4. Maintenance Policy

When business activity falls off, wear and tear on plant and equipment diminishes. Managers of railways and of other business enterprises can reduce repair work to some extent without risking deterioration of their properties. Shortages of funds and impaired prospects of profit, however, may tempt them to cut repairs and replacements below the level required to keep plant and equipment in full-scale operating efficiency. Neglected properties may continue to function for a while, especially at depression levels of output. Conceivably, many enterprises might cut their maintenance work out of proportion to the reduction in the physical volume of their sales. Such a maintenance policy would tend to deepen the contraction in the national level of economic activity. Conversely, greater increases in maintenance than in sales would tend to accentuate booms in business.

Maintenance of track more stable than traffic

The history of British railroad way and works during World War II shows that maintenance can indeed be cut severely for a time without disrupting operations. To conserve resources for war construction and war industries, the railways were required greatly to reduce the quantities of ballast, cross-ties (sleepers), and rails they applied to their tracks (Chart 19). Maintenance policy in this period, however, was obviously governed by nonbusiness considerations. For information on the manner in which railway managers adjust their maintenance activities to cycles in traffic, we should confine our attention to the period ending in 1938.

Neither a train carrying goods nor a passenger train can run except over tracks in usable condition. Most of the tracks are used by both kinds of trains. In comparing changes in the quantities of track materials used with changes in traffic, we should employ some composite measure of the latter in which both classes of traffic would be repre-

sented. The statistical materials needed for a good measure are not available. We can safely assume, however, that from 1919 to 1938 the year-by-year *direction* of change in composite traffic was the same as in ton-miles.[1]

The *degree* of change in composite traffic is harder to estimate than the direction. If we had figures on passenger-miles, we would weight them and combine them with ton-miles. But we have only the number of journeys; for all we know, the average length of journeys may change appreciably during a business cycle, and if it does, the number is not a good measure. Lacking better data, we shall assume, where necessary, that a straight average of the percentage changes in ton-miles and number of passengers roughly approximates the change in composite traffic.

Changes in the quantities of materials used were at times irregular from year to year within an expansion or within a contraction of traffic. Applications of all three materials increased during the first, and diminished during the second year of the 1924-26 contraction. All three diminished during the first year of the 1932-37 expansion; sleepers and rails increased thereafter, ballast fluctuated a little from year to year without noticeable upward tendency.

The direction of net change over a whole expansion was more consistent. Application of each material at each peak was heavier than at the preceding trough.[2] In contraction there was no consistency. Ballast and rails declined in only 3 of 5 traffic contractions, sleepers in only 2.

But even if we found that the direction of change in materials was always the same as in traffic, a more interesting question, previously suggested, would remain to be answered. Were the changes in materials applied more violent than those in traffic?

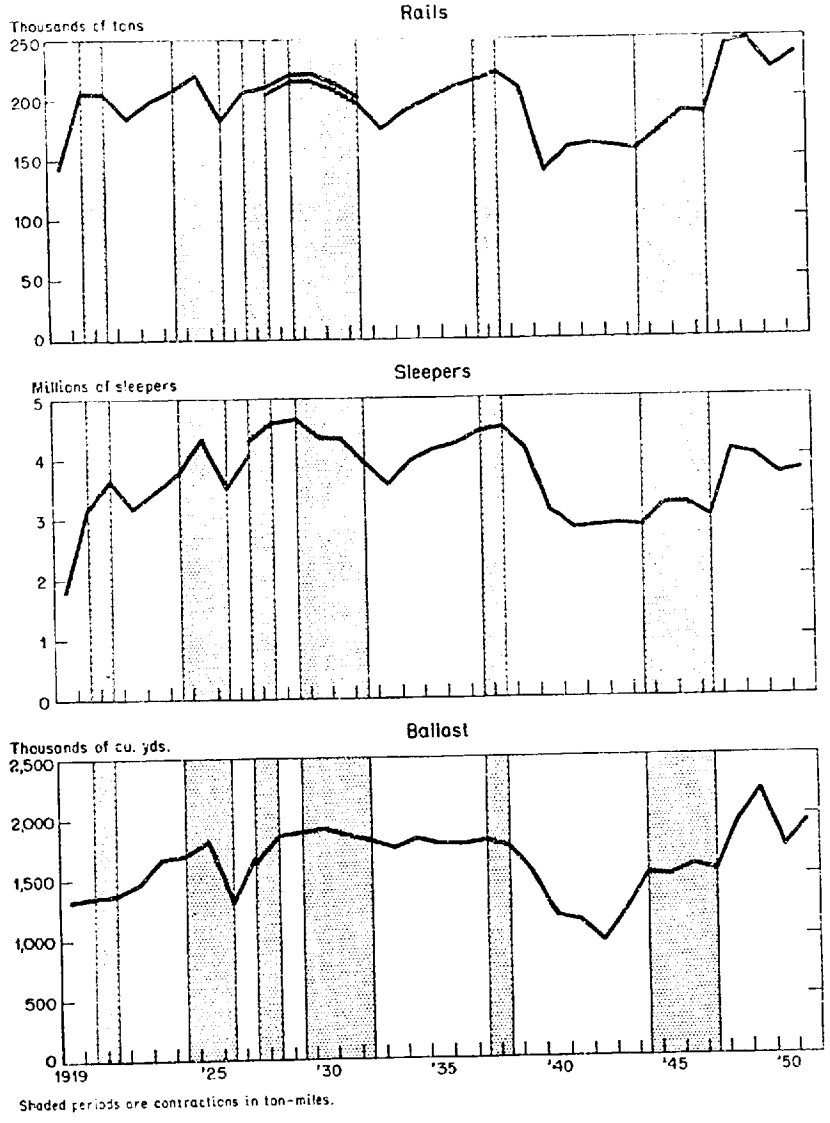
The nature of the data is such that we must examine them in detail

[1] Except in 1921-22, 1923-24, and 1927-28, the number of passengers increased whenever ton-miles increased, and diminished whenever ton-miles diminished. From 1921 to 1922 ton-miles increased 26 per cent, while the number of journeys diminished only 2 per cent: a properly weighted composite measure would surely indicate an increase. From 1927 to 1928 ton-miles diminished 6 per cent, journeys increased only 1 per cent; a composite measure would show a decrease. Only the changes from 1923 to 1924 give trouble. Ton-miles increased 0.5 per cent, journeys fell 1.4 per cent. The peak year in ton-miles, 1924, may not have been a peak year for all kinds of traffic combined, but it was not far from being such a peak, and we shall so regard it.

[2] In 1932-37, however, the increase in ballast was negligible.

CHART 19

Material Used in Maintenance of Way and Works, 1919-1951



Shaded periods are contractions in ton-miles.

to answer this question. In the instances just noted, the railway companies applied more materials although their traffic declined. These, of course, are not instances of sharper decline in maintenance than of traffic; on the contrary, the policy followed was counter-cyclical in

effect. In other instances, the change in maintenance, while similar in direction to the change in traffic, was smaller percentagewise than the change in either ton-miles or the number of journeys; clearly it was smaller than the change in composite traffic. In further instances, the percentage change in a material was intermediate between the percentage changes in freight and passenger traffic; here we must invoke our somewhat dubious measure of composite traffic change to make comparisons. Finally, in a few instances the change in the quantity of a material applied was similar in direction to, but greater percentagewise than, the change in either ton-miles or journeys; here it was clearly greater than the change in composite traffic.

Applying these principles to the data in Table 22, i.e. to the net change over traffic phases, we find that the quantity of ballast applied increased in the 1920-21 and 1927-28 contractions of traffic. In 1919-20 and the 4 phases from 1928 to 1938, ton-miles, the number of journeys, and ballast all changed in the same direction, but the percentage change was smaller in ballast than in either kind of traffic. The change in ballast was mild or actually counter-cyclical, therefore, in 7 instances. But in the 3 phases between 1921 and 1927, the change in ballast, intermediate between the changes in the two kinds of traffic, was greater than the change in the composite measure.

In 3 instances (1920-21, 1927-28, 1937-38) the railway companies installed more sleepers in a trough year than in the preceding peak year. In 1924-26 and 1928-29 the percentage change in sleepers was similar in direction to, but smaller than the change in either ton-miles or journeys. In 1921-24, 1926-27, and 1932-37 the change in sleepers installed was intermediate between the changes in traffic but less than the change in the composite measure. Thus in 8 of 10 phases the change in sleepers was mild or counter-cyclical. In 1929-32 the change in sleepers was only slightly greater than in the composite measure. In 1919-20 it was much greater than the change in either kind of traffic. But here we meet again the effects of war. In 1920 the railroads were still making up for low maintenance in earlier years. The number of sleepers installed is especially likely to decline in wartime because Britain must rely so heavily on imports for timber.

The tonnage of rails laid increased in the 1927-28 and 1937-38 contractions of traffic. In 1920-21, 1929-32, and 1932-37 the changes in ton-miles, journeys, and rails were similar in direction but the per-

TABLE 22

Traffic and Materials Used in Maintenance of Track
Per Cent Change between Years of Peaks and Troughs in Ton-Miles, 1919-1938

DATE	LEVEL OF TON-MILES	NET TON-MILES		PASSENGER JOURNEYS		COMPOSITE TRAFFIC	BALLAST		SLEEPERS		RAILS	
		Billions	*% Change*	*Millions*	*% Change*	*% Change*	*Thous. cu. yds.*	*% Change*	*Thousands*	*% Change*	*Thous. tons*	*% Change*
1919	Trough	.....	.....	2,065	.....	.....	1,323	.....	1,793	.....	142.2	.....
1920	Peak	19.173	4.3[a]	2,186	5.9	5.1	1,346	1.7	3,172	76.9	205.2	44.3
1921	Trough	13,289	−30.7	1,787	−18.3	−24.5	1,365	1.4	3,614	13.9	204.9	−.1
1924	Peak	19,063	43.4	1,747	−2.2	20.6	1,686	23.5	3,773	4.4	207.9	1.5
1926	Trough	14,042	−26.3	1,542	−11.7	−19.0	1,300	−22.9	3,508	−7.0	183.2	−11.9
1927	Peak	18,847	34.2	1,651	7.1	20.6	1,667	28.2	4,064	15.8	206.7	12.8
1927	Peak	18,847	.....	1,651	.....	.....	1,645	.....	4,298	.....	205.6	.....
1928	Trough	17,733	−5.9	1,666	.9	−2.5	1,858	12.9	4,590	6.8	209.3	1.8
1929	Peak	18,855	6.3	1,705	2.3	4.3	1,891	1.8	4,648	1.3	219.9	5.1
1932	Trough	14,942	−20.8	1,557	−8.7	−14.8	1,814	−4.1	3,911	−15.9	201.4	−8.4
1932	Trough	14,933	.....	1,141	.....	.....	1,807	.....	3,873	.....	195.8	.....
1937	Peak	18,384	23.1	1,295	13.5	18.3	1,808	.1	4,428	14.3	215.0	9.8
1938	Trough	16,672	−9.3	1,236	−4.6	−7.0	1,751	−3.2	4,496	1.5	221.6	3.1

[a] Per cent change in tons originated. Computed from Table 1.

centage change in rails was smallest. In the 3 phases between 1921 and 1927, the change in rails was intermediate between the traffic changes but much less than their average. On the other hand, tonnage laid increased a little more than the composite traffic measure in 1928-29, and much more than either component of traffic (although much less than sleepers) in 1919-20. Steel had been diverted from the railways to the war effort before 1919; in 1920 they were still making the deficit good.

On the whole, maintenance of track was more stable than traffic in the interwar period. Cyclical fluctuations in traffic were certainly not regularly accompanied by similar but more violent fluctuations in quantities of track material installed.

Traffic and maintenance of rolling stock equally variable

From 1920 to 1938 the British railways reported the number of vehicles charged to capital account, the number of renewals, and the number of heavy and light repairs. Whether a vehicle is charged to capital or included in renewals depends on whether it is regarded as a net addition to the stock or as a replacement. A "renewal" is not necessarily a rebuilt unit; it may be a newly built unit. Equipment stocks were stable or declining in these years, and vehicles charged to capital account were sometimes negligible in number, always much fewer than renewals. The impact on the national economy of an increase or decrease in equipment work is much the same, however the railway accountants classify the work. We have combined the two kinds of figures under the heading of gross additions.[3]

Locomotives, passenger cars excluding rail motor vehicles, and goods wagons were the three most important objects of equipment maintenance expense. Changes in the supply and condition of passenger cars can be compared with cycles in passenger traffic, and changes in

[3] The classification was changed in 1927. Figures are available for that year on both the old and the new basis. The category of heavy repairs to wagons was seriously affected, since the number dropped from 121,276 to 69,583. Other categories were less seriously affected.

The old classification subdivided wagon renewals into those "on complete renewal account" and those "on partial renewal account." The latter were comparatively few, ranging from 6,281 in 1924 to none in 1927. We use only the "complete renewal" figures.

The London and North Eastern included 175 passenger carriages in suspense account in 1936 but transferred them to capital account in 1937. We include them in our 1936 figure for "additions."

wagons with cycles in freight traffic. Data on locomotives (which were not and probably could not be subdivided by branch of service) may be compared with data on engine miles.[4]

During a long expansion or contraction of traffic, the course of gross additions or repairs to equipment, like that of track materials applied, was sometimes far from smooth (Charts 20, 21, 22). Additions to the supply of carriages, for example, were somewhat fewer in 1933 than in 1932; they increased rapidly in the next three years, then fell off abruptly from 1936 to 1937. Heavy repairs to locomotives fluctuated irregularly in 1921-25.

But the railway companies usually added more vehicles to their stock and made more repairs in a year of peak traffic than in the preceding or following trough year. Column (5) in Table 23 shows the number of traffic phases in which the direction of net change in additions or repairs was the same as the direction of change in traffic, and column (6) the number of phases in which the direction was different. In 8 of the 9 categories of additions or repairs, similarities outnumbered differences. The exception — light repairs to locomotives — is one of the categories for which we have comparatively few observations. When all observations for all categories in all expansions and contractions are totaled, we find 57 instances of similar and only 12 of dissimilar change.

But we have yet to determine how often the changes in additions and repairs were large in comparison with the changes in traffic. The requisite data appear in Table 24 and are summarized in Table 25. The number of phases in which the direction of net change in equipment-traffic ratios agreed with the direction of change in traffic itself is shown in column (5) and the number of disagreements in column (6). For most of the 9 categories the observations divide fairly evenly. Instances of agreement outnumbered instances of disagreement in only 2 categories. When observations on all categories in all traffic phases are totaled, we find 32 instances of agreement and 37 of disagreement. The additions-traffic and repairs-traffic ratios did not consistently rise when traffic was growing and fall when it was diminishing. Cyclical

[4] Maintenance charges on rail motor vehicles were very small, and the use of these vehicles was confined to a minor part of the rail network. We therefore disregard them. Additions and repairs of "other coaching vehicles" (for baggage, mail, parcels traffic, etc.) were a good deal less numerous than in the case of passenger cars; in the absence of a good measure of the traffic that uses them, we disregard them also.

TABLE 23

Gross Additions and Repairs to Equipment
Number of Net Rises and Net Falls during Expansions and during Contractions in Traffic, 1919-1938

	IN EXPANSIONS		IN CONTRACTIONS		TOTALS		
	Rises	*Falls*	*Rises*	*Falls*	*(1)+(4)*	*(2)+(3)*	*(5)+(6)*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Locomotives:							
Additions	4	1	1	4	8	2	10
Heavy repairs	5	0	0	5	10	0	10
Light repairs	0	2*	1	2	2	3	5
Carriages:							
Additions	4	0	2	2	6	2	8
Heavy repairs	3	1	0	4	7	1	8
Light repairs	1	0	1	1	2	1	3
Wagons:							
Additions	4	1	0	5	9	1	10
Heavy repairs	3	2	0	5	8	2	10
Light repairs	2	0	0	3	5	0	5
Total	26	7	5	31	57	12	69

Derived from charts 20, 21, and 22. For example, more locomotives were added to the stock in 1920 than in 1919, in 1925 than in 1921, in 1927 than in 1926, in 1937 than in 1932 – 4 expansions in all. Fewer were added in 1929 than in 1928 – the only instance of decline in expansion. We enter 4 in col. (1) and 1 in col. (2). The procedure for contractions is similar. For each kind of equipment, the dates compared are those of peaks and troughs in the appropriate kind of traffic, as indicated on the charts.

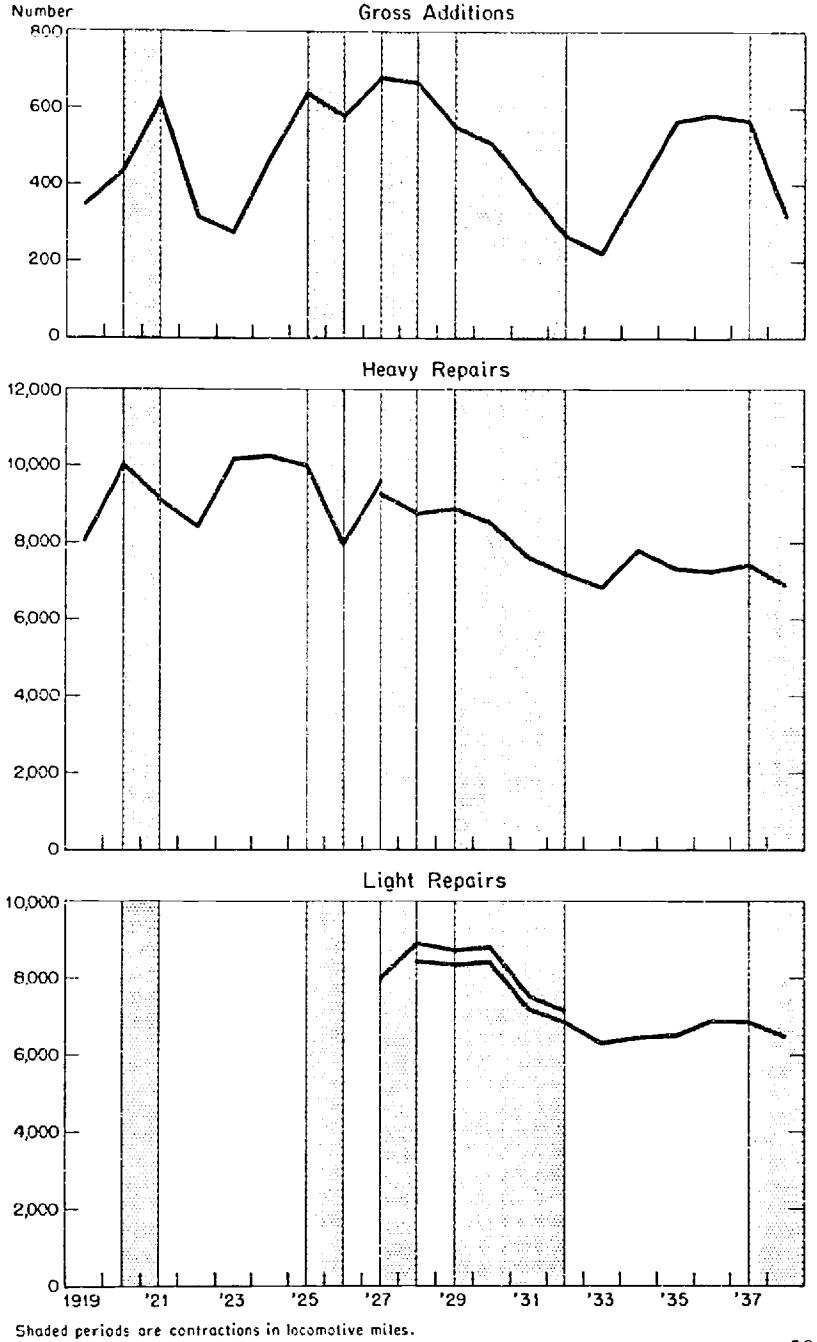
Although there are no traffic data for 1914-18, we assume that all kinds of traffic were at a trough in 1919, i.e. were lower than in 1918. Although engine miles were lower in 1939 than in 1938, aggregate hours worked by engines were higher: hours and miles agree in direction of change in all other years: we assume 1938 was a trough in use of engines. Although passenger traffic declined from 1937 to 1940 we assume that the decline after 1938 was connected with unusual conditions imposed by war and that for business-cycle purposes 1938 may be regarded as a trough.
* Includes one instance of no change (1932-37).

swings in additions and repair work were not consistently greater than swings in traffic; nor were they consistently smaller.[5]

[5] It is possible, of course, that fluctuaninns in traffic did tend to induce disproportionately large changes in additions and repairs, but that their influence was obscured by the influence of other factors. The presence of such a suppressed tendency would be suggested if (a) the additions-traffic and repairs-traffic ratios, when they rose in a traffic contraction, nevertheless rose less rapidly than in the preceding or following expansion, and if (b) the ratios, when they fell in an expansion, nevertheless fell more rapidly in the preceding or following contraction. We made some calculations in accordance with this more subtle test, but they yielded no evidence that fluctuations in the number of additions and repairs tend to be consistently more violent (or consistently less violent) than fluctuations in traffic. We shall not burden the reader with them.

CHART 20

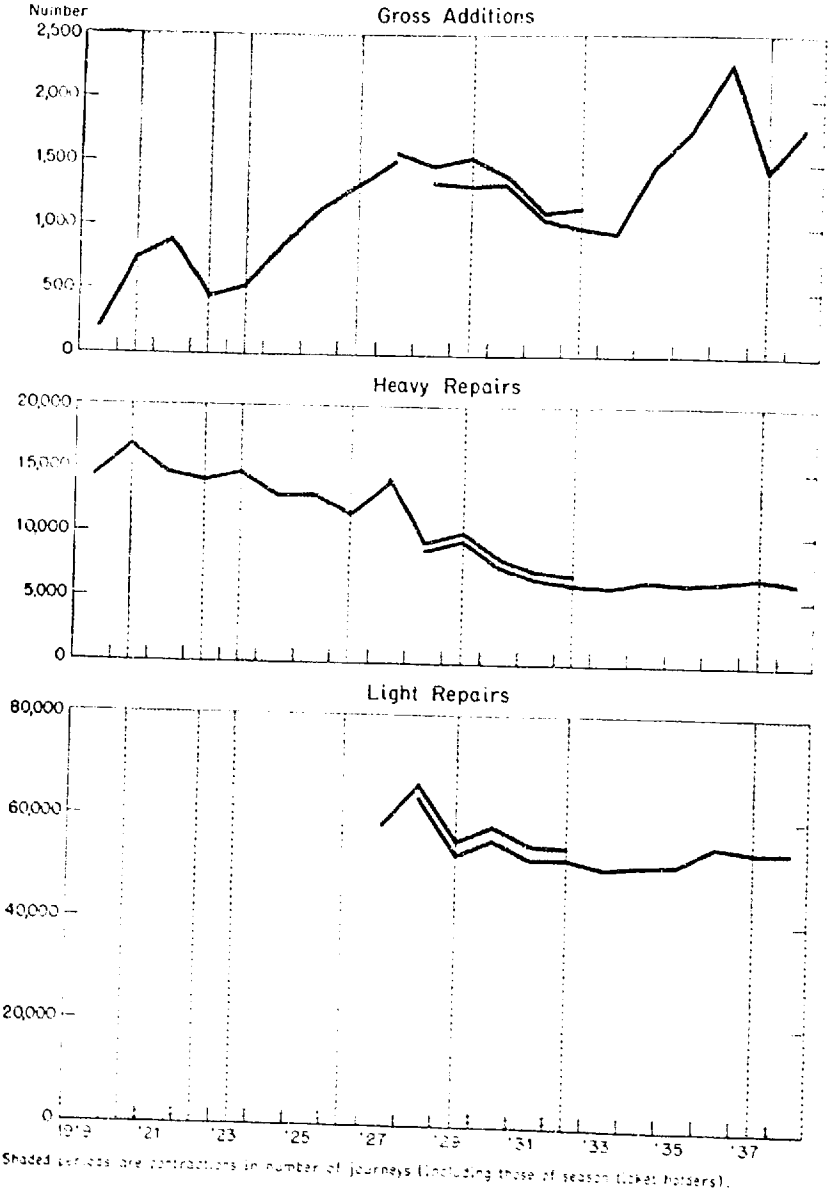
Additions and Repairs to Stock of Locomotives, 1919-1938



Shaded periods are contractions in locomotive miles.

CHART 21

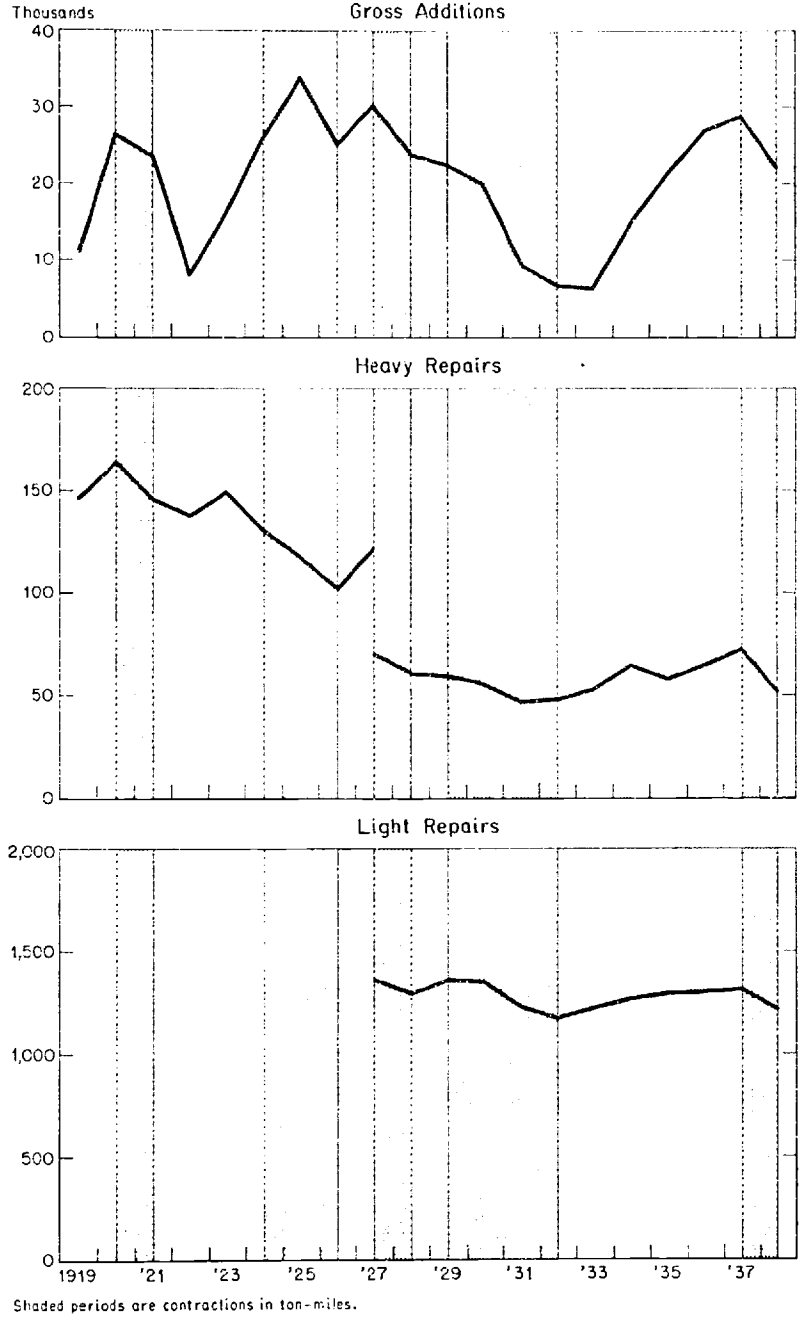
Additions and Repairs to Stock of Passenger Cars, 1919-1938



Shaded sections are contractions in number of journeys (including those of season ticket holders).

CHART 22

Additions and Repairs to Stock of Goods Wagons, 1919-1938



Shaded periods are contractions in ton-miles.

TABLE 24

Ratios of Equipment Additions and Repairs to Traffic in Years of Traffic Peaks and Troughs, 1919-1938

DATE	LEVEL OF TRAFFIC[a]	YEARS FROM PRECEDING DATE	GROSS ADDITIONS[b]		HEAVY REPAIRS		LIGHT REPAIRS[c]	
			Number	*Total change*	*Number*	*Total change*	*Number*	*Total Change*
					LOCOMOTIVES, PER MILLION ENGINE MILES			
1919	Trough	....	.677	.....	15.73	.....		
1920	Peak	1	.783	.106	18.02	2.29		
1921	Trough	1	1.330	.547	19.58	1.56		
1925	Peak	4	1.082	—.248	16.92	—2.66		
1926	Trough	1	1.158	.076	15.89	—1.03		
1927	Peak	1	1.126	—.032	15.85[d]	—0.04	13.21	.....
1928	Trough	1	1.112	—.014	14.62	—0.76	14.78	1.57
1929	Peak	1	.902	—.210	14.43	—0.19	14.22	—0.56
1932	Trough	3	.482	—.420	12.77	—1.66	12.71	—1.51
1929[e]	Peak	....	.944	.....	15.07	.....	14.23	.....
1932	Trough	3	.508	—.436	13.44	—1.63	12.86	—1.37
1937	Peak	5	.948	.440	12.39	—1.05	11.48	—1.38
1938	Trough	1	.539	—.409	11.73	—0.66	11.04	—0.44
					PASSENGER CARRIAGES, PER MILLION PASSENGER JOURNEYS[f]			
1919	Trough	....	.095	.....	6.95	.....		
1920	Peak	1	.342	.247	7.72	0.77		
1922	Trough	2	.252	—.090	8.06	0.34		
1923	Peak	1	.296	.044	8.28	0.22		

1926	Trough	3	.850[g]	.554	7.55[h]	−0.73		
1929	Peak	3	.901	.017	5.91	−1.72	32.4	.....
1932	Trough	3	.737	−.164	4.42	−1.49	34.9	2.5
1929[e]	Peak	....	1.040	.....	7.55	.....	41.6	.....
1932	Trough	3	.872	−.168	5.44	−2.11	45.6	4.0
1937	Peak	5	1.111	.239	5.27	−0.17	41.5	−4.1
1938	Trough	1	1.440	.329	5.21	−0.06	43.6	2.1
					WAGONS, PER MILLION NET TON-MILES[i]			
1920	Peak	....	1.492	.....	8.50	.....		
1921	Trough	1	1.800	.308	10.97	2.47		
1924	Peak	3	1.459	−.341	6.86	−4.11		
1926	Trough	2	1.803	.344	7.28	0.42		
1927	Peak	1	1.608	−.195	6.13	−0.85		
1927	Peak	....	1.608	.....	3.69	.....	72.52	.....
1928[a,j]	Trough	1	1.346	−.262	3.40	−0.29	73.23	0.71
1929	Peak	1	1.193	−.153	3.14	−0.26	72.36	−0.87
1932	Trough	3	.463	−.730	3.21	0.07	78.76	6.40
1937	Peak	5	1.983	1.520	3.93	0.72	71.47	−7.29
1938	Trough	1	1.618	−.365	3.09	−0.84	72.64	1.17

[a] Measured by engine-miles, number of journeys, and ton-miles, as appropriate.

[b] Total of vehicles charged to capital account and to renewals account. Excludes wagons on partial renewal account (none reported after 1926. No such category after 1927).

[c] Not reported, 1919-26.

[d] 15.38 for comparison with later years.

[e] Railways later taken over by London Passenger Transport Board included above, not included on this line or below.

[f] Including estimated journeys of season ticket-holders.

[g] .884 for comparison with later years. Ratio of locomotives charged to capital account plus renewals, new basis, 1927 to same, old basis, 1927 = 1.0396; 1.04 × .850 = .884.

[h] 7.63 for comparison with later years. Ratio of heavy repairs, new basis, 1927 to same, old basis, 1927 = 1.0104; 1.01 × 7.55 = 7.63.

[i] Including free-hauled and livestock.

[j] Figures including and excluding LPTB practically same 1928-32.

TABLE 25

Ratios of Equipment Gross Additions and Repairs to Traffic Number of Net Rises and Net Falls during Expansions and during Contractions in Traffic, 1919-1938

KIND OF EQUIPMENT AND NUMERATOR OF RATIO	IN EXPANSIONS		IN CONTRACTIONS		TOTALS		
	Rises (1)	*Falls* (2)	*Rises* (3)	*Falls* (4)	*(1)+(4)* (5)	*(2)+(3)* (6)	*(5)+(6)* (7)
Locomotives:							
Additions[a]	2	3	2	3	5	5	10
Heavy repairs[a]	1	4	1	4	5	5	10
Light repairs[a]	0	2	1	2	2	3	5
Carriages:							
Additions[b]	4	0	2	2	6	2	8
Heavy repairs[b]	2	2	1	3	5	3	8
Light repairs[b]	0	1	2	0	0	3	3
Wagons:							
Additions[c]	2[d]	3	2	3	5	5	10
Heavy repairs[c]	2[d]	3	3	2	4	6	10
Light repairs[c]	0	2	3	0	0	5	5
Total	13	20	17	19	32	37	69

[a] Denominator, millions of engine-miles.
[b] Denominator, millions of passengers.
[c] Denominator, millions of net ton-miles.
[d] Includes a rise, from 1919 to 1920, in additions or repairs per million tons originated; ton-miles not available.
Derived from Table 24.

Fluctuations in traffic, then, are not usually translated in exaggerated form into fluctuations in maintenance either of track or of equipment. Maintenance of track is somewhat more stable than traffic, maintenance of equipment does not differ appreciably from traffic in amplitude of fluctuation. Track is more vulnerable to the weather than equipment. A large amount of work must be done to keep it usable, whether it is lightly or heavily used. Other components in way and works — ditches, embankments, poles and wires, buildings and bridges — may be similarly vulnerable.