, increased repairs will not necessarily be ordered when expansion begins, especially since in spite of past reductions the margin of serviceable equipment is very comfortable at the trough. Finally, it takes some time for repairs to be completed. For several months after the upturn deliveries from repair shops may continue to reflect the previous downward trend in traffic. Since disablements are increasing and completions of repairs are not promptly increasing but perhaps diminishing, the unserviceable stock continues to rise. Conversely, when a peak in traffic is reached, the new repairs authorized may remain high, deliveries of repairs formerly authorized may continue to increase for some time, reflecting the previous upward trend in traffic, while the number of vehicles disabled will begin to fall. For a while repairs will exceed disablements and the unserviceable stock will continue to dwindle.