

UNITED STATES DEPARTMENT OF COMMERCE

JESSE H. JONES, *Secretary*

The St. Lawrence Survey

PART V

The St. Lawrence Seaway and Future
Transportation Requirements



N. R. DANIELIAN, *Director*

ST. LAWRENCE SURVEY

Reports of the St. Lawrence Survey

- PART I.** History of the St. Lawrence Project.
- PART II.** Shipping Services on the St. Lawrence River.
- PART III.** Potential Traffic on the St. Lawrence Seaway.
- PART IV.** The Effect of the St. Lawrence Seaway upon Existing Harbors.
- PART V.** The St. Lawrence Seaway and Future Transportation Requirements.
- PART VI.** The Economic Effects of the St. Lawrence Power Project.
- PART VII.** Summary Report of the St. Lawrence Survey.

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THE PRESIDENT,
THE WHITE HOUSE,
Washington, D. C.

DEAR MR. PRESIDENT: I have the honor to transmit herewith Part V of the reports of the St. Lawrence Survey. In this part there is an extensive analysis of future traffic possibilities in the United States in the light of growth in population, employment, productivity, and other related factors that influence agricultural and industrial production and consumption.

The St. Lawrence Seaway is here viewed in the perspective of future transportation requirements of the country.

The summary of the facts and conclusions is given in the letter of submittal of Dr. N. R. Danielian, Director of the St. Lawrence Survey.

Very sincerely,

WAYNE C. TAYLOR,
Acting Secretary of Commerce.

LETTER OF SUBMITTAL

FEBRUARY 23, 1941.

The Hon. SECRETARY OF COMMERCE,
Washington, D. C.

DEAR MR. SECRETARY: I have the honor to submit herewith Part V of the reports of the St. Lawrence Survey. This report deals with the future transportation requirements of the United States, and attempts to evaluate the position which the St. Lawrence Seaway will hold in the transportation system of the country. In the preparation of this report the Survey has been assisted by Professor Edgar M. Hoover, Jr., and Mr. Edgar Epstein. The report has been reviewed by many experts in the various branches of the government whose comments and criticisms have been of great value. The charts were executed by Mr. Earl G. Millison, Chief of Graphic Services, and Mr. George Newman, Head Statistical Draftsman, Work Projects Administration.

It is not the purpose of this report to make definite predictions of amount of traffic at any given point of time in the future. Such an objective would be unattainable. The main purpose of the report is to answer these questions: (1) Will the St. Lawrence Seaway divert traffic from the railroads? (2) Do the railroads have such excess capacity that a new medium of transportation such as the St. Lawrence Seaway is unnecessary? (3) Is the seasonal movement of traffic such that the St. Lawrence Seaway will actually cause idleness of railway equipment in the season of open navigation?

This study shows that the St. Lawrence Seaway, besides assisting the railroads in caring for a greatly enhanced traffic, will in fact improve the economical operation of railroads by smoothing out the seasonal variations in rail traffic. Often opponents of the project have reiterated that while they will be burdened with traffic, and hence with the expense of constructing and maintaining facilities to carry cargoes in the 5 months of the winter when the Seaway is closed, "for 7 months of the year these facilities must stand unprofitably idle." This is a plain misstatement of fact. The peak of rail traffic comes in August, September, and particularly October. The facilities constructed to take care of traffic in these peak months *now* stay idle in the winter time. If the St. Lawrence Seaway were operating, the railroads would be freed from constructing and maintaining equipment for these peak summer months, which now stay unprofitably idle on sidings during the winter months. The St. Lawrence Seaway thus will improve the average utilization of cars and locomotives by taking care of a part of the peak load.

In the light of the facts revealed in this report, the Survey is led to the following conclusions:

1. Under very conservative assumptions of employment conditions, assumptions which are at the lower limit of political tolerance, average tons of freight originating in the decade of 1950 will probably be between 242,000,000 and 374,000,000 greater than the average of 1930-39. The 10,000,000 tons of additional American traffic which may use the St. Lawrence at maximum utilization would be but a fraction of the expected increase in railroad activity.

2. The railroads of the United States, though much improved in operating efficiency, have reduced space capacity and tractive power to such an extent that, in the net, their carrying capacity is no more than in the decade of 1920-29. This will not be sufficient to meet traffic requirements of the future.

3. The railroads must, therefore, expand their capacity by purchase of equipment and expenditures on way and structures. The St. Lawrence Seaway will accommodate a small part of the increased demand for transportation. It is an alternative method of meeting a part of our future transportation requirements.

4. The railroads are now burdened with seasonal peak traffic that comes in late summer. The equipment used in carrying this peak traffic stays idle in the winter time. The St. Lawrence Seaway will help the railroads to improve the average utilization of their equipment by taking a part of the load off the peak. This means that the railroads will not have to buy the equipment to meet the October peak to the extent that the St. Lawrence Seaway will carry some of the peak load. As a result, the St. Lawrence Seaway will improve the average utilization of railroad rolling stock.

These conclusions are the result of an extensive study by the Survey of the economic forces that influence traffic in agricultural, manufactured, and mineral products. Among the factors carefully examined and weighed are population growth and geographical distribution, concentration of agricultural production, trends in consumption of foodstuffs and processed products, and the effect of mechanization of agricultural operations upon traffic. Diversion of traffic from railroads has been also considered. An analysis of these elements shows that traffic in agricultural products, which in 1939 accounted for 11.8 percent of total tons of freight originated on Class I railroads, and yielded 20.2 percent of their revenues, will increase in the future at a faster pace than population, because the production centers of principal agricultural commodities have been moving westward, while the concentration of population still remains in the east; the improvement of packing and canning processes have reduced waste and increased utilization of byproducts; and the dispossession and urbanization of farm population have tended to diminish farm consumption and to increase purchases in the market. Assuming an increase in traffic on Class I railroads only in proportion to population, the average of tons

of freight originating of agricultural products during the decade of 1950 would be nearly 12,000,000 tons greater than the average of 1935-39. Making allowance for further diversion of traffic from the railroads, and allowing for export trade commensurate with the least favorable conditions of the past decade, the increase in tons of freight of agricultural products would be probably 5,000,000 short tons. This one increment of future rail traffic in itself would make up for one-half of the additional American traffic of 10,000,000 tons that may utilize the St. Lawrence at full capacity utilization.

A thorough examination of the past trends in manufacturing production, employment, hours of work and productivity per man-hour indicates that even under very pessimistic assumptions with regard to employment, traffic in manufactured products must increase very materially over the experience of the past decade.

Manufactured products gave rise to 25 percent of total tons of freight originated on Class I railroads during 1938. This study shows that assuming no more than 10 million persons working in manufacturing enterprises at an average of 35 hours per week, at a rate of production per man-hour moderately higher than at present, the decade of 1950 would produce tons of freight originated in manufactured products which would be 102,000,000 tons higher than the average of 1930-39. This figure allows fully for all past and probable future diversion of traffic.

The National Resources Planning Board estimates that there would be 9.8 million persons employed in manufacturing when the economy is operating at an annual income of 70 billion dollars (1936 dollars). In view of the increase in population, the national economy operating at these levels would probably leave 10 to 15 million persons unemployed. This is mentioned to indicate that the assumption here made which allows an increase of 102,000,000 tons of manufactured freight originating, above the average of the past decade, is extremely conservative.

If the employment in manufacturing were 11.5 million persons, then the tons of freight originating in manufactured products on Class I railroads would be 150,000,000 tons higher than the average of 1930-39. This increment of future additional traffic would in itself make up for fifteen times the additional American traffic of 10,000,000 tons that may utilize the St. Lawrence at full capacity.

It is the conclusion of the Survey that this figure or a higher figure is the more likely increase in the average rail traffic during the next decade. Although at these levels of industrial activity the problem of unemployment will not have been solved, conditions would probably be nearer to the lower limit of political tolerability. With employment in manufacturing at 11.5 million persons, national income would be between 80 and 90 billion dollars (1936 dollars), and unemployment less than 10 millions.

Commensurate developments in mineral industries when 10 million persons are engaged in manufacturing, promise to produce tons of freight in mineral products originated on Class I railroads 132,000,000 tons higher than the 1930-39 average. This figure, too, makes allowance for diversion. If the second assumption, 11.5 million persons employed in manufacturing, is taken as the basis, then the corresponding tons of freight originated in mineral products would be 214,000,000 tons higher than the average of 1930-39.

This study reveals that the average tons of freight originated of all kinds, carload and less-than-carload lots, during the decade of 1950 would be, at a very conservative estimate, 1,100,000,000 tons. At this level, tonnage originated would be 28 percent higher than the average of the decade of 1930-39. It is very possible that the average tonnage in the next decade may approximate 1,232,275,000, at which rate it would be 43 percent higher than the preceding decade. The actual tonnage increase over the average of 1930-39 would be, in the first case 242,000,000, and in the second case 374,000,000.

In the face of these magnitudes it is plain that the additional American traffic of 10,000,000 tons that may use the St. Lawrence Seaway at its maximum utilization recedes into insignificance. A glance at the Interstate Commerce Commission statistics will show that the annual fluctuations of traffic on American railroads are many times this amount.

Under these circumstances, the additional traffic that will utilize the St. Lawrence Seaway will be a slight, almost unnoticeable, recession from the large increases in traffic which the railroads can confidently anticipate. In fact, the very estimates which are made in this report for the decade of 1950 will be reached sooner under the impetus of the national defense program. The next question, then, is whether the railroads can meet this growing demand upon their services without expanding their facilities.

Here some explanation is needed about the carrying capacity of railroads in the United States. This is a highly controversial subject. It is here intended merely to recite a few facts which will help answer the question: Will the railroads have to expand to take care of future traffic requirements? The claim of the Association of American Railroads is correct that there have been many operating improvements which have increased carrying capacity in spite of reduction in car capacity and tractive power of locomotives. Average number of freight cars per train has increased from 35.6 in 1920 to 48.5 in 1939, and, as a result, revenue and non-revenue freight per train has increased from 708 in 1920 to 813 in 1939. Although there has been much fluctuation in the intervening period, the trend has been definitely upward. Average speeds of freight trains between terminals has increased steadily from 10.3 miles per hour in 1920 to 16.6 miles per hour in 1938, a 60-percent improvement. This rate of speed includes stop-over at way stations.

As a result of all these changes in operating factors, the carrying capacity of railroads, for a given amount of equipment, has definitely improved. This is shown by the net ton-miles per freight-train-hour, which expresses the results of railroad operating efficiency in loadings per car, number of cars per train and speed of travel. The net ton-miles per train-hour has increased from 7,500 ton-miles per hour in 1921 to 13,500 ton-miles in 1939. This is an 80 percent improvement in 19 years. As compared with 1929, the improvement is 30 percent.

On the other hand, there has been considerable reduction in car capacity and tractive power. The capacity of serviceable cars went down from 99 million tons in 1929 to 74 million tons in 1938, a reduction of over 25 percent. Tractive power of freight locomotives was down by 16 percent in the same interval. Furthermore, the average length of rail haul increased by 10 percent between 1929 and 1939.

In the light of these facts, the best that can be said is that the railroads, at the close of 1938, had a carrying capacity which was probably comparable with late 1920's, although it remains still to be proved whether the operating efficiency in speed and train loadings can be maintained under the strains of increasing traffic loads.

In spite of these improvements in performance, the railroads of the United States will need much expansion in order to meet the traffic estimates made here under very conservative assumptions. Although the medium estimate of average tons originated for the decade of 1950 is 1,100,000,000 and a possible estimate is 1,232,000,000, the railroads will have to be ready to meet not only these average conditions, but also the cyclical variations. During the decade of 1920-29, the variations were 23 percent below and 10 percent above the average of the decade. During 1930-39 the variations were 25 percent below and 35 percent above the average of the decade.

On a base average of 1,100,000,000 tons, the peak year may require capacity to carry, on the basis of 1920-29 experience, 1,209,000,000 tons, and on the basis of 1930-39 experience, 1,480,000,000 tons. On the base average tonnage originating of 1,232,000,000, the amplitude of cyclical variation will carry the tonnage in peak years to much higher levels.

The railroads as at present organized and operated are not able to meet such increased demands for service in spite of the splendid improvement in operating efficiency. They will have to expand their facilities. They will have to buy much equipment, and according to Interstate Commerce Commission studies, they will have to spend much money on maintenance of way and structures, and additions and betterments. The St. Lawrence Seaway will do no more than assist in carrying a small part of the greatly increased load in the future for which the railroads are not yet equipped.

Very truly yours,

N. R. DANIELIAN, *Director,*
St. Lawrence Survey.

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THE ST. LAWRENCE SEAWAY AND FUTURE TRANSPORTATION REQUIREMENTS

INTRODUCTION

The St. Lawrence Seaway, when constructed, will undoubtedly become an important channel of transportation in the foreign as well as coastwise and intercoastal trade of the United States. Precisely for this reason, fear is entertained in some quarters that it will result in an impairment of the usefulness of existing transportation facilities, principally the railroads. In this report, an attempt is made to estimate the importance of the St. Lawrence Seaway as a method of transportation, with particular reference to its possible effects upon the railroad system of the United States.

Any major private or public undertaking which requires large outlays for benefits which will not materialize until some time in the future imposes the necessity of making informed reasonable assumptions with regard to future demand. The seaway, undertaken immediately, would take 4 years to complete, if expedited as an emergency project, and 7 years, if pursued at a normal pace. Once constructed, it would be a permanent addition to the transportation system of the country. It is necessary, then, to evaluate the place of the St. Lawrence Seaway in the national transportation system, and to analyze its effect upon the existing systems, in the light of future demand for transportation 10, 20, or 30 years from now. It is not possible to obtain a sound evaluation of the Seaway without placing it in the perspective of the future transportation requirements of a growing population and industry. In this report, therefore, an attempt will be made to estimate the future traffic requirements of the country.

There are, mainly, five modes of freight transportation: Railroads, water carriers, motor vehicles, pipe lines, and airplanes. These five methods of transportation compete with each other for available traffic. Air transportation has not yet reached the stage where it constitutes any considerable threat to the other modes of transportation in anything but passenger and mail traffic. Of these modes of transportation the principal one to receive attention in this report will be railroads.

This report will be limited to freight transportation since the St. Lawrence Seaway will not be an important element in passenger travel.

The basic unit of measurement of freight transportation is ton-miles, which depends upon the number of tons of goods transported and the distance over which they are carried. It is necessary, therefore, to make acceptable assumptions with regard to tons of traffic and average distance of transportation, as of the time when the Seaway becomes a settled means of transportation.

The carrying capacity of the seaway when constructed will, of course, be limited to the load that can be accommodated during the open navigation season. This has been estimated to be 16 million tons a season over and above the traffic that is now utilizing the 14-foot canals on the St. Lawrence River. This traffic in recent years has amounted to between 8 and 9 million tons per season. The additional 16 million tons of traffic would be divided between the United States and Canada. It is assumed that as much as 10 million tons of this new capacity may be utilized by American interests.

The number of tons of traffic originated depends upon many factors—upon the levels of production, consumption, and foreign trade. Many forces influence the level of productive activity and the amounts of consumption and foreign trade. The size of the population is one of those influences, and the most easily predictable. Shifts in consumption habits and technological changes influence the amount of production. The most important, and the least predictable influence affecting the rate of production and consumption is the general tempo of economic activity or, to state it in stricter economic terms, the rate of employment of resources.

The second component part of demand for transportation, namely, distance over which traffic must be carried, depends upon the location of centers of production and consumption. The geographical distribution of natural resources and population, and the extent of local industrial specialization, naturally influence the distance traveled by raw materials and finished goods between source of origin and place of consumption. Relative costs of transportation and differential costs of production (including cost of labor, energy and taxes), and, finally, changes in consumer tastes that cause shifts in demand which affect the location of production, all influence the distance traveled by commodities from source to destination. Assumptions must, therefore, be made with regard to these factors in estimating future transportation requirements, with particular reference to average length of haul of freight traffic.

Traffic potentialities in the future are analyzed in this report in three sections, dealing with agricultural production, manufacturing production, and the products of mines. This is necessary since different forces operate upon these three general categories, and sources of information and the techniques of analysis must be particularized. In each case the principal purpose of the analysis is to determine, in

the light of the past behavior of these industries, what the future transportation requirements may be. As a transportation system, once built, will be available for use over many decades, the most that is necessary for the purpose of planning such a future transportation system is a conception of transportation requirements which may be approximated within wide limits over a period of years. In this report, the estimates for the future, calculated on the basis of known factors, will be presented not as definite possibilities in any given year, but mainly as an average of conditions over a decade or a score of years. The succeeding analyses pretend to offer no more than the establishment of reasonably defensible assumptions for the future within conservative limits.

The analysis of the forces that affect transportation in the three major categories of traffic—agricultural, manufactured and mineral products—are presented in chapters I, II, and III. Then in chapter IV the problem of diversion of traffic from railroads to other means of transportation is discussed. Full allowance is made for past and probable future diversion in making estimates of railroad traffic.

After the establishment of conservative estimates of future traffic possibilities the condition and carrying capacity of American railroads are briefly reviewed in chapter V. In this connection not only are the car capacity and tractive power considered, but also the efficiency factors and the maintenance expenditures over the past two decades are carefully weighed. Then, finally, the St. Lawrence Seaway is placed in the perspective of future transportation requirements of the United States, in the light of the carrying capacity, and the seasonal and cyclical behavior of railroad traffic.

CHAPTER I

TRANSPORTATION REQUIREMENTS OF AGRICULTURAL PRODUCTS

Agricultural products in 1939 originated 106,613,462 tons of freight, 11.8 percent of the total freight carried by Class I railroads, and contributed \$682,956,820 of revenue, or 20.2 percent of the total freight revenue of class I railroads. The principal agricultural commodities which accounted for this freight and revenue are listed in table 1.

With respect to future transportation needs, agricultural goods are of three kinds, each subject to separate analysis.

First, there is a large number of agricultural products for which there are available per capita consumption figures for a long number of years past. In the case of these products, therefore, the analytical problem is simplified. There are reliable estimates of future population which, in combination with per capita consumption, make it possible to arrive at reasonable estimates of future transportation requirements.

TABLE 1
Agricultural commodities transported—Class I railroads, 1939

Commodity group or class	Freight traffic originated		Freight revenue	
	Tons	Percent of total	Dollars	Percent of total
Wheat.....	22,284,550	20.9	74,839,583	11.0
Corn.....	10,342,189	9.7	33,816,722	5.0
Flour, wheat.....	8,638,491	8.1	34,361,755	5.0
Mill products, n. o. s.....	7,891,188	7.4	23,802,225	3.5
Products of agriculture, n. o. s.....	6,211,984	5.8	26,330,619	3.9
Fresh fruits.....	6,040,976	5.7	124,506,656	18.2
Sugar beets.....	5,823,460	5.5	3,763,750	.6
Fresh vegetables.....	5,779,562	5.4	101,127,160	14.8
Barley and rye.....	3,907,539	3.7	12,310,133	1.8
Cattle and calves.....	3,787,230	3.5	31,749,616	4.7
Cotton.....	3,366,871	3.1	24,185,961	3.5
Fresh meats, n. o. s.....	2,939,897	2.7	44,735,960	6.5
Oats.....	2,733,057	2.6	10,052,943	1.5
Hogs.....	2,071,316	1.9	14,924,400	2.2
Cottonseed, cottonseed meal and cake.....	1,775,093	1.7	6,110,864	.9
Animal products, n. o. s. (other than fertilizers and fertilizer materials).....	1,331,752	1.2	9,773,116	1.4
Flour, meal, and cereal.....	1,273,164	1.2	6,844,203	1.0
Dried fruits and vegetables.....	1,234,657	1.1	12,830,459	1.9
Vegetable oilcake and meal, except cottonseed.....	1,025,289	1.0	3,512,227	.5
Dairy products.....	1,019,630	1.0	17,305,735	2.5
Sheep and goats.....	940,968	.9	9,498,188	1.4
Hides and leather.....	849,363	.8	7,629,283	1.1
Tobacco, leaf.....	828,809	.8	6,644,728	1.0
Rice.....	726,686	.7	2,947,630	.4
Packinghouse products, edible, n. o. s., not including canned meats.....	646,565	.6	7,628,730	1.1
Hay, alfalfa, and straw.....	624,459	.6	3,600,075	.5

TABLE 1—Continued

Agricultural commodities transported—Class I railroads, 1939—Continued

Commodity group or class	Freight traffic originated		Freight revenue	
	Tons	Percent of total	Dollars	Percent of total
Flaxseed.....	543,939	0.5	1,799,732	0.3
Meats, cured, dried, or smoked.....	499,363	.5	7,611,096	1.1
Wool.....	294,885	.3	4,666,421	.7
Poultry, live and dressed.....	279,241	.3	6,422,482	.9
Meal, corn.....	234,457	.2	774,542	.1
Fish or sea animal oil.....	213,608	.2	1,569,383	.2
Peanuts.....	204,234	.2	2,167,009	.3
Horses, mules, ponies and asses.....	152,243	.1	2,255,588	.3
Grain, n. o. s.....	73,462	.1	347,048	.1
Butterine and margarine.....	20,399	(¹)	366,878	.1
Animals, live, n. o. s.....	2,886	(¹)	43,920	(¹)
Total, agricultural products.....	106,613,462	100.0	682,956,820	100.0

¹ Less than one-tenth of 1 percent.SOURCE: Interstate Commerce Commission, Bureau of Statistics, *Freight Commodity Statistics of Class I Steam Railways in the U. S.*, calendar year 1939.

A second category of agricultural products enters into consumption only after going through processing and manufacturing operations. In this category are, for example, almost all the vegetable and animal oils. In the case of these products, the analysis applied in this section attempts to arrive at per capita consumption equivalents or to study, by other methods, future developments in consumption and industrial uses.

In third place, there is the problem of exportable agricultural products. This requires separate study, since the forces bearing upon the export movement of American agricultural products are variable and, in the present state of the world, not easily predictable.

In the following sections of this chapter these different classes of traffic in agricultural products are examined.

Section 1

DOMESTIC CONSUMPTION OF FOODSTUFFS

Per capita consumption of foodstuffs has been studied by the Bureau of Agricultural Economics and the Agricultural Adjustment Administration.¹ The amount of foodstuffs available for sale in the retail market has first been determined, and this amount has been converted to a per capita basis.² The results of the investigations are presented in table 2.

¹ *The Agricultural Situation*, January 1939, p. 15.² The general method of computation used by the Bureau of Agricultural Economics (as used for individual products) was to consider production of the commodity in any year, make allowances for changes in the stocks of that commodity during the course of the year, subtract exports, add imports, and allow for farm consumption and waste in transport. The result of that computation is called amount available for sale in the retail market.

Inspection of this table shows that total per capita consumption of the principal food products has been almost unchanged over the period studied, 1920-38. The fact that even in two periods with such violent changes in general business conditions as occurred between 1925-29 and 1930-35, per capita food consumption changed less than 3 percent, indicates that this stability of consumption will probably be characteristic of the future.

It should not be concluded from this, however, that total traffic in agricultural products destined for human consumption will increase in the future no more than proportionately to the increase in population.

TABLE 2

Apparent per capita consumption of principal agricultural products, 1920-38[Pounds per capita per year]¹

Commodity or group	Period				
	1920-38	1920-24	1925-29	1930-35	1934-38
Cereal products.....	215	228	226	211	196
All potatoes.....	163	172	163	157	159
Sugar and sirup.....	110	106	118	107	108
Dairy products:					
Manufactured.....	43	38	43	43	47
Fruits:					
Fresh ²	197	185	201	196	206
Dried.....	6	6	6	6	6
Vegetables ³	139	122	135	141	160
Lean meats and fish.....	131	137	133	129	126
Eggs.....	30	28	32	32	30
Beans, peas, nuts.....	14	11	14	16	16
Fats (excl. butter).....	46	44	47	47	46
Coffee, tea, spices, and chocolate.....	17	16	17	18	19
Total food.....	1,141	1,093	1,135	1,102	1,119

¹ Consumption of foodstuffs in terms of estimated weight available for sale in retail market.

² Fresh and canned fruit in terms of fresh fruit, on basis of total population, consumption of watermelons and cantaloupes per urban inhabitant.

³ Fresh and canned vegetables in terms of fresh. Vegetables for market only, based on urban population, except onions. Onions and all others based on total population.

SOURCE: United States Department of Agriculture, Bureau of Agricultural Economics. Adopted from *Agricultural Situation*, January 1939, p. 15.

Such a limited increase would exist only if the following conditions were to exist or if departures from these conditions were in opposite directions in such amounts as to counterbalance each other precisely and leave the sum total of their effects unchanged:

1. Both production and consumption of agricultural-marketed foodstuffs are distributed relatively in the same geographic pattern as at present;
2. The relative consumption of raw goods and of processed foods do not change;
3. There is no improvement in the waste factor in processing of foods;
4. No new uses for existing waste products are discovered;

5. There is no change in the relative amount of food products consumed in the immediate producing area.

These assumptions are briefly examined in the following paragraphs.

Centers of Agricultural Production.

The center of agricultural production has been moving westward. This may be shown by taking only a few major agricultural products. Between 1899 and 1929, New England, North Atlantic, South Atlantic and East North Central States lost a large part of their wheat production. Conversely, West North Central, West South Central, and Mountain States showed very large increases. In the case of corn, between 1899 and 1929 there was a net reduction in total production throughout the country, but the New England, North Atlantic and East North Central States lost a larger part of their total output than other sections and supplied a reduced percentage of the total output; the Mountain States actually increased their output. Something of the same situation held for cattle. Heads of cattle on the eastern seaboard declined in number, whereas Mountain States gained. These facts are presented in tables 3, 4, 5, and 6.

What do these shifts in centers of agricultural production mean in terms of transportation requirements? Clearly this movement will mean that many products must be moved longer distances to reach the principal eastern markets and must therefore increase ton-miles of transportation. To the extent that this shift also removes centers of production away from processing centers, there may actually be an increase in tons of traffic originated since both raw and processed materials will originate traffic. The same will be true if population increases in locations removed from processing centers.

Geographic Concentration of Population.

The geographic distribution of farm production and general population is always in flux. The population of western regions of the United States has been increasing relatively more rapidly than in the East. In spite of this, however, the preponderant increase of population, in absolute numbers, is in the East. For example, as shown in table 6, although the population of the Pacific States increased during the four decades 1900-40, by 303 percent, in absolute numbers the growth amounted to 7,316,000; in contrast, the Middle Atlantic States showed an increase of 78.2 percent, but in absolute numbers the growth of population amounted to 12,084,000. Of the total increase in population from 1900 to 1940, of 55,673,000, 59 percent was in the New England, Middle Atlantic, South Atlantic, and East North Central States. Thus it would seem that developments in the growth of population and shifts in centers of production of agricultural products point to a growth of tons originated and ton-miles of traffic more than proportional to population growth.

TABLE 3
Wheat production by regions, 1899 and 1929

Region	Production (thousands of bushels)			Percentage of United States total		
	1899	1929	Increase or decrease	1899	1929	Change ¹
New England	166	61	-105	(²)	(²)	(²)
Middle Atlantic	32,948	22,329	-10,619	5.0	2.8	-2.2
East North Central	134,699	101,178	-33,521	20.4	12.7	-7.7
West North Central	306,602	374,837	+68,235	46.6	46.8	+2
South Atlantic	31,903	25,544	-6,359	4.8	3.2	-1.6
East South Central	26,854	4,986	-21,868	4.1	.6	-3.5
West South Central	35,047	95,415	+60,368	5.3	11.9	+6.6
Mountain	18,804	101,226	+82,422	2.9	12.6	+9.7
Pacific	72,231	75,073	+2,842	10.9	9.4	-1.5
Total United States	659,254	800,649	+141,395	100.0	100.0	

¹ The percentages in this column express the change that has taken place in the percentage distribution of 1929 as compared with the percentage distribution of 1899.

² Less than one-half to 1 percent.

SOURCE: *Census of Agriculture, 1930, Vol. IV.*

TABLE 4
Corn harvested for grain by regions, 1899 and 1929

Region	Production (thousands of bushels)			Percentage of United States, total		
	1899	1929	Increase or decrease	1899	1929	Change ¹
New England	7,808	1,437	-6,371	0.3	0.1	-0.2
Middle Atlantic	82,873	44,557	-38,316	3.1	2.1	-1.0
East North Central	827,066	534,553	-292,513	31.0	25.1	-5.9
West North Central	1,114,155	1,009,886	-104,269	41.7	47.3	+5.6
South Atlantic	169,469	163,487	-5,982	6.4	7.7	+1.3
East South Central	215,125	192,674	-22,451	8.1	9.0	+9
West South Central	245,126	156,749	-88,377	9.2	7.4	-1.8
Mountain	2,648	24,948	+22,300	.1	1.2	+1.1
Pacific	2,055	2,461	+406	.1	.1	
Total United States	2,666,325	2,130,752	-535,573	100.0	100.0	

¹ The percentages in this column express the change that has taken place in the percentage distribution of 1929 as compared with the percentage distribution of 1899.

SOURCE: *Census of Agriculture, 1930, Vol. IV.*

TABLE 5
Cattle production by regions, 1900 and 1930

Region	Production			Percentage of United States, total		
	1900	1930	Increase or decrease	1900	1930	Change ¹
New England	1,607	1,271	-336	2.4	2.0	-0.4
Middle Atlantic	4,733	3,906	-827	7.0	6.1	-0.9
East North Central	10,532	10,627	+95	15.5	16.6	+1.1
West North Central	20,089	19,877	-212	29.7	31.2	+1.5
South Atlantic	4,432	3,780	-652	6.5	5.9	-0.6
East South Central	3,669	3,968	+299	5.4	6.2	+0.8
West South Central	14,202	10,243	-3,959	21.0	16.0	-5.0
Mountain	5,916	6,691	+775	8.7	10.5	+1.8
Pacific	2,540	3,533	+993	3.8	5.5	+1.7
Total United States	67,720	63,896	-3,824	100.0	100.0	

¹ The percentages in this column express the change that has taken place in the percentage distribution of 1930 as compared with the percentage distribution of 1900.

SOURCE: *Census of Agriculture, 1930, Vol. IV.*

TABLE 6
United States population by regions, 1900 and 1940

Region	1900		1940		Increase 1900-40		Percent increase
	Popula- tion	Percent of total	Popula- tion	Percent of total	Popula- tion	Percent of total	
New England.....	5,592	7.4	8,437	6.4	2,845	5.1	50.9
Middle Atlantic.....	15,455	20.3	27,539	20.9	12,084	21.7	78.2
East North Central.....	15,986	21.0	26,626	20.2	10,640	19.1	66.6
West North Central.....	10,347	13.7	13,517	10.3	3,170	5.7	30.6
South Atlantic.....	10,443	13.7	17,823	13.6	7,380	13.3	70.7
East South Central.....	7,549	9.9	10,778	8.2	3,230	5.8	42.8
West South Central.....	6,532	8.6	13,065	9.9	6,533	11.7	100.0
Mountain.....	1,675	2.2	4,150	3.2	2,475	4.5	147.8
Pacific.....	2,417	3.2	9,733	7.4	7,316	13.1	302.7
Total United States.....	75,995	100.0	131,668	100.0	55,673	100.0	73.3

SOURCE: 1900: United States *Census of Population*, 1930, Vol. I; 1940: Preliminary census release.

Increasing Popularity of Processed Foods.

The next problem is, what will be the effect of a change in the proportion of raw and processed foods consumed? In the majority of cases, raw foods move but once from producer to distributor. Processed foods, however, usually move at least twice—once as raw and once as processed materials. If the dietary tastes of the consuming public change; for example, if macaroni replaces potatoes, and frozen products replace fresh vegetables and meats, then the total volume of traffic measured in tons originated will be greatly increased.³ Among forces acting in this direction are the improvement and cheapening of canning processes which have increased consumption of canned foods. The increase in the production of canned foods is shown in table 7. In the light of what has been happening, it seems possible that the future might see a sizable increase in the proportion of processed food consumption, and hence in tonnage originating and ton-miles of transportation. Insofar as canned foods increase the consumption of agricultural products out of season, there is, also, a further increase in tons of traffic originated.

³ A shift to processed foods need not affect the demand for transportation in ton-miles unless such a shift results in a changed, seasonal consumption, increases total consumption, or causes some detours in the usual route from producer to consumer.

TABLE 7
Production of canned foods in the United States, 1929-37

Commodity	1929	1933	1935	1937
	1,000 cases ¹			
Asparagus.....	2,727	2,064	2,929	2,754
Beans, not baked.....	13,613	9,116	12,285	16,316
Beans, baked.....	17,204	16,460	17,887	18,352
Corn.....	16,724	10,206	22,053	26,052
Peas.....	17,546	13,292	25,144	24,412
Tomatoes.....	21,401	16,900	26,180	23,574
Tomato juice.....		4,171	11,664	13,809
Canned soups.....		10,584	17,239	20,699
Fruit cocktail.....	1,680	2,242	3,091	4,778
Grapefruit.....	1,175	2,280	2,956	4,928
Peaches.....	8,724	10,487	11,501	13,596
Pears.....	4,932	4,853	4,733	5,166
Salmon.....	1,561	1,137	918	885
Sardines.....	9,273	3,937	6,737	7,080
Tuna.....	1,541	1,443	2,824	3,145
	1,000 pounds			
Total, dried fruits.....	938,699	1,014,069	1,119,691	1,160,489

¹ All sizes.

Source: *Statistical Abstract of the United States, 1938, p. 686, and 1939, p. 709.*

Utilization of By-products.

If there is improvement in the processing of foods in a way which will yield a smaller proportion of unusable waste products, then the total tonnage of processed foods will increase. The more the waste is reduced, the more processed foods will move. In some cases, an improvement in the reduction factor will mean that there will be less raw material moving, but it may mean also a reduction in cost of production, consequent reduction in price, and a larger total movement.

Can we expect further developments in utilization of waste products? Consideration of the history of pork processing, which has now reached the stage of almost 100 percent utilization, and the production of plastics from vegetable products, lead one to the conclusion that the future holds promise of further utilization of waste products.

The Effect of the Revolution in Agriculture.

There exist certain basic indications that changes in the distribution of total population between rural and urban areas (and also changes in the nature of the farm population), may cause agricultural traffic to increase faster than total population. If that portion of our total population which is not in a position to produce any of its foodstuffs increases its relative importance, then correspondingly a larger proportion of total agricultural production must be moved to satisfy the needs of these people.

In table 8 are presented data indicating trends in rural and farm

population over the past 40 years. It is evident from this table that American rural population represents a constantly decreasing proportion of our population. In 1900, 60 percent of the people lived in rural areas and were in a position to produce at least part of their own food; by 1930, only 43.8 percent were so situated; and by 1940, only 43.5 percent lived in rural areas. Table 9 shows that in fact the absolute number of people working on the farms has been decreasing since 1929. It is clear from these tables that a smaller proportion of the total population lives closer to the sources of agricultural production; hence, an increasingly large share of agricultural production must be moved to market; the methods by which it moves—rail, truck, or water—are immaterial at this point.

TABLE 8
Rural population in the United States, 1900-40

Year	Rural population		Year	Rural population	
	Thousands of persons	Percent of total U. S. population		Thousands of persons	Percent of total U. S. population
1900.....	45,614	60.0	1930.....	53,820	43.8
1910.....	49,806	54.2	1935.....	54,832	43.1
1920.....	51,406	48.6	1940.....	57,245	43.5
1925.....	52,584	46.1			

SOURCE: 1900-30, *Statistical Abstract of the United States, 1938*, p. 582; 1940, preliminary release of Bureau of the Census.

TABLE 9
Persons gainfully employed in Agriculture, 1909-38

Year	Thousands of persons	Percent of total U. S. population	Year	Thousands of persons	Percent of total U. S. population
1909.....	12,209	13.5	1924.....	11,362	10.0
1910.....	12,146	13.1	1925.....	11,446	10.0
1911.....	12,042	12.8	1926.....	11,354	9.9
1912.....	12,038	12.7	1927.....	11,246	9.5
1913.....	12,033	12.6	1928.....	11,295	9.4
1914.....	12,000	12.3	1929.....	11,289	9.3
1915.....	11,981	12.1	1930.....	11,173	9.1
1916.....	12,016	11.9	1931.....	11,159	9.1
1917.....	11,789	11.5	1932.....	11,069	8.9
1918.....	11,248	10.8	1933.....	11,023	8.8
1919.....	11,106	10.6	1934.....	10,852	8.6
1920.....	11,362	10.6	1935.....	11,172	8.7
1921.....	11,412	10.5	1936.....	10,997	8.6
1922.....	11,443	10.4	1937.....	10,830	8.3
1923.....	11,385	10.0	1938.....	10,745	8.2

SOURCE: Works Progress Administration National Research Project, *Trends in Employment in Agriculture, 1909-36*, t. 1, p. 11.

The reasons for the movement of population away from agriculture are many and varied. As farms become mechanized, relatively less labor is required, and therefore farmers are driven from the land, and

there is less opportunity for new labor to enter. Again, depressed economic conditions in farming have led to foreclosures, with consequent integration of larger farm acreage under single management, usually under absentee ownership, leading to greater use of farm machinery and hired labor. Table 10 shows that since 1910 the proportion of farm acreage in farms of 500 acres or over has increased considerably. In 1910, only 28.5 percent of total farm land was in these large farms; in 1935, it was 40.2 percent. The principal decreases have come in the medium-sized farms—those between 100 and 500 acres, and the 1,000 acres and over group has absorbed a larger proportion of the total.

TABLE 10

Percent distribution of farm acreage according to size of farms, 1910-35

Size of farm	1910	1920	1925	1930	1935
Under 20 acres.....	1.0	0.9	1.1	1.0	1.2
20 to 49 acres.....	5.2	5.1	5.0	4.7	4.4
50 to 99 acres.....	11.7	11.1	11.0	10.0	9.9
100 to 174 acres.....	23.4	20.3	20.1	18.3	17.9
175 to 499 acres.....	30.2	29.0	27.9	27.0	26.4
500 to 999 acres.....	9.5	10.6	10.5	11.0	10.8
1,000 acres and over.....	19.0	23.0	24.4	28.0	29.4
	100.0	100.0	100.0	100.0	100.0

Source: *Statistical Abstract of the United States, 1938, p. 590.*

Besides the increase in large farms, there has been an increase in the value of farm property represented by capital additions as measured by the value of buildings and implements. In 1910, only 18.5 percent of total farm value was represented in buildings and implements. By 1920 this had risen to 19.3 percent, and by 1930, it had gone to 28.4 percent.⁴ Not only is there more large-scale farming, but an extensive investment in improvements has been created. Among the implements, the number of trucks and tractors on the farms has been increasing. This is shown in table 11. Between 1920 and 1935 there was a 355-percent increase in the number of tractors on farms, from 246,083 in 1920 to 1,123,251 in 1935. Two years later the number of tractors had increased to 1,314,042.

Technological and economic forces bearing upon this situation in farming do not seem to have spent their force. Geographical reallocation of internal trade in farm products has not yet reached a stable condition. It is justifiable to conclude that to the extent the present trend is not reversed, more of the farm population would be added to the rest of the population that subsists upon purchased foodstuffs. To this extent, demand for transportation of agricultural products will increase more than in proportion to population.

⁴ *Statistical Abstract of the United States, 1938, p. 582.*

TABLE 11
Tractors and trucks on farms, 1915-37

Year	Estimated number of tractors on farms on January 1	Estimated number of trucks on farms, Dec. 31	Year	Estimated number of tractors on farms on January 31	Estimated number of trucks on farms, Dec. 31
1915	25,000		1927	665,038	598,654
1916	35,000		1928	768,332	697,300
1917	50,000		1929	826,183	767,200
1918	85,000				
1919	160,000		1930	920,021	900,385
			1931	997,943	
1920	246,083	139,169	1932	1,051,646	
1921	350,000		1933	1,077,121	
1922	360,000	266,140	1934	1,090,203	
1923	400,000	285,250			
1924	455,000	367,928	1935	1,123,251	
			1936	1,204,953	
1925	505,933	478,956	1937	1,314,042	
1926	584,532	499,782			

¹ Jan. 1.

² Apr. 1.

SOURCE: W. P. A. National Research Project, *Tractors, Trucks and Automobiles*, Report A-9, pp. 78, 104.

It is established now that even with a stable per capita consumption of farm products in the future, the growth of demand for transportation of such commodities would increase. The movement of the production areas westward, the increasing popularization of canned and frozen foods, the improved reduction factor in processed materials, the utilization of byproducts, and the diminution of farm population and their urbanization or conversion into day laborers, all tend to increase the demand for transportation of agricultural products more than in proportion to the increase in population.

Section 2

INDIRECT CONSUMPTION OF AGRICULTURAL PRODUCTS

Certain agricultural products—particularly animal and vegetable fats and oils—are industrial raw materials. Consumption of these products is increasing more than proportionately to population due to increased consumer acceptance of them as food products—particularly in manufactured shortenings—and to widening industrial usage.

There is indicated in table 12 the per capita consumption of all vegetable oils for the period 1920 to 1938.⁵ With the exception of 1930-33, the average per capita consumption has increased markedly from one period to the next.

⁵ It should be noted that this table does not duplicate the category "Fats (excluding butter)" of table 2 which covers only animal fats.

TABLE 12

Average annual per capita consumption of vegetable oils, during selected intervals

Interval	Pounds	Interval	Pounds
1920-24.....	17.6	1930-33.....	19.6
1925-29.....	23.1	1934-38.....	24.5

SOURCE: Department of Agriculture, Bureau of Agricultural Economics, *Agricultural Outlook, 1940*, Fats, Oils, and Oilseeds, p. 1. Adjustment made excluding animal fats (cf. table 2).

Not only in food products, but in industrial uses, the consumption of vegetable and animal oils has been increasing steadily. In table 13 are presented data showing factory consumption according to classes of products during each year 1931 to 1937. Twenty-eight different oils are included; however, in 1937, seven varieties of oil accounted for 81 percent of the total.⁶

The tendency distinctly shown by table 13 is toward greater utilization of vegetable oils in edible products, and with improvements in methods of manufacture and consumer acceptance, one is justified to expect an increase in this type of consumption; and therefore, a larger demand for transportation will result.

In the case of the industrial uses of oils, it would be expected that the use in soaps and varnishes would increase at least to the same extent as population. The use of oils in linoleum and inks probably will not decrease in absolute amount in the future, and might show appreciable increases. Any large development in housing construction to take care of a growing population will certainly increase demand for housing materials products. The miscellaneous category holds great promise for the future, since it is here that technological advances will be felt most. Future possibilities in the field of plastics are highly promising; increases in the utilization of these oils, and oil meal and cakes, with consequent increases in traffic, might well be expected. Future traffic in processed agricultural products can definitely be expected to increase more than in proportion to population growth.

⁶ Cottonseed oil, 34 percent; tallow, inedible, 14 percent; coconut oil, 9 percent; linseed oil, 8 percent; palm oil, 7 percent; fish oils, 5 percent; grease, 4 percent.

TABLE 13

Factory consumption of primary animal and vegetable fats and oils, by classes of products, 1931-37

[Thousands of pounds]

Uses	1931	1932	1933	1934	1935	1936	1937
Shortening.....	1,208,142	968,577	972,142	1,214,742	1,552,476	1,614,319	1,604,841
Oleomargarine.....	190,467	166,698	198,794	214,132	306,275	322,719	324,905
Other edible products.....	190,835	190,065	247,753	232,466	320,006	363,237	412,684
Soap.....	1,390,231	1,375,416	1,311,263	1,474,415	1,312,780	1,394,538	1,475,756
Paint and varnish.....	328,390	254,251	297,560	328,894	394,035	428,668	457,785
Linoleum.....	73,473	57,515	69,938	67,811	81,031	101,882	102,763
Inks.....	13,284	10,431	13,419	15,544	18,000	20,206	25,213
Miscellaneous.....	204,358	159,818	239,072	237,959	288,688	321,833	351,766
Loss.....	172,269	172,784	164,700	159,856	216,416	207,839	207,201
Grand total.....	3,771,469	3,355,555	3,514,641	4,026,819	4,489,687	4,775,241	4,963,914

SOURCE: United States Bureau of the Census, *Animal and Vegetable Fats and Oils*.

Section 3

EXPORTS OF AGRICULTURAL PRODUCTS

Exports of agricultural products naturally give rise to railroad freight, but it is impossible to segregate this traffic from total domestic traffic in agricultural products. If it is assumed that all exports of agricultural products enter into rail traffic, then the total tonnage of such exports in relation to total tons originating in agricultural products in Class I railroads has varied from 14 percent in 1920 to about 5 percent in 1935. Generally, it has been more nearly 10 percent of total tons of agricultural traffic originating.

It is not true, however, that all agricultural exports enter into rail traffic. Some amount must move into Canada and Mexico over the road by truck. This is probably a very small item. A much larger amount of exports in fresh and canned fruits, particularly in California, must move from the producing areas to the seaports by truck, and then be shipped directly to foreign countries without at any time entering into rail traffic. A still larger item is cotton, which is traditionally shipped down the Mississippi River to New Orleans and then loaded onto cargo liners.

The total tonnage of 35 principal agricultural exports during five selected years is given in table 14. The exports of these products diminished from 19 million tons in 1920 to 10½ million tons in 1925, 8½ million tons in 1930, and a little over 4 million tons in 1935. In 1937 there was an unusual expansion of exports to over 10 million tons. This was unusual because countries which had drastically diminished their imports from the United States—such as Germany—suddenly began to buy large quantities of foodstuffs in the United States. Of course, since the beginning of the present war, agricultural exports have again suffered seriously. What the future will hold in respect to

agricultural exports is difficult to fathom. One should expect that upon the conclusion of the present war there would be a very large expansion of American exports in agricultural products, because of the reduction of plantings in the warring countries. What will happen after the initial spurt in exports following the cessation of hostilities is still more difficult to predict. One should, perhaps, expect again a reduction from the high levels that exports may reach immediately after the cessation of hostilities. Whether it will decline as low as the 1935 level or will be stabilized at around the 1925 or 1930 level is quite impossible to forecast. The effect upon rail traffic of an unusually low level of exports in 1935 as compared with the levels of 1925 or 1930 probably will be between 2 and 3 million tons a year. When the items of cotton and sugar are disregarded, a slight upward trend of agricultural exports becomes visible between 1925 and 1937.

TABLE 14

Exports of selected domestic agricultural products during designated years

[Short tons]

Commodity	1925	1930	1935	1937 ¹
Wheat, including flour.....	3,241,050	3,944,250	477,870	3,215,820
Corn, including corn meal.....	619,575	82,925	20,400	2,601,525
Barley, including flour and malt.....	730,776	274,632	238,224	426,624
Linseed cake and meal.....	294,583	152,320	229,600	278,880
Apples, fresh.....	257,040	474,600	285,600	255,710
Oranges.....	90,120	159,360	217,840	237,280
Tobacco.....	268,620	295,518	216,334	229,773
Oats, including oatmeal.....	634,992	49,968	22,880	197,296
Rye, including flour.....	354,144	6,356	252	184,184
Rice, including flour, meal, and broken rice.....	24,088	140,503	42,265	155,066
Pork and pork products ²	596,343	395,677	79,552	134,921
Prunes, dried.....	75,703	148,127	108,820	107,419
Raisins.....	67,514	62,550	54,508	70,685
Pears, fresh.....	35,603	67,335	62,073	67,374
Starch, including cornstarch.....	112,285	52,404	27,671	61,285
Grapes.....	12,134	24,900	18,676	35,014
Grapefruit, fresh.....	13,265	42,770	39,010	30,555
Peas, canned.....	37,938	37,178	41,158	29,563
Peaches, canned.....	41,580	37,882	51,479	28,194
Glucose and grape sugar.....	85,071	35,286	19,560	23,486
Apricots, dried.....	9,066	11,824	13,294	10,339
Milk, condensed and evaporated.....	67,933	39,493	14,481	15,847
Apples, dried.....	12,417	18,060	17,254	13,926
Apricots, canned.....	14,774	9,512	13,377	13,465
Pineapples, canned.....	18,772	17,654	11,846	12,592
Beef and beef products ³	70,160	49,190	16,059	12,063
Hops.....	7,499	2,797	3,175	2,802
Eggs in the shell.....	20,938	10,790	1,584	1,791
Cheese.....	2,047	887	569	668
Butter.....	2,640	1,147	549	486
Total⁴.....	7,814,670	6,646,875	2,344,959	8,460,633
Cotton lint.....	2,027,500	1,762,000	1,599,250	1,474,750
Linters.....	25,500	33,000	76,250	88,250
Cottonseed cake and meal.....	358,253	43,680	10,080	87,360
Sugar, raw and refined.....	300,000	70,000	94,000	58,000
Total.....	2,711,253	1,908,680	1,779,580	1,708,360

¹ Preliminary.

² Includes canned, fresh, salted or pickled pork, lard, neutral lard, lard oil, bacon, hams and Wiltshire and Cumberland sides.

³ Includes canned, cured and fresh beef, oleo oil, oleo stock, oleomargarine, tallow, and stearin from animal fats.

⁴ Totals do not include duplications.

SOURCE: U. S. Department of Agriculture, *Agricultural Statistics*, 1939, table 601, pp. 433-4.

Even though 1935 was an extraordinarily bad year in agricultural exports—principally because of the severe drought which curtailed exportable surplus in many commodities to the vanishing point (and in fact, United States had to import several agricultural products from abroad to make up the deficiency in domestic production), in the succeeding estimates of future growth in traffic of agricultural products, an allowance will be made for the possible loss in traffic if such conditions were to be repeated.

Section 4

TRAFFIC POTENTIALITIES OF AGRICULTURAL PRODUCTS

The foregoing discussion has indicated that traffic resulting from domestic consumption of agricultural products will probably increase faster than population for the following reasons: (1) the westward movement of centers of agricultural production; (2) the concentration of population in the East; (3) the increase in consumption of processed foods; (4) improvement of packing and canning processes which reduce waste; (5) greater utilization of byproducts; (6) dispossession and urbanization of farmers. In addition, greater industrial utilization of agricultural products in the future will certainly increase rail traffic. On the other hand, the volume of agricultural exports may remain at a much reduced level as compared with the decade of the 1920's.

The estimate of diversion from rail traffic to other modes of transportation in the future will be deferred to later discussion. Here the diversion that has already taken place will be taken for granted and will be assumed to be present in the same degree in the future. Most of the diversion took effect from 1925 to 1935, principally from 1930 to 1935. The factors that contributed to this situation were depressed prices, which led shippers to resort to cheaper means of transportation, better delivery service provided by truck carriers, and the tendency towards "hand-to-mouth buying," and reduction of inventories.

The average "tons originating" in agricultural products on Class I railroads during the 5-year period 1935 through 1939 was 103,153,000. Average population during those same years was 129,284,000. The estimate of average population in the decade of 1950-59 is 144,093,000 on the basis of conservative assumptions of no immigration, medium fertility, and medium mortality.⁷ Applying the ratio of growth of population as shown between the 1935-39 average and the 1950-59 average, to the average tons originating in the earlier period, it appears that the corresponding average figure for 1950-59 of tons of

⁷ National Resources Committee, *Problems of a Changing Population*, p. 24.

freight originating in agricultural products would be 114,965,000 tons. Similarly, the average population for the decade 1960-69 is estimated to be about 149,341,000. Assuming a growth of traffic in agricultural products in proportion to population, the tons originating on Class I railroads may be expected to be 119,155,000 tons. These figures do not include any allowance for increase in traffic on account of the forces that are operating at the present time tending towards increase in the usage of agricultural products in processed form by consumers, and greater utilization in manufacturing processes. Neither do they include the effect of expulsion of farmers from the land and their possible urbanization in the future. Further, no allowance is made for the separation of the producing areas from the consuming areas by shifts in the centers of production.

These figures are valid on the premise that the forces tending towards an increase in traffic of agricultural products, proportionately greater than the increase in population, fully counteract any possible decline in foreign exports and interfarm movements. If this assumption is not considered defensible, then one might make an adjustment for possible decline in relative tonnage in agricultural products by deducting 2 million tons from the preceding estimates for the decades of the 1950's and 1960's.

The above estimates are by no means definite predictions of expected traffic in any one year, or of the average during the indicated periods. They are minimum estimates below which average traffic conditions are not likely to descend. Considering all the factors enumerated in this discussion, and the likelihood that the industrial organization of the country will be better geared to productive effort than it was in the past decade, with resultant improvement in the average standard of living, it is likely that actual rail traffic in agricultural products will be much above these figures.

CHAPTER II

TRANSPORTATION REQUIREMENTS OF MANUFACTURED PRODUCTS

In the case of agricultural products, it is possible to anticipate future transportation requirements because fairly dependable estimates of population and per capita consumption figures in terms of weights are available. Where the products of manufacturing industries are concerned, the problem is much more complicated, because there are no consumption figures in terms of homogeneous units, and the task involved in converting manufacturing production into measurable units of weight is practically insurmountable. A further complicating element is the fact that manufactured products go through many stages of processing, and hence it would be necessary, in order to measure transportation in terms of weight, to convert manufactured goods in every stage of production into weight equivalents, an unattainable objective. Since per capita consumption figures in terms of weights cannot be developed for all manufactured goods, and annual series of total value of manufactured goods are not serviceable for the purpose of this report, it has been necessary to resort to an index of physical production.

Section 1

COMPARISON OF PRODUCTION AND RAILROAD FREIGHT INDEXES

The best available index of manufacturing production heretofore developed was examined to see whether it would be useful in an analysis of transportation requirements. The index in question is known as the Day-Thomas Index of Manufactures, developed by Prof. Edmund E. Day and Dr. Woodlief Thomas. The results of the researches of these two authorities were published in 1928 by the Bureau of the Census as a Census monograph.¹ The index developed by Professor Day and Dr. Thomas as given in this monograph covered the period 1899 to 1923 for each biennial Census year. Dr. Thomas later developed the intercensal years by interpolation. The Federal Reserve Board and the Central Statistical Board carried this index forward to 1935.² Since then, the Bureau of the Census has cooper-

¹ Census Monograph VIII, *The Growth of Manufactures, 1899 to 1923*, appendix A; also see the *Federal Reserve Bulletin*, February 1927, p. 100.

² *Ibid.*

ated in carrying on this work. The intercensal years were estimated by these same organizations through a sampling process.³

The Day-Thomas index includes all the major classifications of manufactured products. A comparison of the classifications included in the Day-Thomas index with railroad freight in manufactures indicates that both include approximately the same classes of products, and hence the Day-Thomas index is serviceable in any future correlation with railroad freight traffic, so far as commodity composition is concerned.

In the Day-Thomas index, the physical units employed were weighted by value added in manufacturing. A proper index for the purposes of this report would be a straightforward index of physical units of weight. An index of manufactured products for the present purposes should be weighted, not by value added in manufacture, but by either tons originated or ton-miles, which are the basic measurements indicating the importance of each transportable commodity in the total demand for transportation.

A correction of the Day-Thomas index to apply weights representing rail traffic in place of value added by manufactures was beyond the means of the Survey, since for most of the years the original data and compilations of the Day-Thomas index were inaccessible. Hence, it was decided to test the usefulness of the Day-Thomas index as presently constituted by comparing it with another index of physical production which was developed by the Interstate Commerce Commission for the very same purpose.⁴ The Interstate Commerce Commission index of physical production covers only a 10-year period, 1928-37.

TABLE 15
Indexes of manufacturing production.
(1928=100)

Year	Day-Thomas index	I. C. C. index	Year	Day-Thomas index	I. C. C. index
1928.....	100.0	100.0	1933.....	65.9	58.4
1929.....	107.3	105.0	1934.....	68.5	65.7
1930.....	85.0	88.7	1935.....	78.4	74.7
1931.....	71.3	68.7	1936.....	95.1	92.6
1932.....	55.5	51.3	1937.....	102.6	100.5

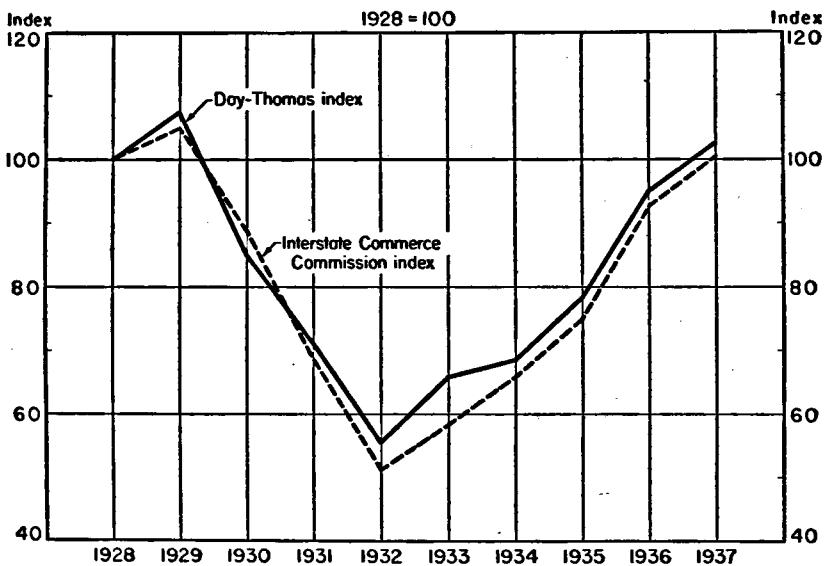
SOURCE: *Census of Manufactures, 1937* and *Federal Reserve Bulletin* August 1935, p. 500. Adjusted to 1928=100. Interstate Commerce Commission, *Fluctuations in Railroad Freight Traffic Compared with Production, Class I Steam Railways, 1928-37*, statement No. 3867, file 314-B-2.

³ In August, 1940, the Board of Governors of the Federal Reserve System published a revision of the index of industrial production. The scope of the index was broadened and new industries were given greater weight than they previously had enjoyed. The most evident change resulting from the revision has been a marked increase in the rate of growth of industrial production as measured by the index. However, the substitution of the revised index for the Day-Thomas index would not affect the net results of this study materially. The Federal Reserve Board index would yield a higher estimate of productivity per worker and also higher estimates of future manufacturing production; this would be counteracted by a wider spread between the index of production and railroad traffic, however, and the end result would be estimates of future railroad traffic only slightly higher than those based on the Day-Thomas index which are made in subsequent sections of this report.

⁴ Interstate Commerce Commission, Bureau of Statistics, *Fluctuations in Railroad Freight Traffic Compared with Production, Class I Steam Railways, 1928-37*, statement No. 3867, file 314-B-2.

A test may be made of the usefulness of the Day-Thomas index by comparing it with the Interstate Commerce index for the period during which they overlap. Such a comparison is presented in table 15 and chart 1. These indicate that there are no radical deviations between the two indexes, and that both series behave almost identically in major movements, as would be expected by those familiar with index number weighting. The Day-Thomas index may be used, therefore, as expressing the physical volume of production, which is of importance in measuring demand for transportation.

Chart 1-INDEXES OF MANUFACTURING PRODUCTION, 1928-1937



Source: Table 15

WPA 3726

In table 16 and chart 2 the Day-Thomas index (average 1920-24 as base) is compared with an index of railroad freight tonnage originating in Class I railroads in the products of manufactures and forestry⁴ (also average of 1920-24 as base),⁵ for the period from 1916 to 1939. It is clearly shown in chart 2 that the Day-Thomas index of manufacturing production and the index of freight originated in Class I railroads moved almost identically from 1916 to 1924. There were slight deviations in 1918, 1919, and 1920, due in the earlier years to congestion of the railways, which caused the index of freight originated to lag slightly behind production, and in 1920, due to the move-

⁴ Unless otherwise indicated, hereafter products of manufactured freight tonnage will actually include both products of manufactures and product of forestry.

⁵ All indexes have been reduced to a base of 1920-24=100 unless otherwise indicated.

ment of inventories, principally for export, which caused the railroad index to jump ahead of the production index. For the rest of the period to 1924, the two indexes moved in identical pattern. From 1924 on they began to diverge slightly, although the direction of their movements was still similar. This divergence would seem to be due to the introduction of truck competition. After 1929, both production and freight indices dropped precipitately, production from 138 to 71 and freight from 128 to 51. There was a much sharper drop in the freight index than in the production index. After 1932, both began climbing approximately in the same velocity, but retaining the newly established relative position, which seems to indicate a permanent divergence of the freight index from the production index. This would seem to be due to a permanent loss of certain types of traffic by the railroads to competing means of transportation. This divergence between the two indexes amounted to about 30 percent in 1938, as compared with 1924, or 25 percent as compared with 1930.

TABLE 16

Indexes of manufacturing production and railroad freight originating in manufactured and forest products on Class I railroads, 1916-39

[Average 1920-1924=100]

Year	Manufacturing production	Railroad freight originating	Year	Manufacturing production	Railroad freight originating
1916.....	99.5	97.9	1929.....	138.4	128.1
1917.....	100.0	102.8	1930.....	109.7	104.6
1918.....	98.2	97.5			
1919.....	95.4	91.7	1931.....	91.9	75.5
1920.....	98.9	106.3	1932.....	71.5	51.2
			1933.....	85.1	57.3
1921.....	75.6	74.9	1934.....	88.4	64.8
1922.....	98.8	93.3	1935.....	101.1	72.0
1923.....	117.0	115.6			
1924.....	109.7	110.0	1936.....	122.7	89.9
1925.....	122.3	118.4	1937.....	132.4	97.6
			1938.....	101.8	71.9
1926.....	125.5	120.8	1939.....	127.2	85.4
1927.....	122.0	117.7			
1928.....	129.0	123.2			

SOURCE: Interstate Commerce Commission *Freight Commodity Statistics, Census of Manufactures, 1937*, p. 17. *Recent Economic Changes*, Vol. II, p. 762; *Federal Reserve Bulletin*, 1935-40.

In the light of the foregoing analysis, the problem of determining transportation requirements of manufactured goods in the future necessitates reasonable assumptions with regard to (a) the average production index during some future period, say the decades of 1950-59 and 1960-69, and (b) the divergence of the freight index from the production index. In the succeeding pages the bases of the assumptions regarding these two are discussed in some detail.

Chart 2 - INDEX OF MANUFACTURING PRODUCTION AND INDEX OF TONS OF MANUFACTURED FREIGHT ORIGINATED, CLASS I RAILROADS, 1916 - 1939



Source: Table 16

WPA 3727

Section 2

LIMITS OF FUTURE EMPLOYMENT POSSIBILITIES IN MANUFACTURING

In order to be able to estimate average possibilities in manufacturing production in a distant future, one would have to know what will then be the average employment in manufacturing, the average number of hours of work, and the probable average productivity per man-hour. To be conservative in this estimate, our assumptions, therefore, with regard to such items as employment, productivity, and hours of work will be judged in terms of past experience and present trends. This is justified upon the *a priori* premise that with a population 10 to 15 percent higher than at present, and technology progressing at a rapid pace, we as a Nation cannot look forward to minimum levels of activity below those experienced in a year of industrial demoralization such as 1932, and may even look forward to experiencing periods of activity that are at least as high as 1929 and 1937.

Employment in Manufacturing Industries.

The best single series indicating employment in all manufacturing industries is that given in the Biennial Census of Manufactures. As shown in this Census, employment figures are given under two classifications—wage earners and salaried employees. These facts for the

period 1919 to 1937 are presented in table 17. This series is biennial, and does not indicate the marked decrease in the number of hours of work per employee since 1929. The latter problem will be treated later in connection with the discussion of productivity. The biennial series can, however, be completed to give an annual series indicating employment in manufactures.

TABLE 17

Number of wage earners and salaried employees in manufacturing industries, census years, 1919-37

Year	Wage earners	Salaried employees	Total employment	Salaried employees, percent of total
1919.....	8,431,157	1,374,920	9,806,077	14.0
1921.....	6,484,447	1,086,539	7,570,986	14.4
1923.....	8,202,779	1,284,365	9,487,144	13.5
1925.....	7,879,508	1,319,136	9,198,644	14.3
1927.....	7,857,015	1,231,600	9,088,615	13.6
1929.....	8,380,536	1,303,735	9,684,271	13.5
1931.....	6,163,144	890,000	7,053,144	12.6
1933.....	5,787,611	770,314	6,557,925	11.7
1935.....	7,203,794	1,058,501	8,262,295	12.8
1937.....	8,569,231	1,217,171	9,786,402	12.4
1939 ¹	7,887,242	1,049,468	8,936,710	11.7

¹ No actual data; estimated on basis of 1929 and 1931 ratios; 14.5 percent of wage earners.

² Preliminary.

SOURCE: *Census of Manufactures, 1937.*

The United States Bureau of Labor Statistics publishes a monthly series of wage earners employed in manufacturing.⁷ This series is constructed on the basis of monthly reports from individual concerns operating in 87 industries. This sample series is periodically checked with the results of each Census of Manufactures, and is revised if necessary. The latest revision was that made to agree with the 1937 Census of Manufactures. The data for 1938 and 1939 are, therefore, subject to possible revision when the final data for the 1939 Census of Manufactures are published. The Bureau of Labor Statistics series is published as an index number with the monthly average 1923-25 as 100. It is presented in the second column of table 18.

Since the Bureau of Labor Statistics index is comparable to the Census data, we have interpolated the intercensal years according to fluctuations in the Bureau of Labor Statistics Index. The results are given in the third column of table 18. In the fourth column the annual employment figures are reduced to relative basis, with the average of 1920-24 as 100.

From table 18 it appears that employment in manufacturing was at its highest in 1920, when there were 9,861,768 people estimated to be engaged in manufacturing. With the exception of 1921, 1922, and

⁷ United States Bureau of Labor Statistics, *Monthly Labor Review.*

1924, employment in this field remained above 9 millions throughout the decade of the 20's. After 1929, there was a precipitate decline to a low of 5,955,729 in 1932. From then on employment in manufacturing climbed appreciably year by year, until in 1937 it reached almost the level of 1920, with 9,786,402 people engaged in manufacturing. There was a pronounced decline in 1938, but improvement has been in progress since then. Preliminary estimates for late 1940 and early 1941 indicate that manufacturing employment has again reached 1929 levels.

TABLE 18

Estimated annual number of wage earners and salaried employees in manufacturing industries, 1919-39

Year	Total employment	B. L. S. index (1923-25=100)	Interpolated series	Index (1920-24=100)
1919	9,806,077	106.7	9,806,077	111.2
1920		107.1	9,861,768	111.8
1921	7,570,986	82.0	7,570,986	85.8
1922		90.7	8,331,702	94.5
1923	9,487,144	103.8	9,487,144	107.6
1924		96.4	8,847,592	100.3
1925	9,198,644	99.8	9,198,644	104.3
1926		101.7	9,330,975	105.8
1927	9,088,615	99.5	9,088,615	103.0
1928		99.7	9,107,595	103.3
1929	9,684,271	106.0	9,684,274	109.8
1930		92.4	8,392,692	95.2
1931	7,053,144	78.1	7,053,144	80.0
1932		66.3	5,955,729	67.5
1933	6,557,925	73.4	6,557,925	74.4
1934		85.7	7,706,144	87.4
1935	8,262,295	91.3	8,262,295	93.7
1936		99.0	8,939,700	101.4
1937	9,786,402	108.6	9,786,402	111.0
1938		89.7	8,081,970	91.6
1939	8,936,710	97.4	8,936,710	101.3

SOURCE: *Census of Manufactures, 1937*. United States Bureau of Labor Statistics, *Monthly Labor Review*, November 1939 and April 1940.

Manufacturing Employment Relative to Population.

It is significant that employment in manufacturing should reach approximately comparable levels in the three peak years of 1920, 1929, and 1937. Over this span of years, population had increased by at least 20 percent. This is important because it explains why productive activity and manufacturing employment in 1937, comparable with the last years of the previous decade, were considered unsatisfactory, for there still remained large numbers of unemployed people in 1937 in spite of better than average industrial activity. Hence the assumptions of minimum and maximum employment which may be considered possible in the future will be defined here in terms of relation of employment to population.

For this reason, the relation of employment to population in past

years is shown in table 19 and chart 3. Table 19 presents an index of manufacturing employment relative to population. This consists simply of the annual relative figures of the ratio of manufacturing employment to population. In chart 3 this series is plotted along with the index of manufacturing employment given in table 18, and with the production index given in table 16.

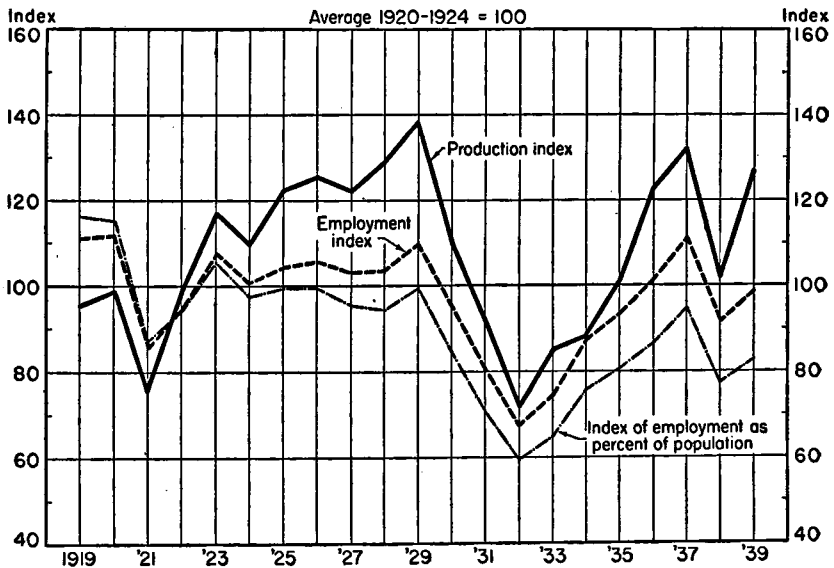
TABLE 19

Gainfully employed persons in manufacture as a percent of total population, 1919-39

Year	Percent of population	Index: Manufacturing employment ÷ population (average 1920-24=100)	Year	Percent of population	Index: Manufacturing employment ÷ population (average 1920-24=100)
1919.....	9.34	116.2	1932.....	4.77	59.4
1920.....	9.26	115.2	1933.....	5.21	64.8
1921.....	7.00	87.1	1934.....	6.09	75.8
1922.....	7.58	94.3	1935.....	6.48	80.8
1923.....	8.51	105.9	1936.....	6.96	86.6
1924.....	7.82	97.3	1937.....	7.57	94.2
1925.....	8.01	99.7	1938.....	6.21	77.3
1926.....	8.01	99.7	1939.....	6.80	84.6
1927.....	7.69	95.7	Average:		
1928.....	7.60	94.6	1920-29.....	7.95	99.0
1929.....	7.97	99.2	1931-34.....	5.45	67.8
1930.....	6.82	84.9	1935-39.....	6.75	84.0
1931.....	5.68	70.7	1930-39.....	6.25	77.8

Source: See table 20.

Chart 3 - INDEXES OF MANUFACTURING PRODUCTION AND EMPLOYMENT, 1919-1939



Source: Tables 16, 18, and 19

Since 1925, there has been a reduction in the proportion of the population employed in manufacturing industries. Although when production increased as it did in 1937, manufacturing gave employment to persons in absolute numbers comparable to the level of the 20's, manufacturing did not absorb as large a proportion of a growing population. Whether this indicates a permanent reduction of the percentage of the population that may in the future expect to find employment in manufacture cannot be asserted with certainty. It is clear, however, that the early years of the past decade were not favorable for employment opportunities in manufacturing. In 1932 as little as 4.77 percent of the total population were employed in manufacturing, compared with 7.97 percent in 1929 and 7.57 percent in 1937. This was the period when unemployment estimates ranged from 9 to 15 million people, and the Federal Government had to add to the purchasing power of the country huge sums of money, ranging between \$1,500,000,000 in 1934 and \$2,500,000,000 in 1936.⁸

The condition of employment or unemployment is determined not merely by manufacturing activity, but by total employment in all lines of business. In 1932, when the proportion of total population working in manufacturing enterprises was down to 4.77 percent, only 31 percent of the population was employed in any occupation. This is to be compared with 39 percent in 1929. If we are to make assumptions with regard to the tolerable minimum of manufacturing employment, it is necessary to study the relation of this segment of employment in relation to the total.

Employment in manufacturing is basic to total employment. This is clear from an examination of table 20 and charts 4 and 5, where manufacturing employment and total employment are compared for the decennial census year, 1870-1930, and during the decade 1929-39. Chart 5 indicates that until 1920, in each census year employment in manufacturing became more and more important in relation to both total employment and population. During the twenties this trend was reversed slightly. While total employment at the beginning and end of the decade stood, relative to population, at about the same level, 40 percent, employment in manufacturing lost ground. This reversal of trends had fundamental reasons, among them the increase in productivity per man-hour in manufacturing without compensating reduction in hours of work, as will be shown later in this chapter. These reasons, however, were not strong enough to vitiate the fundamental dependence of total employment on manufacturing employment, for after 1929 when the latter dipped severely, total employment declined in direct response. And after 1932 when manufacturing employment picked up, total employment also began to improve. The minimum and maximum levels of both manufacturing and total

⁸ U. S. Department of Commerce, National Income Section, *Work Relief Wages*.

employment are experienced almost simultaneously. At the minimum level, in 1932, the proportion of manufacturing employment to total population was 4.77 percent, while that of total employment to population was 31.1 percent (31.0 percent in 1933), and the ratio of manufacturing employment to total employment, 15.4 percent.

TABLE 20

Employment in the United States, census years, 1870-1930, annually 1929-38

Year	Manufacturing employment	Total employment ¹	Population	Percentage of total population		Manufacturing employment as percent of total employment
				Manufacturing	Total employment	
CENSUS YEARS						
1870.....	<i>Persons</i> 2,707,421	<i>Persons</i> 12,505,923	<i>Persons</i> 38,558,371	7.0	32.4	21.6
1880.....	3,784,726	17,392,099	50,155,783	7.5	34.7	21.8
1890.....	5,678,468	23,318,183	62,622,250	9.1	37.2	24.4
1900.....	7,085,309	29,073,233	75,994,575	9.3	38.3	24.4
1910.....	10,656,545	37,167,337	91,972,266	11.6	40.4	28.7
1920.....	12,831,879	41,614,248	105,710,620	12.1	39.4	30.8
1930.....	14,110,652	48,829,920	122,775,046	11.5	40.0	28.9
ANNUAL YEARS						
1929.....	9,684,274	47,737,000	121,526,000	8.0	39.2	20.3
1930.....	8,392,692	45,350,000	123,091,000	6.8	36.8	18.5
1931.....	7,053,144	42,415,000	124,131,000	5.7	34.2	16.6
1932.....	5,955,799	39,104,000	124,974,000	4.8	31.3	15.2
1933.....	6,557,925	40,871,000	125,770,000	5.2	32.5	16.0
1934.....	7,706,144	43,256,000	126,626,000	6.1	34.2	17.8
1935.....	8,262,295	45,407,000	127,521,000	6.5	35.6	18.2
1936.....	8,939,700	48,035,000	128,429,000	7.0	37.4	18.6
1937.....	9,786,402	48,536,000	129,257,000	7.6	37.5	20.2
1938.....	8,081,970	46,969,000	130,215,000	6.2	36.1	17.2

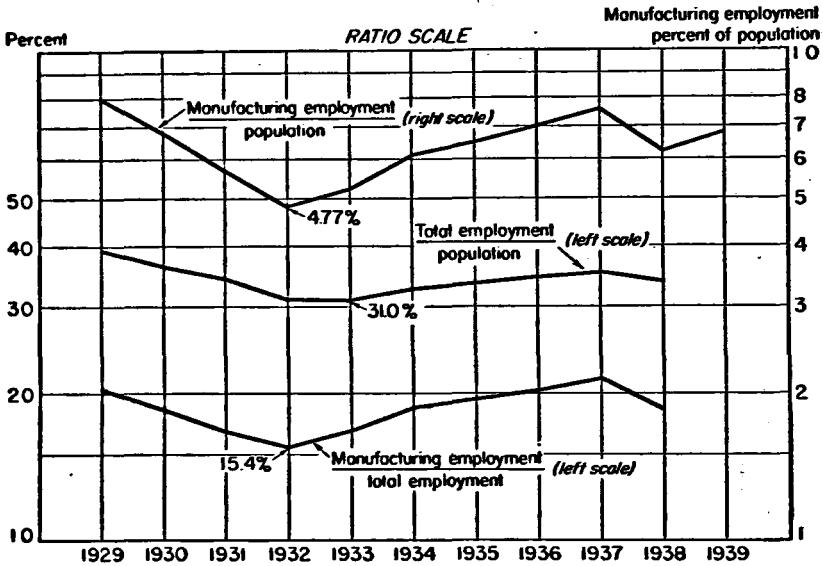
¹ Includes (1) average number of persons in Agricultural Employment (Farm Labor) as of the first of each month; (2) average number of persons engaged at any time of the week ending nearest middle of each month in nonagricultural employment including self-employed and firm members, casual workers, and domestic servants excluding military and naval forces. The totals for the United States have been adjusted to conform to the figures shown by the 1930 *Census of Occupations* for the number of nonagricultural "gainful workers" less the number shown to have been unemployed for 1 week or more at the time of the census; (3) average number of persons employed on Federal Works program during the calendar month, including Civil Works program, Work Projects Administration, Public Works Administration (Federal and non-Federal), general work relief and excluding National Youth and Civilian Conservation Corps.

SOURCES: Employment in Manufacturing: United States Department of Commerce, Bureau of the Census. Census years: 1870, *Ninth Census of the United States, 1870, vol. I, The Statistics of the Population of the United States*, p. 671; 1880-1900, *Thirteenth Census of the United States, 1910, vol. IV, Population*, p. 41; 1910-30, *Fifteenth Census of the United States, 1930, Population, vol. IV, Occupations by States*, p. 6. Annual: See t. 18. Total employment—Census years: United States Department of Commerce, Bureau of the Census, *Fifteenth Census of the United States, 1930, Population, vol. IV, Occupations, by States*, p. 6. Annual: Agricultural: United States Department of Agriculture, Agricultural Marketing Service; Data for 1930-36 are from Works Progress Administration, National Research Project, Report No. A-8, Philadelphia, Pa., *Trends in Employment in Agriculture 1909-36*, p. 163. Nonagricultural: United States Department of Labor, Bureau of Labor Statistics, mimeographed statement of December 1940, *Estimates of Nonagricultural Employment*. Federal Works Program: Federal Work Agency, Work Projects Administration, *Federal Works Programs and Public Assistance*, November, 1940.

POPULATION: United States Department of Commerce, Bureau of the Census; for Census years, *Fifteenth Census of the United States, 1930, Population, vol. IV, Occupations, by States*, p. 6; for 1929-38, *Statistical Abstract of the United States, 1939*, p. 10.

The conditions of employment in 1932-33 seem to define a scale of employment politically intolerable. Their repetition would not guarantee social stability for any length of time. In fact, the history of the past decade indicates that the limit of tolerance is above the levels of 1932-33. When business recession set in during 1937 (although manufacturing employment had reached a level comparable with 1929, total employment absorbed 3.5 percent less of the total

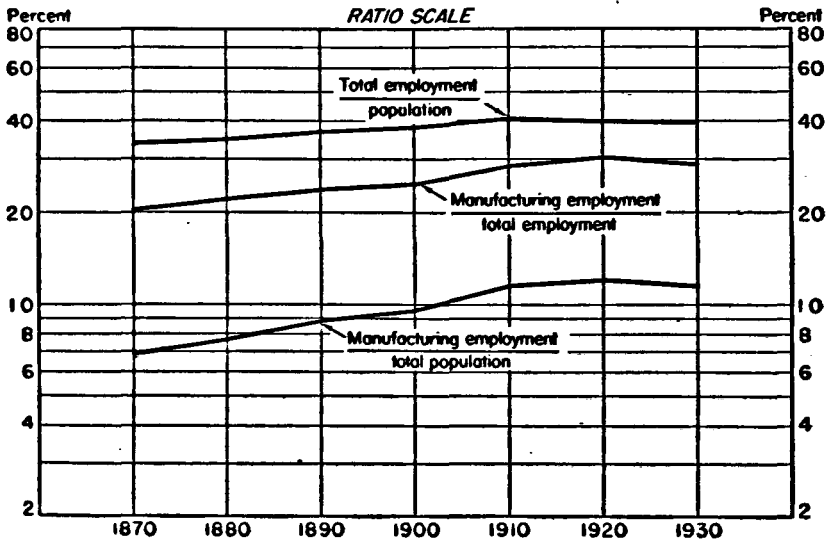
Chart 4 - MANUFACTURING AND TOTAL EMPLOYMENT RELATIVE TO POPULATION, 1929-1939



Source: Table 20

WPA 3729

Chart 5 - MANUFACTURING AND TOTAL EMPLOYMENT RELATIVE TO POPULATION, CENSUS YEARS, 1870-1930



Source: Table 20

WPA 3730

population than in 1929), the Congress deemed it expedient in 1938 to appropriate large sums of money for public works. In 1938 the proportion of employment in manufacturing to total population was 6.2 percent, and of total employment to population, 33.6 percent.

Thus, the conditions during the 1930's cannot be considered satisfactory, but by one means or another the Government succeeded in maintaining social stability. The average proportion of employment in manufacturing to total population during this decade must be considered a minimum basic factor in the total employment situation which might keep the country on the safe side of disruptive social unrest.

Minimum and Maximum Employment Conditions.

The average employment conditions during the decade 1930-39 would certainly be conceded as a minimum for any future decade. Defined in relation to population, this minimum condition presupposes employment in manufacturing 6.25 percent of total population. It is possible that in the future such a condition will be considered less than minimum, indeed, politically intolerable. For present purposes, it is assumed as a minimum limit of possibility.

The National Resources Committee's study of population indicates that a conservative estimate of population in 1955, assuming medium mortality, medium fertility, and no immigration, would be 144,093,000 and in 1965, 149,341,000. As the growth of population is evenly distributed, with nearly equal percentage growth from year to year, these mid-decade figures are taken as representative of the average of the decade. Applying to these figures 6.25 percent as a minimum estimate of gainful employment of the total population in manufacturing and forestry products, we obtain a figure of slightly over 9 million people in the decade of the 50's and 9,333,000 in the 60's. At these levels, employment in manufacturing and forestry products in the 50's would be much lower than in 1937, and nearer the levels of 1936 and 1939. When one considers that population will be almost 15,000,000 greater, and with a change in the age distribution of the population, a proportionately larger percentage would be available for gainful employment, an assumed absolute amount of employment in manufacturing that compares with 1936 and 1939 would not, certainly, seem to be too optimistic. In the decade of the 60's, the assumed average employment in manufacturing of 9,333,000 would compare with the level of 1926 and would be lower than the levels of 1929 and 1937, even though population would be between 23 and 20 million greater than in those respective years.

During the decade 1920-29, the average ratio of employment in manufacturing to population was 7.95 percent. If this percentage is carried into the succeeding two decades, in the light of the medium population estimates of those periods, average manufacturing em-

ployment in the 1950's would be 11,455,000 and in the 1960's, 11,875,000. At these levels, manufacturing would be giving employment to about 2 million people more than the best years in the past two decades. This in the face of an increase of 15 to 20 million persons in total population—which means that of the 6 to 10 million additional people fit for employment, all but 2 millions would have to find employment in enterprises other than manufacturing. It would seem that the assumption of 6.25 percent of the population to be employed in manufacturing is indeed too low and that 7.95 percent is clearly not beyond the probability of achievement. Without overreaching the bounds of practical possibilities, one can easily assume some middle point between these two percentages as an extremely conservative estimate for the future. At 7 percent of the population gainfully employed in manufacturing, the average of the decade of the 50's would be 10,085,000 and the average of the decade of the 60's would account for 10,450,000 as possibilities of employment in manufacturing.

Section 3

HOURS OF WORK AND PRODUCTIVITY IN MANUFACTURING

In order to be able to translate any estimates of the number of gainfully employed people into production figures, it is necessary to make assumptions with regard to average hours of work per week per wage earner and productivity per man-hour.

The National Research Project of the Works Progress Administration made a careful canvass of the available indexes of the weekly hours of work per wage earner. It developed a series based upon sample studies of the Bureau of Labor Statistics, the National Industrial Conference Board and the Census of Manufactures.⁹ The National Research Project series covers the period 1919-36.¹⁰ The Bureau of Labor Statistics supplies a series that covers the period 1932-39. These two series are presented in table 21. The index of weekly hours of work presented in this table, on the basis of 1920-24 as 100, covers the National Research Project series up to and including 1931, and the Bureau of Labor Statistics series from then on.¹¹

The resultant series indicates that hours of work remained fairly consistent around 48 hours per week from 1920 to 1929. Beginning in 1930, there was a gradual diminution in the hours of work; in 1935, according to the B. L. S. series, the average hours worked were 35.5. In 1939, the average hours worked per wage earner were reported to

⁹ For a discussion of the method of derivation of the National Research Project series, see *Production, Employment, and Productivity in 59 Manufacturing Industries*, pt. I, pp. 51-54.

¹⁰ *Ibid.*, p. 66.

¹¹ The industrial coverage of the National Research Project series is fairly comprehensive. It includes all the principal manufacturing industries. The percentage of wage earners in the industries included by the sample studies varies in the case of each industry, ranging from 91 percent of wage earners in automobile manufacturing to 27 percent for bread and bakery products.

TABLE 21

Average hours worked per week per wage earner in selected manufacturing industries, 1920-39

Year	National Research Project	U. S. Bureau of Labor Statistics	Index (average 1920-24=100)	Year	National Research Project	U. S. Bureau of Labor Statistics	Index (average 1920-24=100)
	<i>Hours</i>	<i>Hours</i>			<i>Hours</i>	<i>Hours</i>	
1920	48.2		101.3	1930	44.5		93.5
1921	46.3		97.3	1931	43.0		90.4
1922	48.2		101.3	1932	(38.3)	38.2	80.3
1923	48.4		101.7	1933	(38.4)	37.8	79.4
1924	46.8		98.4	1934	(35.8)	34.5	72.6
1925	48.0		100.9	1935	(36.6)	36.5	76.7
1926	48.2		101.3	1936	(38.7)	39.1	82.2
1927	48.3		101.5	1937		38.6	81.1
1928	48.1		101.1	1938		35.5	74.6
1929	48.2		101.3	1939		37.5	78.8

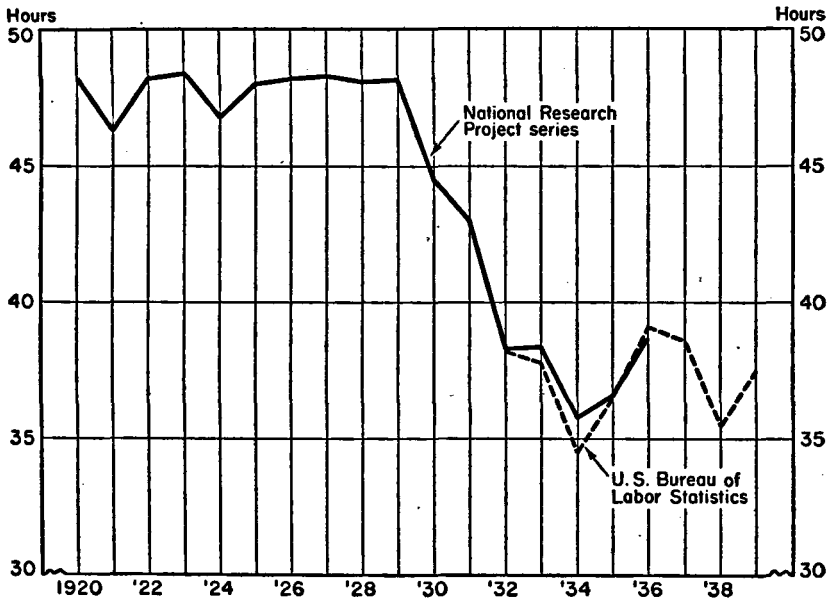
SOURCE: Works Progress Administration National Research Project, *Production, Employment and Productivity in 69 Manufacturing Industries*, Report 8-1: United States Bureau of Labor Statistics, *Monthly Labor Review*, April 1940.

be 37.5. The question that must be resolved for the present purposes is, What would be a reasonable assumption for the average length of the work week in the decade of the 50's and 60's? The reduction of hours shown in table 21 includes the changes that took place during the 30's, effectuated through legislative enactments and part-time work, and through staggering of employment and share-the-work programs employed during the depression. This reduction is shown graphically in chart 6. Unless there is a national emergency, it would not seem likely that the statutory standards introduced during the 30's will be relaxed to any appreciable extent, particularly since labor unions jealously guard the advantages hitherto gained in this line. On the other hand, the possibilities of reducing the work week by further legislative enactments or through collective bargaining agreements below 37½ hours a week would seem to be limited. In the worst period of the depression of the 30's, no agitation appeared advocating a reduction of hours below 30 hours a week, and there was no effective voice even for this claim. The best that could be achieved was national legislation reducing hours of work to 40 by October 1940. The question here presented is not whether a drastic reduction of the work week to a level of 25 percent below the statutory limit, as demanded by the most advanced proponents of reduction in hours of work, is desirable; the question is whether it is politically and economically possible in the next decade or two. It is impossible to anticipate such a development so closely related to political action. In order to be conservative, however, we shall assume an average work week of 35 hours in manufacturing industries during the decades of the 50's and 60's. This may be a distinct possibility, if the work week is reduced to 5 days, 7 hours a day. Even if there is no substantial change in the statutory limits now established, 35 hours a week may still be achieved, consider-

ing the possibilities of voluntary agreements on the part of employers; and also in view of the fact that this estimate includes part-time employment.

The next problem is to establish a reasonable assumption with regard to the productivity of workers per man-hour. Having this, it should be possible, with the estimate of average weekly hours of work and the various levels of employment assumed for the future, to estimate the index of future production of manufactured products within

Chart 6 - AVERAGE HOURS WORKED PER WEEK PER WAGE EARNER IN SELECTED MANUFACTURING INDUSTRIES, 1920-1939



Source: Table 21

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the limits of minimum and maximum employment which have been selected as conservative possibilities.

First, it is necessary to study the past record of production per man-hour. There are no original data measuring man-hour production. This can be obtained only by resort to statistical methods, which have received widespread acceptance in similar studies. The statistical methods involve two separate steps. In the first step, production per wage earner is obtained, and from this, in the second step, production per man-hour is derived. In each case it is necessary to work by means of indexes, as it is difficult, for lack of a homogeneous unit of measurement in manufacture, to obtain a figure of production per wage earner or per man-hour for all manufacturing industries in anything

but index numbers. To obtain the index of production per wage earner it is necessary to divide the index of production as given in table 16 by the index of employment as given in table 18. The resultant index expresses the production per wage earner over the past years on the same relative basis, with the average of 1920-24 as 100. With this index at hand, it is now possible to derive the index of production per man-hour. Since the index of hours of work per week per wage earner is available, one has only to divide the index of production per wage earner by the index of hours of work per week per worker to obtain the index of production per man-hour on the same relative bases, the average of 1920-24 as 100.

These calculations have been made and the results are presented in table 22. Column 1 of this table repeats the index of physical production as given previously in table 16. Column 2 reproduces the index of employment as given in table 18, and column 3, which is the index of productivity per worker, is obtained by the division of column 1 by column 2. Column 4 repeats the index of weekly hours of work per worker from table 21. By dividing this into column 3, the index of productivity per worker, column 5, is obtained, which is the final result aimed at—namely, the index of productivity per man-hour.

The indexes of productivity per worker and productivity per man-hour are graphically presented in chart 7. This chart clearly shows the fact that the index of productivity per man-hour has steadily progressed upward from 86 in 1919 to 159 in 1939, an increase of almost 100 percent over a period of 21 years. The index of productivity per worker kept pace with the index of productivity per man-hour until 1929. That was due to the fact that, as shown in chart 3, while employment remained within stable limits during the 20's, production was moving constantly upward; hence, productivity per worker and per man-hour moved together. From 1929 on, however, with reduction of hours of work and the increase of part-time employment, productivity per worker began to fluctuate around a horizontal plane, whereas productivity per man-hour continued to increase progressively at nearly a constant rate. Whereas there are legal and economic factors that affect the number of man-hours worked during a given time interval, such as legislation bearing upon the hours of work, labor contracts, and enforced part-time employment, which influence the total productivity per worker, productivity per man-hour is principally affected by technology. Of course, such factors as labor contract limitations on rate of production, health regulations, and company policies may influence the rate of operation of workers and hence the productivity per man-hour. Generally, technological factors remain the principal influence bearing upon output per unit of time.

TABLE 22

Indexes of employment, production, and productivity in manufacturing industries, 1919-39

[Average 1920-24=100]

Year	Physical production	Employment	Productivity per worker	Weekly hours per worker	Productivity per man-hour
1919	95.4	111.2	85.8	100.0	85.8
1920	98.9	111.8	88.5	101.3	87.4
1921	75.6	85.8	88.1	97.3	90.5
1922	98.8	94.5	104.6	101.3	103.3
1923	117.0	107.6	108.7	101.7	106.9
1924	109.7	100.3	109.4	98.4	111.2
1925	122.3	104.3	117.3	100.9	116.3
1926	125.5	105.8	118.6	101.3	117.1
1927	122.0	103.0	118.4	101.5	116.7
1928	128.0	103.3	124.9	101.1	123.5
1929	138.4	109.8	126.0	101.3	124.0
1930	109.7	95.2	115.2	93.5	123.2
1931	91.9	80.0	114.9	90.4	127.1
1932	71.5	67.5	105.9	80.3	131.9
1933	85.1	74.4	114.4	79.4	144.1
1934	88.4	87.4	101.1	72.5	139.4
1935	101.1	93.7	107.9	76.7	140.7
1936	122.7	101.4	121.0	82.2	147.2
1937	132.4	111.0	119.3	81.1	147.1
1938	101.8	91.6	111.1	74.6	148.9
1939	127.2	101.3	125.6	78.8	159.4

1 Estimated.

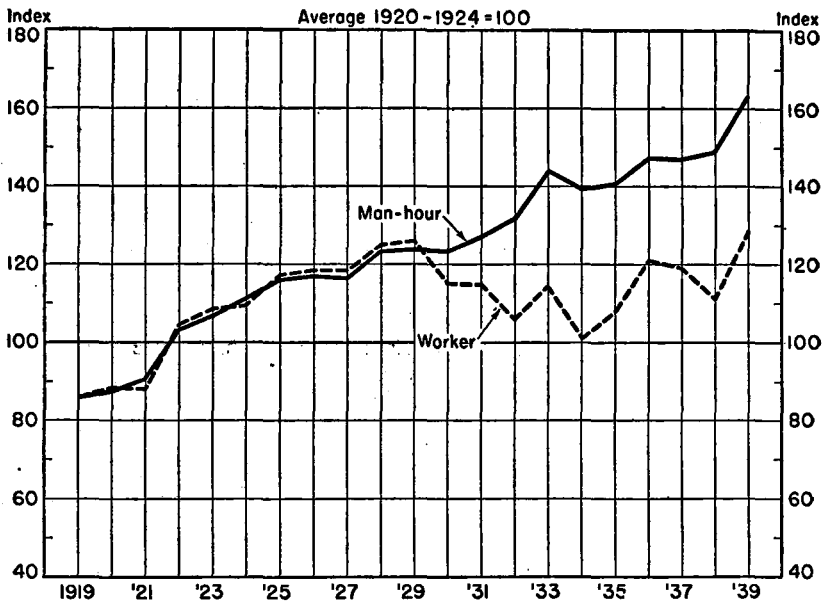
SOURCE: Physical production, table 16; Employment, table 18; Productivity per worker, Physical production divided by employment; Hours per worker, table 21; Productivity per man-hour, Productivity per worker divided by hours per worker.

What is likely to be the progress in the index of productivity per man-hour over the next 20 or 30 years? If one were to project into the future the rate of growth experienced in the past, the average of the index of productivity in the decade of the 50's would approach 220 on the basis of the average of 1920-24 as 100, in comparison with 1929 as 124 and 1939 as 163, and the average of the decade of the 60's would be 260. There are no indications that the pace of technological advance has slowed down. On the contrary, all known factors bearing upon technological improvement in industry lead to the expectation of continued improvement in man-hour performance.

It may be objected that the rate of progress during times of depression is usually accelerated by the desire of industrial concerns to save upon their costs, and by the breathing spell which partial operation gives them to introduce technological improvements, and by the usual, policy of dispensing with the services of the least productive workers first. Hence, one might say the progress experienced during a time of depression should not be projected into the future on a uniform basis when there may be a period of more intensive industrial activity which may necessitate sacrificing possible improvements in the technological structure of industry. This, however, is not supported by the index of productivity per man-hour. Curiously, the progress made between 1920 and 1929 is almost exactly the same in number of

points as the progress made during the period 1930-39—namely, approximately 40 points per decade. It is reasonable then to assume that progress will be effective regardless of the general condition of business; hence, no assumptions need be made as to whether average business conditions in the decades of the 50's and 60's would be good, bad, or indifferent. This gradual improvement in productivity per man-hour is explainable by the fact that industrial improvements do not come in jumps, involving major discoveries, but they are the

Chart 7 - INDEXES OF PRODUCTIVITY PER WORKER AND PER MAN-HOUR IN MANUFACTURING INDUSTRIES, 1919-1939



Source: Table 22

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result of slow and continual research and partial improvements undertaken step by step and from year to year. Industrial plants are not ordinarily rebuilt completely in one operation, but are improved as more up-to-date machinery becomes available. And even if in certain industries there are cases, such as recently occurred in the steel industry, where large plants are constructed with the purpose of superseding existing plants, the average index need not reflect such individual cases as violent movements, because industry at large still maintains a gradual rate of displacement of old machinery and old methods with the new.

In order to protect our estimates against a too liberal interpretation of past trends in their application to the future, the average indexes of productivity per man-hour for the 50's and the 60's may be reduced

by approximately 10 percent, giving thereby 200 instead of 220 for the decade of the 50's and 235 instead of 260 for the decade of the 60's. That these assumptions are very conservative is shown by the fact that in the next two decades improvement is assumed in productivity per man-hour, which is less than the improvement actually experienced during each of the past two decades. These estimates are conservative in the light of the tendency toward larger units of production in industry and mass production methods in many enterprises now operating under a custom-built system of production, such as the airplane industry; the introduction of synthetic materials, plastics, and chemurgic processes; and the utilization of electricity to an increasing degree in industry.

Section 4

SUMMARY ESTIMATE OF TRAFFIC IN MANUFACTURED AND FORESTRY PRODUCTS

To this point, there have been estimated minimum, maximum and conservative numbers of gainfully employed persons in manufacturing in the decades of the 50's and 60's, the possible number of hours of work per wage earner per week, and the index of productivity per man-hour. It will be recalled that assuming the same ratio of employment in manufacturing to total population as existed during the decade of the 30's (6.25 percent), there might be an average of gainfully employed people in manufacturing of slightly over 9 millions in the decade of the 50's, and 9,333,000 in the decade of the 60's. On the basis of the maximum assumptions that were obtained by applying the average ratio of the gainfully employed people in manufacturing to employment as it existed during the decade of the 20's—namely, 7.95 percent—to the population that would exist on the average in the 50's and 60's, there was obtained an estimate of 11,455,000 and 11,875,000 people, respectively, for those two decades. With a medium conservative assumption involving a 7 percent relationship, on the average, between gainfully employed people in manufacturing and total population, the absolute numbers would be 10,085,000 and 10,450,000. Reduced to a relative basis, with the average of 1920-24 as 100, the minimum assumption would give an employment index in manufacturing of 102.1 for the decade of the 50's and 105.8 for the decade of the 60's. On the maximum basis, the respective indexes will be 129.9 and 134.7, and on the conservative basis 114.4 and 118.5.

The productivity per worker for these future periods may be obtained by multiplying the index of productivity per man-hour with the index of the number of hours per week per worker here assumed. The average length of the work week that is assumed here is 35 hours a week. This, converted to a relative basis with the average of

1920-24 as 100 gives 73.5 as the index of the hours of work per week. In order to obtain productivity per hour in the future, this must be multiplied by the index of productivity per man-hour—namely, 200 for the decade of the 50's and 235 for the decade of the 60's. The resultant index of productivity per worker gives 147.0 and 172.7 for the two successive periods, respectively.

It is possible, now, to estimate the indexes of physical production on the basis of 1920-24 as 100 by multiplying productivity per wage earner with the employment index. The results are tabulated in table 23, where these calculations are made for all three different assumptions of employment. If we assumed no better relationship between employment in manufacture and total population than existed during the abnormal period of the 30's, the index of production would be, in the 1950-59 period, an average of 150.2 and in the 1960-69 period, an average of 182.8. At these levels, it would be still higher than the best years in the past, being 12 points higher than in 1929 and 18 points higher than in 1937. If the relationship of workers in manufacturing to total population were as good as existed in the period of the 20's, then on a 35-hour a week basis and the productivity per man-hour herein assumed, the index of production would be, for the two successive periods, respectively 191.1 and 232.8. On the basis of the conservative employment assumptions—namely, 7 per cent of the total population being gainfully employed in manufacturing—the index of manufacturing production would be 168.3 and 204.8 for these two periods, respectively. On this conservative basis, the average production index would be, for the decade of the 50's, 29 points higher than in 1929 and 37 points higher than in 1937 in the earlier decade, and, for the decade of the 60's, 67 points higher than in 1929 and 73 points higher than in 1937.

TABLE 23

Estimates of the index of physical production in manufacturing under various assumptions of employment

[Average 1920-24=100]

Period	Employment	Productivity per worker	Physical production
"POSSIBLE" EMPLOYMENT			
1950-59	129.9	147.0	191.1
1960-69	134.7	172.7	232.8
"MINIMUM" EMPLOYMENT			
1950-59	102.1	147.0	150.2
1960-69	105.8	172.7	182.8
"CONSERVATIVE" EMPLOYMENT			
1950-59	114.4	147.0	168.3
1960-69	118.5	172.7	204.8

Section 5

EMPLOYMENT, PRODUCTION, AND PRODUCTIVITY IN CERTAIN SPECIFIED INDUSTRIES

In this section certain specified industries are examined in greater detail as a check upon the methods employed in the preceding sections, to see whether in any major industries which create demand for transportation services our assumptions and estimates of productivity are valid. The elements which must be particularly checked are the trends of total production and productivity per man-hour. It is not possible to make any assumptions with regard to the amount of employment that a given industry may accord. It will be recalled that the assumptions on general employment in all manufacturing industries were not based on purely economic reasoning or study of curves and charts, but were based on an assumption of minimum conditions of employment which, in the face of a greatly enlarged population, would be the outside limit of political tolerance in a democracy. It is, of course, more defensible to reason in this vein on the question of employment as a whole or employment in all manufacturing industries, than it would be to make any assumptions as to what segment of total employment a given specified industry might use. Consequently, in this brief reference to individual industries no attempt will be made to indicate employment possibilities. However, the past trend of production, employment and productivity must be illuminating in the evaluation of the general indexes pertaining to all manufacturing industries which have been offered previously.

The specific industries selected for brief test studies were the automobile industry, the cement industry, iron and steel, forestry products, and refined petroleum. In 1939 these five industries accounted for about 20 percent of the total tons originating on Class I railroads (including less-than-carload tonnage). As only 31.4 percent consisted of manufactures and forest products. These five industries accounted for over 63 percent of tons of freight originating in manufactured and forestry products. In terms of revenue these five items yielded 52.5 percent of all revenues derived by Class I railroads from the transportation of manufactured goods and forestry products. Hence these five industries may be considered an important sample study insofar as they reflect only a little less than two-thirds of the tonnage and more than half of the revenues derived by Class I railroads from the transportation of manufactured goods and forestry products.

To present at one glance the mutual relationship and movements of the indexes of production, employment, and productivity per man-hour of these five industries and their relative behavior in comparison with the indexes that were previously used for manufacturing as a

whole, tables 24, 25, 26, and Charts 8, 9, and 10 are presented. Before interpreting these tables and charts, however, it is well to indicate the sources and composition of the various indexes included.

The indexes of production, employment, and productivity in the motor vehicle industry are based on the work of the National Research Project.¹² The industry includes establishments classified by the Census in two industries: "Motor Vehicles" and "Motor Vehicle Bodies and Parts." The data for odd-numbered years were taken from the Census of Manufactures; the intercensal years were interpolated by means of data from the Automobile Manufacturers Association. The index of employment and man-hours was based on studies of the United States Bureau of Labor Statistics. The index of productivity was obtained by dividing the index of production by the index of man-hours. As the indexes of the National Research Project were on a 1929 base, all series were converted to the base, average 1920-24=100, in order to put them on a basis comparable with the overall indexes developed earlier in this chapter.

The indexes of employment, production, and productivity in the Cement Industry are based on a study made by the National Research Project.¹³ The basic data on production were furnished by the Bureau of Mines, data on employment by the Census and the United States Bureau of Labor Statistics. The index of productivity per man-hour was based on data supplied by the Portland Cement Association and the Bureau of Mines.

The index of production in the iron and steel group consists of a combination of production in blast furnaces, and steel works and rolling mills, each weighted by changing employment figures. The basic information comes from the Bureau of the Census and the American Iron and Steel Institute.¹⁴ The data on employment come from the United States Bureau of Labor Statistics, adjusted to Census of Manufactures data. The index of productivity was derived by dividing the index of production by the index of man-hours.

The forest products group comprises logging camps, saw-mills, and saw-plane mills.¹⁵ The indexes of production in the latter two groups were based on Census of Manufactures data; the index for the first was derived by converting consumption of forest products into log-equivalents. The three series were combined on the basis of man-hour weights. The data on employment were obtained for Census years from the Census of Manufactures; the intercensal years were interpolated according to Bureau of Labor Statistics data. The man-

¹² Works Progress Administration, National Research Project: *Production, Employment, and Productivity in 59 Manufacturing Industries*, Part Two, pp. 136-144; Part Three, pp. 93-95.

¹³ *Ibid*, Part Two, pp. 30-35; Part Three, pp. 25-26; also, National Research Project, *Mechanization in the Cement Industry*.

¹⁴ *Production, Employment, and Productivity in 59 Manufacturing Industries*, Part Two, pp. 93-100; Part Three, pp. 68-69.

¹⁵ *Ibid*, Part Two, pp. 129-28; Part Three, pp. 83-88.

hours information was derived from special studies made by the Bureau of Labor Statistics. The index of productivity per man-hour was obtained by a process of division comparable to that used for the other industries.

The petroleum refining industry includes those establishments engaged primarily in the refining of crude petroleum by distillation and processes.¹⁶ The index of production is based on Bureau of Mines data relating to the total volume of crude petroleum refined. The index of employment and man-hours was derived from Census wage-earner statistics for the odd-numbered years 1919-37, and rendered continuous for the period 1923-36 by means of the Bureau of Labor Statistics index. No satisfactory data were available for 1920 and 1922. In this industry, therefore, the indices are based on the average of the 3 years 1921, 1923, and 1924, instead of the 5 years 1920-24. The index of productivity was derived by a process of division.

Employment.

In the matter of employment, a study of chart 8, shows that the three important industries—namely, automobiles, iron and steel, and petroleum refining—showed a relatively higher percentage advance in periods of rising industrial activity, such as from 1923 to 1929 and from 1934 to 1937, than the general index of employment. Only in two brief periods did the index of employment in the iron and steel industry fall below the general index of employment; namely, in 1921 and in 1931. The indexes of employment in cement and forest products industries have lagged considerably behind the index of total manufacturing employment. The reasons for this would seem to be obviously in the greatly diminished activity in new housing during the period. One should expect that with the growing deficit in housing and an expanding population, the need for new housing would become so pressing as to be irresistible, and the immediate future for these two essential materials used in construction and housing would seem to be definitely upward. Generally, then, so far as employment opportunities in the five industries which we have considered can be guessed at all by reference to past performance and present needs, one can say without stretching probabilities that three of these five industries—namely, automobiles, iron and steel, and petroleum refining—may continue to supply employment opportunities perhaps at a higher rate of increase than general manufacturing, and that the cement and forest products industries are likely to show a spurt forward as soon as a politically feasible means of overcoming the housing shortage is found.

¹⁶ *Ibid.*, Part Two, pp. 181-84; Part Three, pp. 116-17. Also, National Research Project, *Petroleum and Natural Gas Production*.

TABLE 24

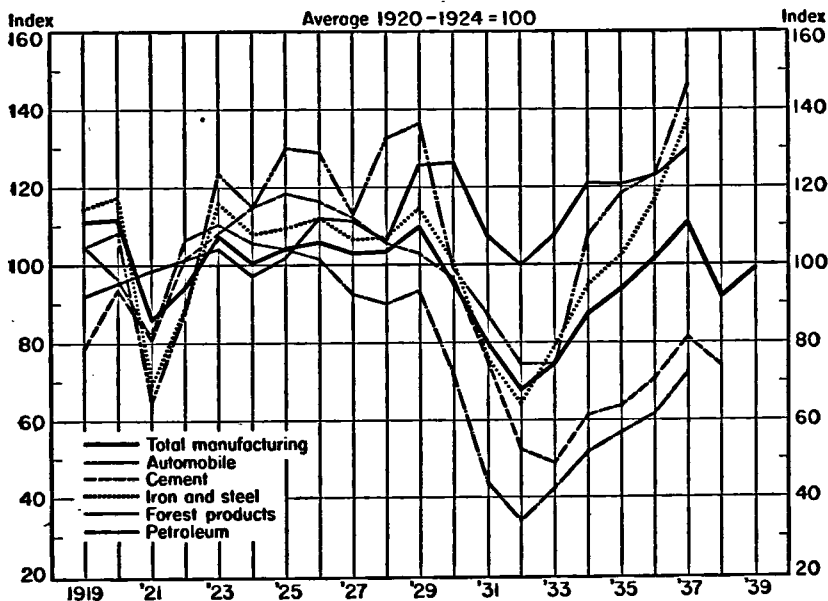
Indexes of employment in manufacturing and selected industries

[Average 1920-24=100]

Year	Total manufacturing	Automobiles	Cement	Iron and steel	Forest products	Petroleum
1919	111.2	104.6	78.8	114.6	104.7	91.9
1920	111.6	108.3	94.0	117.4	96.2	N. A.
1921	85.8	64.9	80.9	69.5	81.3	98.6
1922	94.5	88.3	101.6	88.8	106.5	N. A.
1923	107.6	123.6	108.8	116.2	110.6	104.1
1924	100.3	115.0	115.1	108.0	105.4	97.2
1925	104.3	130.0	118.6	109.4	104.1	102.0
1926	106.8	128.8	116.4	112.2	101.8	112.1
1927	103.0	112.9	112.1	106.5	92.3	111.2
1928	103.3	132.7	105.5	107.0	90.0	105.9
1929	109.8	136.7	103.0	114.8	93.5	125.8
1930	95.2	98.6	96.5	100.4	72.1	126.3
1931	80.0	87.2	75.1	76.1	43.9	107.4
1932	67.5	74.4	52.2	64.3	33.8	99.8
1933	74.4	74.4	48.8	79.1	42.3	107.8
1934	87.4	107.4	61.3	95.0	51.7	121.0
1935	93.7	118.5	63.8	102.5	56.9	120.8
1936	101.4	122.5	70.4	116.8	61.6	122.4
1937	111.0	146.4	81.4	137.5	72.3	129.8
1938	91.6		74.1			
1939	101.3					

SOURCE: Total manufacturing from table 18; Works Progress Administration, National Research Project: *Production, Employment, and Productivity in 60 Manufacturing Industries, Parts One, Two, and Three.*

Chart 8 - INDEXES OF EMPLOYMENT: TOTAL MANUFACTURING AND SELECTED INDUSTRIES, 1919-1939



Source: Table 24

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Production.

The relative movement of production indexes of the five industries in comparison with the index of physical production of all manufactures shows that physical production of the petroleum refining industry has moved to higher levels at a nearly constant rate, with only a brief break between 1929 and 1932, after which the upward climb was resumed. The production index of the automobile industry has shown an equally persistent forward movement, except that the breaks in the continuity of this movement have been much greater in amplitude. It is characteristic of the industry that after the index of production climbed from 80 in 1920 to 222.5 in 1929, at which time it was 84 points further advanced than the index of manufacturing production, it then persistently declined to below 67 in 1932, where it was almost five points below the index of physical production of all manufactures. From then on it moved forward again by leaps and bounds to 208.4 in 1937, 76 points further advanced than the general index of physical production. This experience of the automobile industry would seem to indicate that its response to increased purchasing power and employment among the people is much more accelerated, and consequently the output of physical products of this industry, for every improvement in the employment and income situation—whether this improvement is due to growth in population, improved per capita output or higher wages—will advance more quickly and to higher levels than manufacturing products as a whole.

On the other hand, the index of production of the iron and steel industry shows a much closer relationship to the general index of physical output than that of the automobile industry. In times of improved business conditions, the output of blast furnaces, steel works, and rolling mills seems to proceed at a slightly higher pace than that of manufacturing industry as a whole. In less prosperous years the output of iron and steel seems to decline at a greater rate than that of all manufacturing. On the average, therefore, one may expect that the iron and steel industry over a period of a decade or more will behave as favorably as total manufacturing.

In the case of forest products and the cement industry, the indexes of production reflect the same conditions that we discussed above in connection with employment. The index of physical production of forest products indicates that since 1925 it has fallen below the index of production of all manufactures and has in fact continued to lose ground in its relative position. The same is true of the cement industry. Since 1932 neither industry has been able to regain lost ground. We may expect improvement in these two industries if and when housing projects, particularly in small units, are undertaken on a large and expanding scale.

TABLE 25

Indexes of physical production in manufacturing and selected industries

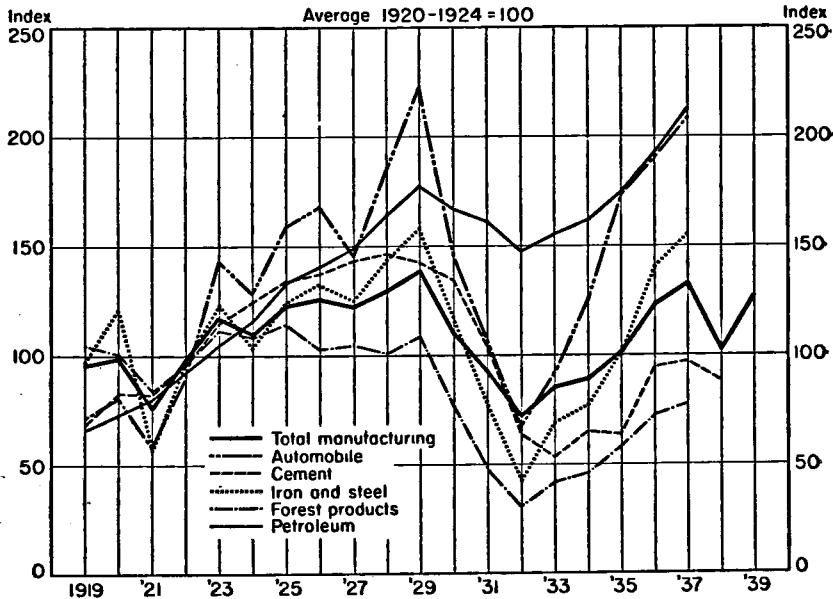
[Average 1920-24=100]

Year	Total manufacturing	Automobiles ¹	Cement	Iron and steel	Forest products	Petroleum
1919	95.4	71.2	68.1	97.1	104.4	65.7
1920	98.9	60.6	82.9	120.5	100.9	N. A.
1921	75.6	67.4	81.7	55.8	83.2	79.7
1922	98.8	90.6	98.2	97.9	96.1	N. A.
1923	117.0	143.1	114.7	122.9	111.6	104.5
1924	109.7	128.2	124.4	102.9	108.1	115.8
1925	122.3	158.7	133.6	123.9	114.7	133.1
1926	125.5	167.9	137.0	132.7	102.7	140.1
1927	122.0	144.7	143.2	124.5	104.2	149.0
1928	129.0	184.8	146.4	143.4	100.8	164.2
1929	138.4	222.6	142.2	157.6	108.7	177.6
1930	109.7	144.9	134.6	116.0	76.4	166.8
1931	91.9	106.0	103.2	75.8	48.5	160.9
1932	71.5	66.8	63.7	41.8	30.0	147.5
1933	85.1	91.1	62.9	68.9	41.5	154.9
1934	88.4	125.3	64.7	76.9	45.8	161.1
1935	101.1	173.0	63.4	101.0	57.9	173.8
1936	122.7	189.9	94.4	140.4	72.0	192.2
1937	132.4	208.4	97.2	154.3	77.1	212.8
1938	101.8		88.0			
1939	127.2					

¹ Includes parts.

SOURCE: Total manufacturing from table 16; Works Progress Administration, National Research Project: Production, Employment and Productivity in 69 Manufacturing Industries, Parts One, Two, and Three.

Chart 9 - INDEXES OF PHYSICAL PRODUCTION: TOTAL MANUFACTURING AND SELECTED INDUSTRIES, 1919-1939



Source: Table 25

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Productivity Per Man-Hour.

The most important assumption that we made in previous sections of this chapter next to plausible employment levels, was productivity per man-hour. To what extent may the component segments of manufacturing industry that are analyzed here substantiate and support the assumptions that were made in the preceding section with regard to productivity in manufacturing industry in the future? For the decade of 1950-60, the level assumed was 200, as compared with 100 on the basis of 1920-24 averages. This, indeed, implied a 100-percent increase in productivity per man-hour over 35 years. In chart 10 the indexes of productivity per man-hour in petroleum refining, in automobile manufacturing, cement, iron and steel, and forest products industries are plotted alongside the index of productivity per man-hour of manufacturing industry as a whole. From these indexes it is clear that only the forest products industry has been slow in improving productivity per man-hour. Even there, productivity increased by 34 percent over the average of 1920-24. The other industries, however, showed much better progress in production per man-hour than manufacturing industry as a whole. Iron and steel improved 60 percent to the end of 1937. For the same period automobiles improved 87 percent, petroleum 28 percent, and cement 62 percent. These improvements must be compared with a 47 percent increase at the end of 1937 in the index of productivity per man-hour in all manufacturing. At the end of 1937, therefore, four of these major component parts of manufacturing industry—namely, petroleum refining, the automobile industry, the cement industry and iron and steel—had improved productivity per man-hour at a greater pace than all manufacturing, and had already made up a good part of the progress we anticipate for 15 years from now. Indeed, in the case of petroleum, our assumed estimate of productivity per man-hour was far surpassed by the end of 1937.

It would seem that with such relentless progress in these major industries in the matter of productivity per unit of time, our assumed estimates for the decades of 1950-59 and 1960-69 are not beyond the range of possibility. In fact, it should not be a matter of surprise if they turn out to be grossly understated.

To the extent that these solutions result in employment and productivity which surpass the very modest limits assumed for the next two decades, to that extent the estimates in this study will be far understated.

TABLE 26

Indexes of productivity per man-hour in manufacturing and selected industries

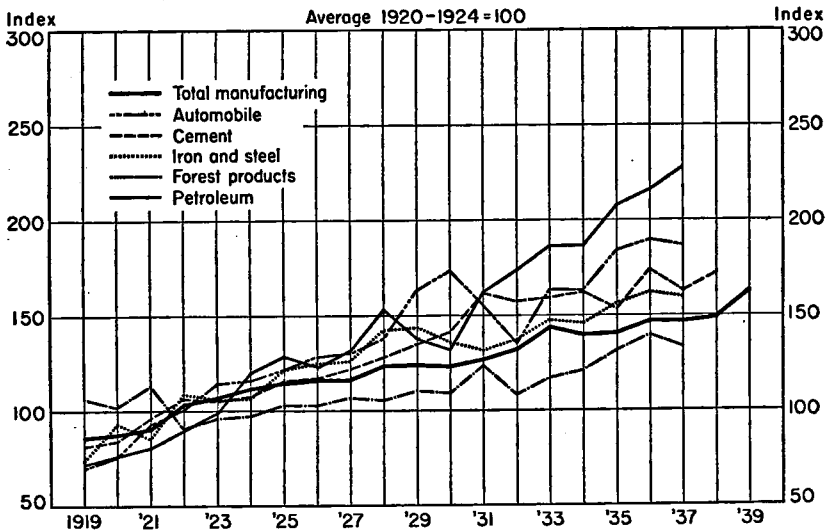
[Average 1920-24=100]

Year	Total manufacturing	Automobiles	Cement	Iron and steel	Forest products	Petroleum
1919	85.8	70.0	81.6	73.4	106.3	72.0
1920	87.4	76.1	84.0	93.4	101.7	
1921	90.5	83.1	96.7	85.3	113.6	81.0
1922	103.3	100.3	106.8	109.0	90.8	
1923	106.9	114.4	106.0	105.4	96.1	99.0
1924	111.2	116.1	107.5	106.9	97.8	120.0
1925	116.3	121.6	116.5	121.5	102.9	129.0
1926	117.1	128.6	117.2	117.2	102.8	123.0
1927	116.7	130.2	122.2	126.1	106.8	132.0
1928	123.5	137.5	128.0	142.9	105.3	153.0
1929	124.0	163.9	135.5	143.9	110.9	138.0
1930	123.2	173.6	141.5	136.0	109.4	132.0
1931	127.1	155.1	161.8	132.1	124.0	162.0
1932	131.9	135.1	157.7	137.7	108.1	174.0
1933	144.1	163.9	159.5	148.0	117.3	186.0
1934	139.4	163.6	162.7	146.7	121.0	186.0
1935	140.7	184.3	153.0	156.2	131.8	208.0
1936	147.2	189.7	174.4	162.3	140.0	216.0
1937	147.1	186.7	163.3	159.9	133.5	228.0
1938	148.9		172.1			
1939	159.4					

¹ Estimated.

SOURCE: Total manufacturing from table 22; Works Progress Administration, National Research Project *Production, Employment and Productivity in 69 Manufacturing Industries, Parts One, Two, and Three.*

Chart 10 - INDEXES OF PRODUCTIVITY PER MAN-HOUR: TOTAL MANUFACTURING AND SELECTED INDUSTRIES, 1919-1939



Source: Table 26

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CHAPTER III

TRANSPORTATION REQUIREMENTS OF MINERAL PRODUCTS

Mineral products are the most important commodities so far as tonnage of railroad freight is concerned. In 1939, products of mines accounted for 496,938,982 tons of revenue freight originating in Class I railroads, and yielded \$945,284,497 in freight revenue. This tonnage was 55 percent of the total tons of freight originating on Class I railroads, and the revenue was 28 percent of total freight revenue. Products of mines constitute by far the largest tonnage of goods transported, more than both agricultural and manufactured products combined. In revenue yielded, however, it is much less important than manufactured products, which supplied 44 percent of freight revenue of Class I railroads. The future trends in the mining industries are, therefore, of paramount importance in estimating traffic requirements and railroad capacity.

The method of estimating future production possibilities in mining industries adopted for the purposes of establishing a minimum or "floor" below which the average annual production and freight traffic is not likely to fall in the decades to come is different from the method employed in estimating potential freight traffic in agricultural and manufactured commodities. Mining production is so closely related to manufacturing activity that it may be considered almost a mathematical function of manufacturing production.

TABLE 27

Indexes of physical production of minerals and manufactures, and revenue freight originating in mineral products and manufactured products on Class I railroads, 1919-38

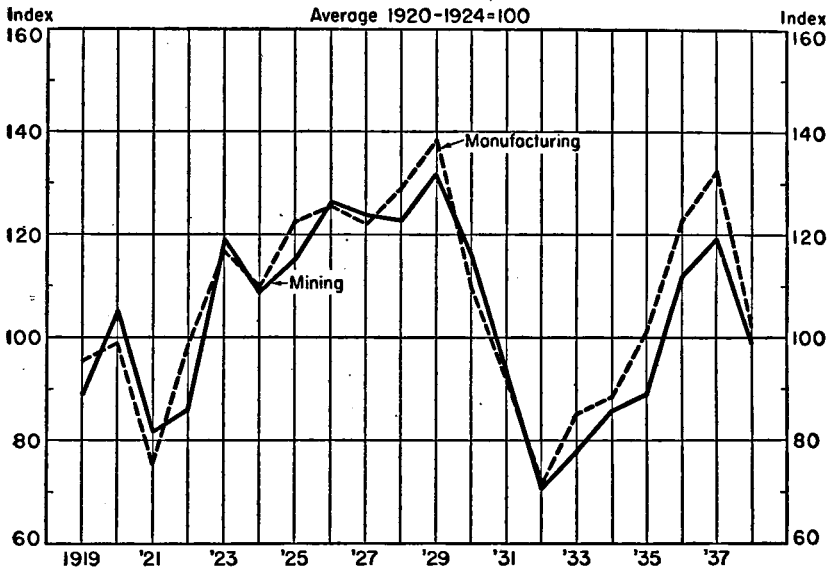
[Average 1920-24=100]

Year	Physical production		Railroad freight originating		Year	Physical production		Railroad freight originating	
	Minerals	Manufactures	Minerals	Manufactures		Minerals	Manufactures	Minerals	Manufactures
1919.....	88.8	95.4	94.9	91.7	1929.....	131.8	138.4	118.7	128.1
1920.....	105.0	98.9	114.6	106.3	1930.....	115.6	109.7	103.4	104.6
1921.....	81.2	75.6	82.3	74.9	1931.....	93.0	91.9	80.8	75.5
1922.....	86.0	98.8	85.8	93.3	1932.....	70.5	71.5	58.3	51.2
1923.....	119.2	117.0	114.8	115.6	1933.....	78.1	85.1	63.6	57.3
1924.....	108.6	109.7	102.6	110.0	1934.....	85.6	88.4	70.2	64.8
1925.....	115.0	122.3	109.1	118.4	1935.....	89.0	101.1	71.6	72.0
1926.....	126.3	125.5	121.9	120.8	1936.....	111.7	122.7	87.1	89.9
1927.....	123.7	122.0	114.8	117.7	1937.....	119.2	132.4	91.7	97.6
1928.....	122.6	120.0	112.1	123.2	1938.....	98.7	101.8	65.8	71.9

Source: Minerals Production: Physical production in tons of anthracite coal, bituminous coal, iron ore, petroleum, stone, sand and gravel, copper, coke; basic data from United States Bureau of Mines. Manufacture: Table 16. Freight: Interstate Commerce Commission, *Freight Commodity Statistics*.

This becomes evident in an examination of table 27, which presents the indexes of physical production of minerals and manufactured goods and the tons of revenue freight originated on Class I railroads of these two classes of goods. The production index of mineral products is a straight physical production series, obtained by summing up for each year the weight equivalents of production of the following mineral products: Anthracite coal, bituminous coal, iron ore, crude petroleum, stone, sand and gravel, copper, and coke. The index of

Chart II - INDEXES OF PHYSICAL PRODUCTION IN MINING AND MANUFACTURE, 1919-1938



Source: Table 27

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physical production of manufactured goods with which the index of mining production is compared is the Day-Thomas index, previously discussed. It will be remembered that this index differed somewhat in its construction insofar as the component indexes were weighted by value added in manufacturing. When the two indexes are plotted together, as in chart 11, a very close correspondence is revealed in the movements of the two indexes from year to year, as well as over period covering 20 years. This similarity of direction and amplitude of movement reflects the close dependence of the mining index upon the manufacturing index. Mining activity seems to keep step with manufacturing activity.

From an estimate of future activity in manufacturing production, we should therefore be able to arrive at a very close estimate of corresponding rate of activity in mining production. This is due to

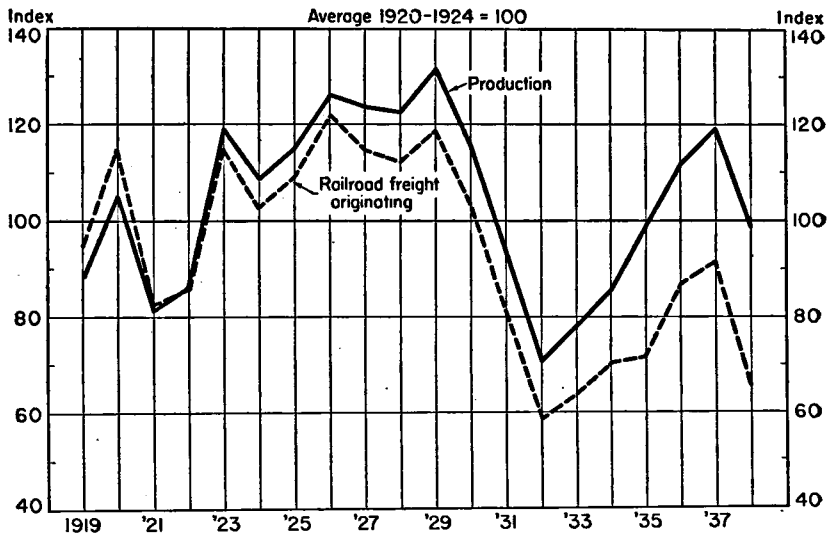
the fact that the most important component minerals which form the mining index are, to a large extent, used in manufacturing processes. Iron ore, for instance, enters into manufacturing of iron, and iron and steel products. Crude petroleum is largely manufactured into refined petroleum and by-products. Sand and gravel is utilized, to a large extent, in the production of concrete, although some amount is also used directly in road and building construction. Coke is utilized in iron and steel. Copper also enters into manufacturing.

Only in the case of anthracite and bituminous coal is there an appreciable proportion of use in direct consumption without entering into manufacturing process, and a large portion of bituminous coal is, of course, used by the railroads. It is possible that the increase in population will automatically increase consumption of anthracite and bituminous for domestic heating in proportion to the increase in the number of residences. Similarly, consumption in the electric light and power industry will probably continue to increase with the growth of domestic load, as well as greater electrification of industrial processes. In any event, the likelihood is that in the case of these two commodities domestic and industrial uses will probably continue to increase, although perhaps not in the same degree as other mineral products. Generally the mineral products composing the tonnage are raw materials that enter into manufacturing processes, and therefore production and consumption should vary in direct relation to manufacturing. As seen in chart 11, in the past this relationship has been very close.

Since 1932 there has been some slight tendency toward a deviation of the mining index from the manufacturing index. This deviation has fluctuated between three and ten points. The probable reasons for the slight drop in the mining index as compared with the production index is the more efficient utilization of coal, substitute of petroleum for coal, which increases the B. t. u. yield per unit of weight and hence diminishes physical volume of production necessary to obtain a certain amount of energy. Another factor may be the increasing utilization of water power, which supplies energy to a considerable amount of manufacturing activity. Efficiency in consumption of coal in the generation of electricity is reaching theoretical maximum; on the other hand, improvement in steam locomotives should lead to greater economies in the utilization of coal in the future. Petroleum is being more and more widely utilized in house heating, which means that manufacturing activity in petroleum refining will increase at the same time as a lighter substitute for coal per equivalent B. t. u. is extracted from the soil. This movement is the more significant so far as petroleum is, by and large, transported by pipe lines and tanker, whereas railroads are the principal beneficiary in the transportation of coal.

It is necessary, therefore, to make allowance for possible developments in the future which may cause a divergence of the index of mining production from the index of manufacturing production. An average deviation of 10 percent between the index of mining production and that of manufacturing production would seem sufficient. It was estimated that in the decades of the 1950's the medium average annual index of manufacturing production would equal 168.3. The low estimate was 150.2 and the high 191.1, on the

Chart 12 - INDEXES OF MINING PRODUCTION AND REVENUE FREIGHT IN MINERAL PRODUCTS ORIGINATING ON CLASS I RAILWAYS, 1919-1938



Source: Table 27

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basis of 1920-24 average as 100. Allowing a 10-percent deviation from these levels, mining index of physical production would equal 151.5, corresponding to the medium estimate of the manufacturing index, and 135.2 and 171.9, respectively, corresponding to the low and high estimates of the manufacturing index. For the succeeding decade, 1960-69, the low, medium, and high estimates of the manufacturing index were, respectively, 182.8, 204.8, and 232.8. The corresponding indexes for mining production, allowing again for a 10-percent spread, would be, respectively, low, 164.5, medium, 184.3, high, 209.5.

The next problem is to analyze how mining production is related to revenue freight in mineral products originating on Class I railroads. The index of revenue freight was presented in table 27, along with the index of physical production. These two indexes have been plotted

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on chart 12. It will be observed that generally the two indexes have moved together, although, as in the case of manufacturing production, there has been a growing divergence between the indexes of mining production and tons of freight originating. This is the element of diversion of traffic which will be discussed in the next chapter, before a final estimate is made of the relationship of the production index to the freight index.

CHAPTER IV

ESTIMATES OF FUTURE RAILROAD TRAFFIC

In the preceding chapters of this report provisional estimates of future production and railroad traffic were made in the products of agriculture, manufacturing and mining. In the case of agriculture it was estimated that the total demand for transportation would increase at least as fast as population. Compared to the average of 1920-24 as 100, the total tonnage originating in agricultural products on all means of transportation would be 131.1 in 1950-59 and 135.9 in 1960-69. These estimates of future traffic are based on the estimated increase in population.

Three estimates of future manufacturing production were made, based on high, medium, and low assumptions concerning future employment. If total traffic in manufactured goods (including products of forests) were to increase as fast as production, then compared to the average of 1920-24 as 100, tonnage originating in 1950-59 would range from a low of 150 to a high of 191, and in 1960-69, from 183 to 233.

The estimates of mining production were based on those made for manufacturing production, allowing for a 10-percent deviation. If the total demand for transportation of products of mines were to increase as fast as production, then, compared to the average of 1920-24 as 100, total tonnage originating on all modes of transportation would range from a low of 135 to a high of 172 in 1950-59, and from 164 to 209 in 1960-69.

These estimates would hold for the railroads if they were to carry in the future as large a share of total traffic as they carried in the period 1920-24. It has already been pointed out that there was considerable amount of diversion in all three types of traffic. For purposes of comparison there is set down the traffic that would result for railroads on the basis of the method employed here if there had been no diversion since 1924. Against this may be set the estimates of traffic which would result, if it is granted that the diversion which had occurred up to 1935-39 would be permanently lost to railroads, but that no further diversion would take place. Finally, a third estimate will be made allowing not only for the diversion that has already taken place, but for further diversion in the future.

On the first basis, with no allowance made for any diversion since 1924, the estimates of total tonnage originating on Class I railroads would be as follows:

Estimated carload tonnage originating on Class I railroads with no diversion since 1924

[Thousands of tons]

	Agricultural products	Manufacture and forest products	Mineral products	Total carload tonnage originating
Average 1950-59:				
Possible.....	152,410	634,040	1,068,440	1,854,890
Medium.....	152,410	558,400	941,645	1,652,455
Low.....	152,410	496,345	840,330	1,521,085
Average 1960-69:				
Possible.....	189,090	772,400	1,302,145	2,263,635
Medium.....	189,090	679,500	1,145,510	2,014,100
Low.....	189,090	606,505	1,022,445	1,818,040

Estimates of this magnitude are based on the assumption that there has not been, and will not be, any shifting of total traffic away from the railroads. This has been demonstrated to be false in each of the individual sections of the report. It was shown that there has been considerable shift diversion in the case of all three types of traffic. In the case of agricultural products, in the period 1935-39, the railroads were originating tonnage, relative to the total demand for transportation generated in agricultural products, which was only 63 percent of that in the period 1920-24. A similar computation for manufactured goods (including forest products) showed that in 1935-39 only 71 percent of the 1920-24 proportion moved by rail. In the case of mining, it was 75 percent. If one were to assume that there would be no further shifting of tonnage away from the railroads, other than that which occurred up to and including 1935-39, then future traffic originating on the railroads could be estimated by applying 63 percent in agriculture, 71 percent in manufacture, and 75 percent in mining, to the estimates arrived at above. Under these conditions, future traffic would be:

Estimated carload tonnage originating on Class I railroads with diversion as in 1935-39

[1,000 tons]

	Agricultural products	Manufacture and forest products	Mineral products	Total carload tonnage originating
Average 1950-59:				
Possible.....	114,965	450,170	801,330	1,366,465
Medium.....	114,965	366,465	706,235	1,217,665
Low.....	114,965	353,825	630,245	1,099,035
Average 1960-69:				
Possible.....	119,155	548,400	976,610	1,644,165
Medium.....	119,155	482,445	859,130	1,460,730
Low.....	119,155	430,620	766,635	1,316,410

Before we can proceed to make allowance for future diversion beyond the levels of 1937, and to estimate future tonnage figures, it is necessary to review briefly the forces that have brought about diversion of traffic from railroads.

Section 1

TRAFFIC IN AGRICULTURAL PRODUCTS

In the chapter dealing with agricultural traffic, it was shown that population was the principal component of the forces determining the demand for transportation. An analysis of the relation of railroad traffic in agricultural products to population may reveal some indication of "diversion." It will not be an exact explanation, since there are forces other than population which act on agricultural traffic, and in any one year changes in inventories, crop conditions, etc., may be extremely important. However, if the analysis is limited to comparisons over 5-year periods, one should obtain a general picture of the extent of diversion which has occurred in the past. In table 28, railroad freight originating in agricultural products is shown as averages for the 5-year periods, 1920-24, 1925-29, 1930-34, and 1935-39. Also shown are comparable averages of population and the relationship of tonnages to population.

In the period 1920-24, 1.27 tons of agricultural freight were originated for each person. During the 5-year interval 1925-29, this dropped to 1.18 tons per capita. In the next interval of 5 years, it was down to 0.9 ton per capita. By 1935-39, it was reduced to 0.80 ton per person. The decrease in tonnage between 1930-34 and 1935-39, both percentage wise and in number of tons, is the smallest since 1920. This may well be an indication that diversion may be stabilizing, and that railroads are meeting the competition of other agencies more successfully now than in the past. It may also mean, as was discussed in Chapter I, that agricultural traffic is increasing faster than population, which would appear in this type of computation as retardation in the rate of increase of diversion. It makes little difference for the purposes of this report which is the true causal factor, since both factors might be expected to continue to act in the future in such a fashion as to prevent future precipitate drops in the tonnage of agricultural transportation when tonnage is measured on a per capita basis.

TABLE 28

Per capita railroad tonnage originating in agricultural products on Class I railroads, 5-year averages, 1920-39

Period	Average railroad tonnage originating (thousands of tons)	Average population (thousands)	Average freight originating per capita (tons)
1920-24	139,138	109,873	1.27
1925-29	139,384	118,197	1.18
1930-34	110,192	124,915	.88
1935-39	103,153	129,284	.80

SOURCE: Tonnage from *Freight Commodity Statistics*, Interstate Commerce Commission; Population from *Statistical Abstract of the United States*, 1939, p. 10.

Further evidence of this same tendency can be seen in a study made by the Interstate Commerce Commission in 1938.¹ In this study a comparison was made between railroad traffic and physical production for each item carried by the railroads over the period 1928-37. Physical production of agricultural commodities is not an ideal measure of the demand for transportation, due to such causes as farm retention of products, changes in stocks, etc. In spite of these imperfections in the index, the analysis of the relationship of production and transportation over a period of years shows the same general tendency revealed in the analysis of freight and population. In table 29 are presented the Interstate Commerce Commission indexes of agricultural production, railroad agricultural tonnage, and the ratios of tonnage to production. Between 1928 and 1933, tonnage went about 25 percent lower than production compared with 1928 as "normal", but since 1935 there has been no loss in relative movement.

In the period 1935-39, the average per capita railroad tonnage originating in agricultural products averaged 0.80 ton. If this rate were assumed for the future, it would imply the acceptance of the following conditions:

- (1) Per capita consumption of foodstuffs will not increase or decrease in the future.
- (2) Industrial consumption of agricultural products will increase only as fast as total population.
- (3) There will be no increase in the interfarm movement of agricultural raw materials.
- (4) Export tonnage in the future will be approximately 4 million tons per year.
- (5) There will be no decrease in the portion of processed agricultural food consumed.
- (6) No lower proportion of the population than at present will produce any of their own agricultural products (or that farm retention will not decrease).

¹ *Fluctuations in Railroad Freight Traffic Compared with Production*, Statement No. 38867.

TABLE 29

Interstate Commerce Commission indexes of production and railroad tonnage originating in agricultural products

[1928=100]

Year	Index of production	Index of railroad tons originating	Ratio of tonnage to production	Year	Index of production	Index of railroad tons originating	Ratio of tonnage to production
1928.....	100.0	100.0	100.0	1933.....	91.2	69.2	75.9
1929.....	97.3	97.6	100.3	1934.....	85.4	69.4	81.3
1930.....	95.1	93.2	98.0	1935.....	80.1	63.7	79.5
1931.....	88.4	82.9	93.8	1936.....	91.8	71.6	78.0
1932.....	91.4	68.9	75.4	1937.....	91.6	72.9	79.6

SOURCE: Interstate Commerce Commission, *Fluctuations in Railroad Freight Traffic compared with Production*, Statement No. 3367.

It was shown in chapter 1 that all these assumptions except that with regard to export tonnage and interfarm movements were over-conservative. On the assumption that any increase in these factors would slow down or counteract the rate of diversion to other means of transportation, 0.80 ton per capita railroad tonnage originating in agricultural products may be considered conservative. At this level, the effects of past diversion would be taken for granted.

In order to be still further on the conservative side, a further diversion of agricultural traffic may be allowed. A per capita tonnage of 0.75 would mean that a further concession of 6 percent from the average of the period 1935-39 may be made by the railroads to other forms of transportation. On this basis, the application of 0.75 ton per capita to the future expected population yields the following results, as compared to previous periods:

	Population	Per capita railroad freight in tons	Tons of freight originated
Average 1920-29.....	114,035,000	1.22	139,261,000
Average 1930-39.....	127,100,000	.84	106,674,000
Average 1950-59 ¹	144,093,000	.75	108,070,000
Average 1960-69 ¹	149,341,000	.75	112,000,000

¹ Estimated.

Section 2

TRAFFIC IN MANUFACTURES

In chart 2, the courses of manufacturing production and of railroad freight in comparable commodities were plotted for the period 1916-38. It is there shown that serious diversion began to be noticeable around 1924. This was the time when truck transportation on any consider-

able scale had its start. What happened after this time is better presented in a new index.

In table 30 an index of diversion is given. This is obtained by dividing the index of railroad freight originally given in table 16 by the index of physical production also from the same table. The resulting ratio is then multiplied by 100 which gives a new index. The plus or minus deviations of this index from 100 are called the index of diversion. From 1916 to 1924, the diversion index fluctuated around the zero line. From 1925 to 1930 the diversion increased slowly to about 5 percent. There was a large drop through 1932, when depressed economic conditions drove shippers to cheaper and more convenient means of transportation; since then railroad freight index has fluctuated about 30 percent below the index of physical production.

TABLE 30

Index of diversion of railroad freight from physical production of manufactured products

Year	Index	Year	Index
1916	-1.6	1928	-4.5
1917	2.8	1929	-7.5
1918	-6	1930	-4.6
1919	-3.8		
1920	7.5	1931	-17.7
		1932	-28.5
1921	-1.0	1933	-32.6
1922	-5.5	1934	-26.6
1923	-1.1	1935	-28.9
1924	.3		
1925	-3.4	1936	-26.7
		1937	-26.1
1926	-3.9	1938	-29.5
1927	-3.5	1939	-33.0

What are some of the reasons for this diversion? One set of reasons centers around the competition of other means of transportation—such as trucks, pipe lines, and water carriers. The other set includes such factors as possible decentralization of industry, changes in inventories, and changes in the mechanism of distribution. Certain of the annual fluctuations in diversion, such as those which occurred in 1921–22, in 1929–30, and in 1933, are possibly due to a lag between production and transportation arising from changes in inventories. Decentralization of industry theoretically has as one goal the reduction in transportation costs, and results in some reduction in tonnage. However, as yet there has been no adequate proof of this tendency or its effect on tonnage of freight. Changes in the distributive mechanism might affect the relation of freight originating to production by reducing or increasing the number of times any individual article is moved. Since 1929 there has been some simplification of the distributive mechanism with a consequent reduction in the ratio of freight to production. The growth of chain stores with central warehousing, elimination of the middleman in an attempt to reduce

distribution costs, etc., are symptoms of this movement. For example, in 1929, 32 percent of manufacturers' sales were distributed to jobbers and 20 percent directly to retailers. In 1935, only 27 percent were distributed to jobbers and 23 percent to retailers.²

Decentralization of industry is often advanced as a factor in reduction of rail traffic. This may be true if decentralization takes place with the principal intention of diminishing transportation costs. Also, where decentralization for any reason brings plants nearer to the markets so that truck transportation may be utilized, rail traffic may again diminish. On the other hand, decentralization of industry may take place with other motives in mind, for reasons of military strategy, to get closer to sources of raw materials, or even closer to markets but further removed from the origin of bulky raw materials, in which case rail traffic in ton-miles will certainly tend to increase.

Finally, the most formidable factors in bringing about diversion of traffic from railroads are the competitive means of transportation. What is the future of such competition?

Truck transportation is considered to be the most threatening competitive force causing diversion of traffic from railroads. Judging by the course of diversion since 1916 all the competing means of transportation, and in particular trucks, made their big inroads into railroad freight traffic in the early part of the depression when the shippers were harrassed by depressed prices and sought cheaper and more flexible modes of transportation. Since 1932, there has been no increase in diversion. One would be tempted to imply from this that trucks have taken full advantage of the opportunities opened by the depression, and that they will not have the same favorable circumstances again, or at least to as large a degree.

There are two principal factors in the situation, however, which encourage further truck competition. In the first instance, continuing improvements in lighter weight trucks will increase the range of truck transportation both in distance and types of service. With greater capacity, higher speeds, more economical operation, development of Diesel-powered engines, refrigeration, are all forces in this direction. Also, since 1925, there has been a vast improvement in the public roads system, thus opening up larger areas for economical truck transportation.³ New roads, of course, will continue to be built.

There is no comprehensive information available at present as to the feasible limits of truck transportation as to types of traffic and length of haul. The Public Roads Administration has conducted a field survey to obtain such data, but the results will not be known for some time. Future possibilities, of course, will be still less easily

² *Statistical Abstract*, 1938, p. 806.

³ In 1926 there were 163,000 miles of surfaced State highways in the United States. In 1930 this had increased about 39 percent to 226,000 miles. By 1936 mileage had risen 77 percent over 1926 to 289,000 miles. *Statistical Abstract of the United States*, 1938, p. 365.

fathomable than present conditions. Hence, one is driven to the less satisfactory method of making liberal, though arbitrary, allowances for future diversion from rail to truck transportation. For lack of information, the same procedure must be applied in connection with other forms of diversion.

In relation to the period 1920-24 as 100, the average index of freight originated in manufactured products in 1935-39 was 30 percent below the index of physical production in manufacturing. Despite the fact that the index has not varied greatly since 1934, we shall assume for the period 1950-59, a further divergence of the index of tons originated in manufactured products from the index of physical production equivalent to a loss of 6 percent of total tonnage—expressed in our index of diversion as a drop from -30 to -36, as compared with the 1920-24 level of 100. Similarly the estimates of future railroad traffic in manufactured goods are assumed to include a further diversion of 2 points for the period 1960-69. The index of diversion will then be -38 compared with the average of 1920-24. Making allowance for these diversions, the index of future railroad traffic, to the base average 1920-24 as 100, can be computed by multiplying the diversion figures by the estimates of future production arrived at in an earlier stage of the report. The computation is as follows:

[Average 1920-24=100]

	Diver- sion index	Production index			Railroad freight index		
		Possible	Medium	Low	Possible	Medium	Low
Average 1950-59.....	-36.0	191.1	168.3	150.2	122.3	107.7	96.1
Average 1960-69.....	-38.0	232.8	204.8	182.8	144.3	127.0	113.3

Freight tonnage originating in manufactured and forest products in the base period, average 1920-24, was 331,787,000 tons. The index of future freight can be converted into tonnage figures, yielding the following results:

*Estimated tonnage originating in manufactured and forest products (C. L.)
Class I railroads*

	Possible	Medium	Low
Average 1920-29.....		367,660,000	
Average 1930-39.....		255,528,000	
Average 1950-59 ¹	405,775,000	357,335,000	318,845,000
Average 1960-69 ¹	478,770,000	421,370,000	375,915,000

¹ Estimated.

On the very conservative assumptions herein granted, tons of freight in manufactured goods on Class I railroads are expected to reach 357,335,000 tons during the decade of 1950-59, upon "medium"

assumptions of employment in manufacturing (7 percent of total population), or 101,810,000 more than in the decade 1930-39, but 10,325,000 tons less than the average of 1920-29. During the decade of 1960-69, tons of freight in manufactured goods originating are expected to reach, upon medium assumption of employment, 421,370,000 tons, at which level traffic will be 165,845,000 tons more than 1930-39 average, and 53,710,000 more than the 1920-29 average.

Section 3

TRAFFIC IN MINERAL PRODUCTS

A similar analysis to that used in manufactured goods can be applied to the problem of diversion of the index of tons originating from the index of physical production of mineral products. The index of diversion is presented in table 31. Diversion between the index of mining production and railroad tonnage originating in mineral products has been increasing steadily, so that by 1937 it had reached 23 points below, and by 1938, 33 points below the level of 1920-24. The principal reason for this tendency is the increasing share of total production of these products which move by means other than railroads—particularly petroleum moving by pipe lines and tankers.

Pipe lines for liquid mineral products, and water transportation, where available, in the case of coal and ores, are the principal competitors of railroads. As for coal and ores, no great immediate shifts in major producing areas are expected in the near future, and hence there is no immediate anticipation that any marked changes will take place in the relative position of mines to the means of transportation; hence, there should be no appreciable change in the proportions transported by different media.

TABLE 31

Index of diversion of railroad freight from physical production of mineral products

Year	Index	Year	Index
1919	+6.9	1929	-9.9
1920	+9.0	1930	-10.5
1921	+1.2	1931	-13.1
1922	-.2	1932	-17.5
1923	-3.8	1933	-18.5
1924	-5.5	1934	-18.0
1925	-5.1	1935	-19.5
1926	-3.6	1936	-22.0
1927	-7.2	1937	-23.0
1928	-8.4	1938	-33.4

SOURCE: Table 27.

To make allowance for any unforeseen shifts in the location of mines and deposits actively exploited nearer to water transport facilities for

consuming centers, and to allow for any movement of coal- and ore-consuming industries nearer the mine pits, a further diversion of tons of traffic originated from the production index may be assumed. In 1937 this diversion amounted to 23 points; that is, the index of diversion stood at -23 below the parity of 1920-24. If a further permanent deviation of 12 points of rail tonnage index from production index is allowed so that the index of deviation will be -35, then the future tonnage originating on Class I railroads in mineral products would be in comparison with previous decades, as follows:

Estimated average annual railroad tonnage in mineral products

	Possible	Medium	Low
Average 1920-29		669,164,000	
Average 1930-39		480,025,000	
Average 1950-59 †	694,270,000	612,225,000	546,340,000
Average 1960-69 †	846,550,000	744,615,000	664,435,000

† Estimated.

On the basis of medium estimates, the average annual tons originating in the decade of 1950-59 would be about 57,000,000 tons less than 1920-29 decade, but 132,200,000 tons more than in the decade of 1930-39. Not until the period 1960-69 would the annual tons originated in Class I railroads medium estimates surpass the previous record of 1920-29, and then by only 75,500,000 tons. In this decade, however, medium, average tons of freight originating in mineral products would be 164,000,000 tons higher than the average of the decade 1930-39.

To the foregoing estimates of the three types of freight must be added an estimate of less than carload lot railroad freight. During the decade 1920-29, the proportion of less than carload to all carload freight was 3.5 percent; during the next decade, it was 2.1 percent. Assuming that in the future less than carload freight will amount only to 2 percent of the carload lot freight, there must be added to the total estimates between 19,500,000 tons and 24,200,000 tons for the period 1950-59 and between 23,000,000 tons and 28,800,000 tons in the following decade.

Section 4

TOTAL ESTIMATES OF RAILROAD FREIGHT ORIGINATING

The combined results of all estimates are presented in table 32. On the conservative basis used in this study, it is indicated that "medium" expectations for the decade of 1950's should be average annual tons of freight originated on Class I railroads of 1,099,180,000 tons. At this level it would be 28 percent higher than the average of 1930-39, but 10 percent lower than the average of 1920-29. In the decade

1960-69, the "medium" estimates give 1,303,545,000 tons as annual averages, which is 52 percent higher than 1930-39 averages, and 7 percent higher than the 1920-29 averages.

TABLE 32

Estimated future revenue tonnage originating on Class I railroads

[Thousands of tons]

Type of traffic	Average 1950-59			Average 1960-69		
	Possible	Medium	Low	Possible	Medium	Low
Products of agriculture.....	108, 070	108, 070	108, 070	112, 000	112, 000	112, 000
Manufactured and forest products.....	405, 775	357, 335	318, 845	478, 770	421, 370	375, 915
Products of mines.....	694, 270	612, 225	546, 340	846, 550	744, 615	664, 435
Total carload.....	1, 208, 115	1, 077, 630	973, 255	1, 437, 320	1, 277, 985	1, 152, 350
Less than carload.....	24, 160	21, 550	19, 465	28, 745	25, 560	23, 045
Total (all freight).....	1, 232, 275	1, 099, 180	992, 720	1, 466, 065	1, 303, 545	1, 175, 395

These estimates are believed to be extremely conservative. They were based upon certain assumptions of underlying economic conditions which cannot be lowered much further. Merely to reiterate some of these basic assumptions is to establish the truth of this statement.

First, tons of freight originating in agricultural products was assumed to increase only in proportion to the increase in population on the premise that per capita consumption would remain about the same as it has been in the two decades since 1920. At the same time, it was assumed that exports of agricultural products may reach in tonnage the low figure of 4 million tons a year. Exports by weight have been lower than this only in the years when conditions were complicated by a combination of drought and depressed agricultural markets. Tendencies toward greater utilization of farm products by consumers in processed form and increased consumption of agricultural products in industrial processes, particularly in the manufacture of synthetic products, promises sufficient traffic for the future to offset possible loss in export commerce.

Medium estimates of tons of manufactured goods originated on Class I railroads were based upon the assumption that only 7 percent of the population will be employed in manufacturing enterprises as compared with 7.95 percent in the decade of the 1920's and 6.25 in the depression decade of the 1930's. Of the 7 percent total population, the actual number employed in manufacturing during the decade of the 'fifties would be only 10,085,000 persons, which is only slightly higher than, for example, the total employment in manufacturing in 1937. In other words, assuming 7 percent of the population would be employed in manufacturing, it would still not solve the question

of absorbing the 10 million or more people estimated to be unemployed in 1937, and that portion of the increase of total population of 15 millions who would be available for employment. This additional labor force may amount to as much as 6 to 10 million people. That is, the assumption that not more than 7 percent of the total population employed in manufacturing, would leave the question of employment of between 16 and 20 million employable people unsolved.

The conditions above assumed do not make any allowance for the continued diminution of employment in agricultural undertakings. It is, of course, likely that some of this excess working population might be absorbed in service undertakings, but certainly such a development would not take care of as much as 16 to 20 million employable people outside manufacturing enterprises over and above the present employment in service undertakings. It is not believed that the country would tolerate the continued existence of conditions that have been characteristic of the economic system during the past decade without some effort to induce acceleration of economic activity. Any such effort will, of course, raise the proportion of gainfully employed people in manufacturing above 7 percent of total population. To the extent that this happens the above estimates are entirely too low. If full employment were assumed, the estimates of production and railroad freight traffic for the next two decades may have to be raised 20 or 25 percent higher.

The estimates were also based upon the assumption of an average work week of 35 hours in manufacturing enterprises and a productivity per hour which was obtained on the basis of a trend assumed to be lower than has been characteristic of industry as a whole during the past two decades. Furthermore, the estimates of productivity per worker in the future were lowered an additional 10 percent in order to be extremely conservative. The estimate of mineral freight is based upon these conservative assumptions of manufacturing production, allowing for a spread of 10 percent.

Section 5

ESTIMATES OF TON-MILES OF RAILROAD FREIGHT

It was previously indicated that railroad activity results from two forces, the number of tons of freight transported and the distance each ton is moved on the average. Up to this point there have been developed estimates of possible tonnage originating in the decades 1950-59 and 1960-69, but nothing has been said concerning the distance this freight will move.

In table 33 are furnished data on the average length of haul per revenue ton originating on Class I railroads since 1916. The average length of haul was obtained by dividing revenue ton-miles by revenue

tons originating on Class I railroads each year. These data are presented graphically in chart 13. It can be seen from this chart that the average length of haul has been increasing rapidly, albeit somewhat erratically, over the entire period. The low point was 301.2 miles in 1916, and the high was 376.2 miles in 1938; this represents an increase of 25 percent in 22 years. There was a marked increase from 1916 to 1919, possibly due to war conditions. The rise from 1920 to 1930 was very slow, but between 1930 and 1932 the average length of haul jumped from 332.5 miles to 362.1 miles. The 1930-32 movement was presumably an erratic condition, occasioned by the inroads of truck competition on short haul merchandise, when the depression necessitated all possible savings in transportation costs. After 1932, the average length of haul decreased slowly through 1937 to 355.1 miles, but then took a sudden upward spurt, and in 1938 and 1939 was well above any previous levels.

It is extremely doubtful if the average length of haul of railroads will increase as rapidly in the future as it has in the past. With respect to the future, three factors will have a determining influence: (1) The nature and average length of haul of competing transportation agencies; (2) the geographic movement of population; and (3) industrial decentralization. In the previous sections of this report, particularly those dealing with diversion from rail to other modes of transport, and the future of agricultural transportation, it was shown that there is no reason for expecting that all of these forces will act as strongly in the future as they have in the past.

As long as the average length of haul of competing agencies is less than that of railroads, increases in the amount of diversion of traffic from the railroads will increase the length of average rail haul. However, it was indicated that the future rate of diversion may be expected to be slower than it has been and it is reasonable to expect that increases in the average length of haul of railroads due to competing agencies will be less in the future than they have been in the past.

For these reasons, the estimates of the average length of haul per revenue ton of freight originating in the decades 1950-59 and 1960-69 will be assumed as 380 miles and 385 miles respectively.

The average haul per revenue ton originating was 330 miles in the decade 1920-29, and 356 miles in the decade 1930-39. Between these two periods, there was an 8-percent increase in the average haul; the increase between the 30's and 50's, a period twice as long, this increase in average haul here assumed is less than 7 percent.

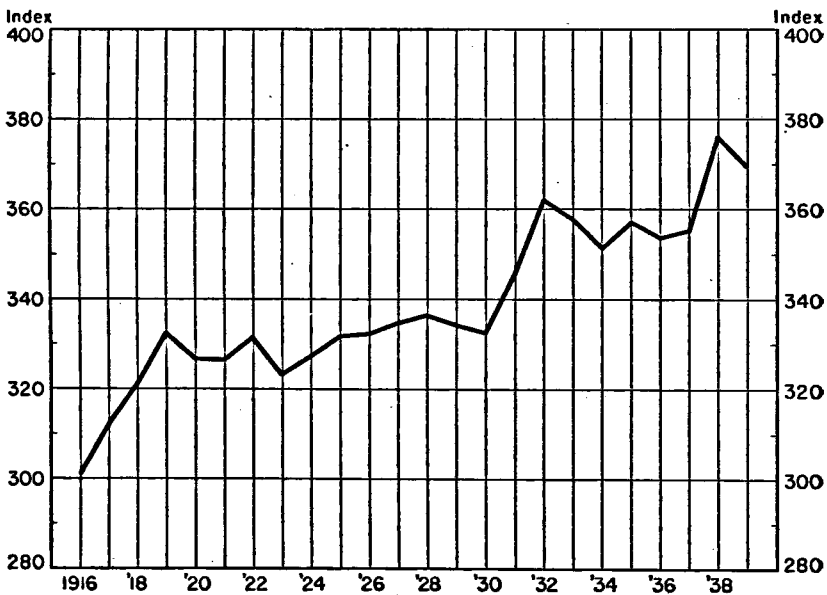
TABLE 33
Average length of haul on Class I steam railways, 1916-39¹

Year	Miles	Year	Miles
1916.....	301.2	1928.....	336.7
1917.....	312.1	1929.....	334.1
1918.....	321.1	1930.....	332.5
1919.....	332.5		
1920.....	326.8	1931.....	345.8
		1932.....	362.1
1921.....	326.4	1933.....	357.4
1922.....	331.4	1934.....	351.1
1923.....	322.9	1935.....	357.2
1924.....	327.1		
1925.....	331.8	1936.....	353.8
		1937.....	355.1
1926.....	332.1	1938.....	376.2
1927.....	334.5	1939 ²	369.4

¹ Average haul per revenue ton originated on Class I Steam Railways of the United States considered as a system.
² Preliminary.

SOURCE: Interstate Commerce Commission, *Statistics of Railways in the United States*.

Chart 13 - AVERAGE HAUL ON CLASS I STEAM RAILWAYS, 1916-1939



Source: Table 33

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Applying average hauls of 380 and 385 miles to the estimates of average annual tons of freight originating in the decades 1950-59 and 1960-69, respectively, we obtain estimates of average annual ton-miles of revenue freight on Class I railroads, as follows:

	1950-59	1960-69
Possible.....	468,264,500,000	564,435,025,000
Medium.....	417,688,400,000	501,864,825,000
Low.....	377,233,600,000	452,527,075,000

For purposes of comparison, average revenue ton-miles of freight on Class I railroads was 401,380,255,000 ton-miles in the decade 1920-29, and 305,001,676,000 ton-miles in the decade 1930-39. The medium average estimates for 1950-59 would be 4 percent higher than the average of the decade 1920-29, and 37 percent higher than the average of 1930-39. The medium estimates for 1960-69 would be, correspondingly, 25 percent higher than the average of 1920-29, and 64 percent higher than 1930-39.

In the decade 1920-29, the annual revenue ton-miles of freight varied from a low of 306,840,000,000 ton-miles to a high of 447,321,500,000 ton-miles, ranging from 76 percent to 111 percent of the average for the decade. In the decade 1930-39, the range was from 77 percent to 126 percent of the average. If we were to apply the 1920-29 range of variation to the estimates for 1950-59 (medium assumptions only) ton-miles of revenue freight would vary between 319,114,000,000 and 465,305,000,000 ton-miles, and in the decade 1960-69, between 383,425,000,000 and 559,077,000,000 ton-miles. If the range of variation which existed in the decade 1930-39 were to be applied to the medium estimate of traffic, in the decade 1950-59, it would vary between 320,367,000,000 and 526,287,000,000 ton-miles, and in the decade 1960-69, between 384,930,000,000 and 630,844,000,000 ton-miles. These are the limits within which railroad traffic in the next two decades may vary.

CHAPTER V

THE RAILROADS AND FUTURE TRAFFIC

It has been seen that under the conservative assumptions made concerning physical production, consumption and the relationship of production to railroad traffic, future transportation activity on the railroads in the decade 1950-59 will be slightly higher than that which existed during the decades of the 1920's, and much higher than in the decade just past. In the decade 1960-69 rail traffic will be considerably higher than in any past period. Under these conditions, it could be said that even if the entire potential extra capacity of the St. Lawrence Seaway, about 10 million tons, assumed to be available for American commerce, were to be diverted from railroads, it would still be less than 1 percent of tons of freight originated; and even then it would be a deduction from a net increase in traffic, and therefore, relatively unimportant and harmless to the railroads.

This type of analysis could be developed to show that the railroad management and railroad labor have no strong reason for opposing the seaway. This is not the sole point of this report, however. It is still necessary to consider the broad economic question as to which of the two available means of transportation, the seaway or the railroads, would provide the cheaper transportation facilities to meet future requirements.

In considering this question, two further points must be analyzed; first, can the railroads handle the predicted future traffic without any increase in existing facilities; and second, if they cannot, what is cheaper for the nation—to have the railroads expand or to take care of some portion of the necessary expansion by means of the seaway. The succeeding portion of this report is devoted to the first of these problems. The comparison of the cost of railroad expansion and the cost of the seaway will be taken up in the Summary Report, Part VII.

The first question necessitates an examination of railroad capacity. The problem of capacity in turn must be clearly separated into two parts—the capacity to handle seasonal and cyclical variations in traffic, and the capacity to handle long period (secular) changes. There is a marked seasonal fluctuation in railroad volume—for example, in the period 1933-37, average weekly carloadings in January were 565,480 cars, and in October they were 28 percent greater at 725,560 cars per week.¹ Hitherto this has usually been handled fairly easily by the railroads, because capacity has been geared up to the expected seasonal peak. The railroads have also been able to take

¹ *Statistical Abstract of the United States, 1939, p. 420.*

care of cyclical fluctuations in traffic—for example, in 1935 annual average weekly carloadings were 605,849, but in 1936 this had increased 14 percent to 694,406. The increase from the peak month of October 1935 to October 1936 was almost 15 percent.² Temporary fluctuations in traffic have usually been handled successfully, and the probabilities are that they will continue to be so handled.

In considering average traffic conditions in a period from 10 to 30 years distant, the problem is somewhat altered. It is necessary to study the existing capacity of the railroads, compare it with capacity in the past in relation to traffic, and the needed capacity in the future. Over and above this must be superimposed a pattern of cyclical and seasonal peaks.

Railroad capacity depends ultimately upon the amount of equipment available to handle traffic and the way and structures over which the traffic is dispatched. It would be generally agreed that the amount of rolling stock available to railroads is almost completely variable over a 20-year period. New cars can be purchased, locomotives can be repaired or constructed as desired. Whether or not way and structures are as variable is doubtful. Some roads can be double-tracked, branches can be built or abandoned, bridges or underpasses can be built, but the flexibility thus introduced is probably much less than the flexibility in equipment. The consideration of existing railroad capacity will therefore be limited to those elements which are known to be variable. This means that the way and structures of railroads as presently constituted will be assumed to be sufficient, with repairs, to handle increased traffic in the future.

Section 1

RAILROAD CAPACITY

The capacity of railroad equipment depends upon the number and capacity of freight cars and locomotives available and the efficiency with which they are used. The Interstate Commerce Commission and the Bureau of Railway Economics of the Association of American Railroads have comprehensive data on these points extending over a series of years. The data of the Bureau of Railway Economics are based on Interstate Commerce Commission statistics. Wherever possible, the original source, the Interstate Commerce Commission has been used. Information is presented hereafter on the number and capacity of freight cars, number and capacity of various types of locomotives, freight cars per train, tons of freight per train and speed of trains, for periods starting in 1916 or 1920 and running through 1938 (and 1939 whenever preliminary estimates were available).

² *Ibid.*

Freight Cars.

In table 34 are presented data on the number of freight cars owned by Class I Steam Railways from 1920 to 1938. Column 1 gives the total number of cars owned, and column 2 gives the average of the end of the month percentages of those cars which were unserviceable during the year. Column 3 gives the average number of serviceable cars during the year, and column 4 the aggregate capacity of all cars. Columns 5 and 6—the capacity of serviceable and unserviceable cars, respectively—were obtained by applying the percent of cars unserviceable (column 2) to total capacity (column 4). This computation is based on the assumption that unserviceable cars have the same average capacity as serviceable cars, which we are informed by Interstate Commerce Commission experts is probably valid. The facts in table 34 are presented graphically in chart 14.

The facts in table 34 and chart 14 are extremely clear. Total capacity of all freight cars, as of December 31, 1938, was 19 million tons less than it averaged during the period 1920–29 and the estimated capacity of serviceable cars was about 20 million tons below 1920–29 levels. This represents a reduction of total capacity of almost 20 percent, and a reduction of serviceable capacity of 22 percent. In comparison with 1930, when capacity was at the peak, the reduction amounted, at the end of 1938, to 22.2 million tons aggregate capacity, and 25.4 million tons in serviceable capacity.

If the railroads were to regain the position of repair that they once maintained—with only 6 percent of the freight cars unserviceable (the best year on record was 1927 with 5.9 percent)—which would not be at all impossible if traffic and revenues warranted the heavier maintenance expenditure, than in 1939, total serviceable capacity would have been about 77.5 million tons, still about 18 percent less than the average aggregate serviceable capacity of 1920–29. Existing freight car capacity, then, is 20–22 percent short of the capacity levels of 1920–29. This is but one item in the measurement of total carrying capacity, and must be considered along with utilization factors.

Steam Locomotives.

In table 35 and chart 15 are presented some facts about locomotives. Since under stress conditions passenger locomotives could be pressed into service as freight locomotives, and since switching engines are an important part of railroad activity, data are presented on all types of locomotives. Again comparing with the average of 1924–29,³ as of December 31, 1938 there were 10,488 fewer freight steam locomotives in service; 92 fewer combination freight or passenger steam locomotives; 5,056 fewer passenger steam locomotives; and 3,000 fewer switching engines. Comparing with the average of 1921–29, there

³ Due to lack of data prior to 1924, averages are based on the 1924–29 period except in one case of "all locomotives," which are based on the 1921–29 period.

TABLE 34

Number and capacity of all freight cars and of serviceable freight cars on Class I steam railroads, 1920-39

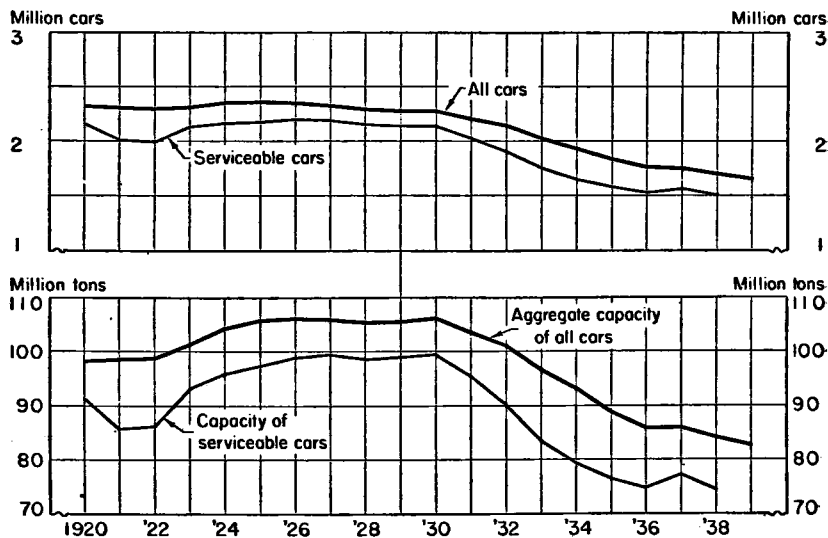
Dec. 31--	Number of all cars	Percent of cars unserviceable	Number of serviceable cars	Aggregate capacity all cars	Capacity of serviceable cars †	Capacity of unserviceable cars †
	Thousands	Percent	Thousands	Millions of tons	Millions of tons	Millions of tons
1920.....	2,322	7.0	2,159	98.3	91.4	6.9
1921.....	2,316	13.1	2,013	98.5	85.6	12.9
1922.....	2,293	12.8	1,999	98.8	86.2	12.6
1923.....	2,316	8.0	2,131	101.3	93.2	8.1
1924.....	2,349	7.8	2,166	104.1	96.0	8.1
1925.....	2,357	7.7	2,176	105.6	97.5	8.1
1926.....	2,349	6.5	2,196	106.0	99.1	6.9
1927.....	2,325	5.9	2,188	105.8	99.6	6.2
1928.....	2,298	6.2	2,156	105.3	98.8	6.5
1929.....	2,277	6.0	2,140	105.4	99.1	6.3
1930.....	2,277	6.2	2,136	106.2	99.6	6.6
1931.....	2,201	7.8	2,029	103.4	95.3	8.1
1932.....	2,145	10.6	1,918	100.9	90.2	10.7
1933.....	2,035	14.1	1,748	96.7	83.1	13.6
1934.....	1,938	14.6	1,655	93.0	79.4	13.6
1935.....	1,836	14.0	1,579	88.7	76.3	12.4
1936.....	1,758	12.8	1,533	85.7	74.7	11.0
1937.....	1,744	10.1	1,568	85.8	77.1	8.7
1938.....	1,700	11.7	1,501	84.0	74.2	9.8
1939 *.....	1,655	-----	-----	82.4	-----	-----

† Based on the assumption that unserviceable cars have an average capacity.

* Estimated from Association of American Railroads.

Source: Number and capacity of all cars, Interstate Commerce Commission, *Statistics of Railways in the United States*. Unserviceable cars, Interstate Commerce Commission, *Monthly Reports of Operating Statistics*. Last 2 columns computed.

Chart 14 - NUMBER AND CAPACITY OF ALL FREIGHT CARS AND OF SERVICEABLE FREIGHT CARS ON CLASS I STEAM RAILROADS, 1920-1939



Source: Table 34 .

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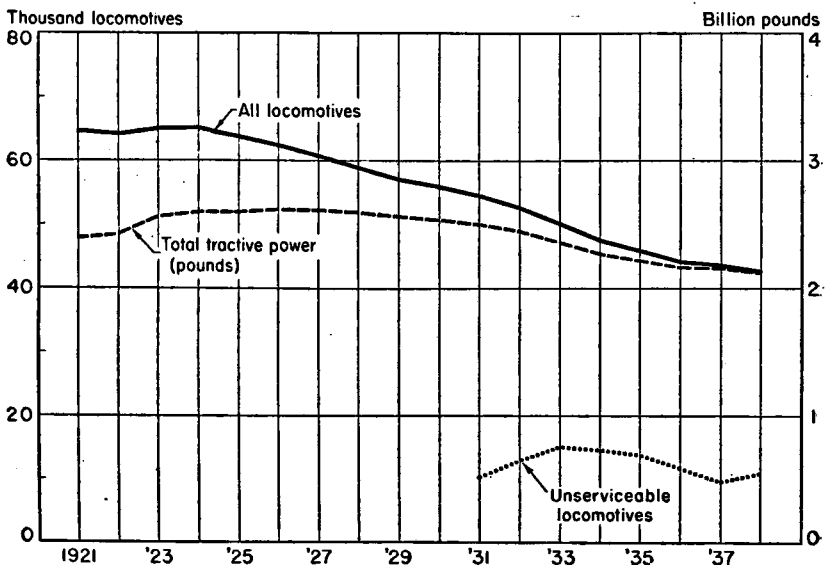
TABLE 35
Locomotives—Class I railroads, 1924–38

	Freight locomotives		Freight or passenger locomotives		Passenger locomotives		Switching engines		All locomotives			
	Number	Total tractive power (thous. of pounds)	Number	Total tractive power (thous. of pounds)	Number	Total tractive power (thous. of pounds)	Number	Total tractive power (thous. of pounds)	Number	Total tractive power (thous. of pounds)	Percent un-serviceable	Number un-serviceable
1924.....	39,119	1,801,839	1,546	45,989	13,585	389,913	10,756	355,437	65,006	2,593,178	(1)	(1)
1925.....	37,992	1,783,054	1,589	51,969	13,210	386,185	10,821	365,661	63,612	2,586,868	(1)	(1)
1926.....	37,139	1,790,933	1,697	61,418	12,769	388,587	10,737	377,300	62,342	2,611,238	(1)	(1)
1927.....	36,001	1,770,734	1,646	60,133	12,520	393,987	10,728	381,316	60,895	2,606,171	(1)	(1)
1928.....	34,808	1,751,340	1,627	59,979	11,847	384,666	10,563	383,658	58,845	2,579,643	(1)	(1)
1929.....	33,605	1,726,224	1,584	59,116	11,321	377,311	10,426	388,162	56,936	2,550,813	(1)	(1)
1930.....	32,900	1,700,020	1,808	79,910	10,868	358,051	10,299	388,959	55,875	2,526,940	(1)	(1)
1931.....	32,063	1,674,290	1,824	81,313	10,430	348,757	10,068	384,501	54,385	2,488,861	19.2	10,442
1932.....	31,197	1,643,878	1,880	82,634	9,786	333,572	9,629	370,244	52,492	2,430,328	24.7	12,966
1933.....	29,935	1,595,961	1,838	81,483	9,107	314,305	9,184	357,072	50,064	2,348,821	30.1	15,069
1934.....	28,520	1,542,195	1,710	78,511	8,444	298,728	8,762	343,833	47,436	2,263,267	30.9	14,658
1935.....	27,462	1,501,004	1,612	76,121	7,983	289,426	8,557	339,650	45,614	2,206,201	30.6	13,958
1936.....	26,695	1,474,808	1,563	75,199	7,655	281,529	8,249	331,103	44,162	2,162,699	28.4	11,769
1937.....	26,517	1,474,143	1,692	84,784	7,522	279,755	7,893	316,923	43,624	2,155,555	22.0	9,597
1938.....	25,956	1,452,049	1,523	79,109	7,486	282,915	7,672	309,391	42,637	2,123,464	25.4	10,830

1 Data not available.

Source: Interstate Commerce Commission, *Statistics of Railways in the United States and Monthly Report of Operating Statistics*.

Chart 15 - NUMBER AND TOTAL TRACTIVE POWER OF ALL LOCOMOTIVES, CLASS I RAILROADS, 1921-1938



Source: Table 35

was a reduction in all locomotives, including electric and direct powered engines of 19,730 units.

There was an 18-percent reduction in the aggregate tractive power of freight locomotives and a 16.4-percent reduction in the aggregate tractive power of all locomotives including electric and Diesel powered units. At the same time, the percent of all locomotives unserviceable was at 25.4 percent, which compares very unfavorably with the 1931 figure of 19.2 percent (earliest available estimate).

There has been a serious decrease in the number and aggregate power of locomotives compared to the average of 1924-29. The reduction in locomotives is not quite as acute as that in freight cars, but is still very marked.

The figures presented above are not as bad as they first seem, because they have been offset by improvements in the efficiency of operation of freight trains. In the absence of undue congestion, the total carrying capacity of railroads will be the same if there are 2 trains, each consisting of 10 cars and a locomotive, working at a rate of 10 miles an hour; or 1 train, consisting of 1 locomotive and 20 cars, working at 10 miles an hour; or 1 train, consisting of 1 locomotive and 10 cars, working at 20 miles an hour. The improvements in operating efficiency of railroads may be briefly described.

Utilization of Freight Capacity.

Since 1920, the railroads of the country have tended toward operating fewer trains, with more cars to a train moving at higher speeds. The facts on this are shown in tables 36 and 37. In 1920, the average number of freight cars (both loaded and empty) in freight trains was 35.6; this rose steadily through 1930, when there were almost 48 cars to a train, but then decreased, and in 1932 there were only 44 cars per train. Since 1932, the number of cars per train has been increasing steadily, and in 1939 surpassed the 1930 level. Tons of freight per loaded car have not fluctuated very much, ranging between 25 and 28 tons per car. Tons of all freight (both revenue and nonrevenue) per train rose from a low of 651 tons in 1921 to a high of 804 in 1929, dropped back to 663 in 1932 and rose again to 796 in 1937. In 1939 it reached the peak of 813 tons per train. In order to facilitate inspection of these facts, they have been presented in chart 16.

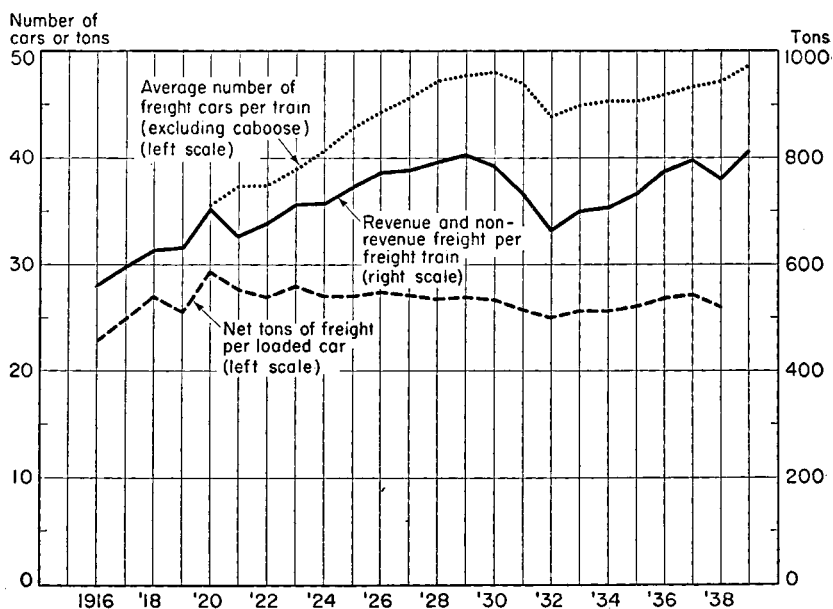
TABLE 36

Selected operating statistics for freight service on Class I railroads, 1916-39

Year	Average number of freight cars per train, excluding caboose (loaded and empty)	Net tons of freight per loaded car	Revenue and nonrevenue freight per freight train
1916		22.8	1 560
1917		24.8	1 597
1918		27.0	1 628
1919		25.5	1 631
1920	35.6	29.3	708
1921	37.4	27.6	651
1922	37.4	26.9	676
1923	38.9	27.9	713
1924	40.7	27.0	715
1925	42.8	27.0	744
1926	44.2	27.4	772
1927	45.5	27.1	777
1928	47.1	26.7	792
1929	47.6	26.9	804
1930	47.9	26.7	784
1931	46.9	25.7	733
1932	43.8	24.9	663
1933	44.8	25.6	699
1934	45.2	25.6	706
1935	45.2	26.0	731
1936	45.8	26.8	774
1937	46.6	27.1	796
1938	47.1	26.0	759
1939	48.5		813

1 Includes revenue freight only. Nonrevenue freight is approximately 3/8 ton per car and 50 tons per train.
 SOURCE: Interstate Commerce Commission, *Statistics of Railways in the United States*.

Chart 16 - SELECTED OPERATING STATISTICS FOR FREIGHT SERVICE ON CLASS I RAILROADS, 1916-1939



Source: Table 36

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There has, then, been some increase in the potential carrying capacity of locomotives, as evidence in the number of cars attached to a locomotive, but these potentialities have not been realized fully (as seen in net tons of freight per train), possibly due to the general reduction in railroad activity.

Improvements in Operating Speeds.

Data on the operating speed of trains are shown in table 37. The average speed between terminals (including stop-overs at way stations) has risen steadily from 10.3 miles per hour in 1920 to 16.6 miles per hour in 1938. The speed in 1926 was 11.9 miles per hour, while in 1939 it was 40 percent higher at 16.7 miles per hour. Although the speed between terminals has increased greatly, the over-all speed has not increased markedly. In 1920, the average freight locomotive moved 62.5 miles a day; it moved only 44.0 miles a day in 1935. These figures are based on all locomotives, including those unserviceable and those stored. If the comparison is restricted to serviceable, unstored locomotives, which is a better indication of the over-all speed of freight trains, then the situation is more favorable. This comparison is limited to the period 1930-38, because of lack of data prior to that time. In 1930, the average distance covered per day of serviceable locomotives was 89.6 miles. In 1936 it reached a high of 105.2 miles, but by 1938 it was back to 99.0 miles, the trend over the period is upward.

The average distance covered in the course of a day by freight cars is about one-quarter to one-third of that covered by locomotives. This rose from a low of 22.4 miles a day in 1921 to a high of 32.3 miles a day in 1929, dropped to a low of 19.8 miles in 1932, then rose to a new high of 32.9 miles in 1937. Since these figures are based on all freight cars, regardless of whether they are loaded or empty, in use or on sidings or yards, it would be expected that they would fluctuate with general railroad activity. In this respect they are not as good indicators of changing efficiency of operation as is the information on miles per serviceable unstored freight locomotive day.

Finally, in table 37 are given figures on net ton-miles per freight train hour. These include revenue and nonrevenue freight, and freight train hours include the time between terminals only. It is this computation which really summarizes the changes in railroad operating efficiency. This has increased from 7,500 ton-miles per hour in 1921 to 13,500 ton-miles per hour in 1939. From the average of 1921-29 to 1938, the gain was 40 percent, or considerably more than the reduction in freight cars and locomotives which ranged between 18 and 22 percent.

This 40-percent increase in operating efficiency is by no means a net gain in capacity. In the first place, it was shown in the preceding chapter that the average length of haul per revenue ton originated on

TABLE 37
Selected operating averages for freight service, Class I Railroads.

	Average speed between terminals	Average distance covered per day			Net ton-miles per freight-train-hour
		Freight locomotives		Freight cars, total	
		Total	Serviceable ¹		
<i>M. p. h.</i>	<i>Miles</i>	<i>Miles</i>	<i>Miles</i>	<i>Ton-miles</i>	
1920	10.3	62.5		25.1	
1921	11.5	49.5		22.4	7,506
1922	11.1	52.0		23.5	7,479
1923	10.9	60.3		27.8	7,770
1924	11.5	55.3		26.8	8,222
1925					
1926	11.8	58.3		28.5	8,773
1927	11.9	61.8		30.4	9,201
1928	12.3	60.9		30.3	9,583
1929	12.9	61.5		31.3	10,183
1930	13.2	60.9		32.3	10,580
1931					
1932	13.8	61.4	89.6	28.7	10,836
1933	14.8	65.1	88.2	24.5	10,825
1934	15.5	58.0	86.2	19.8	10,265
1935	15.7	49.9	89.8	21.3	10,974
1936	15.9	42.2	94.3	24.2	11,225
1937					
1938	16.0	44.0	93.5	25.8	11,718
1939	15.8		105.2	30.7	12,146
1940	16.1		104.5	32.9	12,695
1941	16.6		99.0	28.5	12,473
1942	16.7				13,494

¹ Not stored.

SOURCE: Interstate Commerce Commission, *Statistics of Railways in the United States* and Association of American Railroads, Bureau of Railway Economics.

Class I railroads has been increasing steadily. The gain in average length of haul between the average in the period 1920-29, and 1938, was 14 percent. Therefore, although carrying capacity has increased 40 percent, the average distance to be covered has also increased 14 percent, so that the net gain in effective carrying capacity has been, at most, 26 percent.

Comparing 1938 with the average of 1920-29, the following situation exists: There has been an 18- or 22-percent reduction in the apparent tonnage capacity of railroads, offset by a maximum of 26 percent increase in the carrying capacity of existing facilities. Effective capacity, then, may be somewhat above the average of 1920-29, but certainly not far above these levels.

The foregoing facts indicate that during the decade 1950-59, the railroads would not have a problem of excess capacity. This is true in relation to average traffic requirements; it is certainly true in relation to possible annual and cyclical peaks. Indeed, even to meet the very modest estimates of future traffic made in this report, railroad rolling stock would have to be increased in capacity and efficiency of usage above present levels. The problem of evaluating the St. Lawrence Seaway then is reduced to a consideration of the alternative costs of supplying additional transportation facilities during the season of peak railroad traffic.

Section 2

CONDITION OF WAY AND STRUCTURES

Carrying capacity of the railroads depends upon other factors in addition to cars, locomotives and efficiency of operation, particularly "Way and Structures" which includes tracks, right of way, building, sidings, etc. The potential capacity of existing systems cannot be measured in the way the capacity of cars and locomotives was measured, for there are no commensurable units; but certain salient facts indicate that there may be accumulated deficiencies in this field which may limit carrying capacity.

Rails.

In table 38 and chart 17 are given data on the number of ties and the number of tons of rails laid in replacement on Class I railroads from 1920 to 1938. From 1920 to 1929, railroads were replacing between 2,500,000 and 3,800,000 tons of rail each year on their tracks. By 1932 they were replacing well under a million tons, and in 1938 only replaced 1,200,000 tons. From 1920 to 1929 the average annual replacement was 3,258,000 tons. From 1930 to 1938 the average annual replacement was 1,472,000 tons (if 1930 is excluded, it was 1,322,000 tons). It should be recognized that this rate of replacement means a more than proportionate decrease in the miles of track replaced since "in replacing rails the tendency has been to utilize heavier rail. . . . in 1921, the weight of rail per yard. This is an increase (in weight) of 13.6 percent."⁴ Each ton of new rail meant 13.6 percent less mile of rail laid in 1938.

Ties.

The story in the case of ties is approximately the same. From 1920 to 1929 the average annual replacement was 82,135,000 ties, 49,309,000 of which were treated. In 1930-38, the average replacement was 46,169,000 ties, of which 35,447,000 were treated. Although the decrease in replacement of treated ties (28 percent) is much less than the decrease in all ties (44 percent), and treated ties have a life approximately three times as long as untreated ties, there is still a great decline. Since rails and ties must be replaced because of time as well as usage, then there is a serious deficiency in the existing tracks which must be rectified if the rails are to stand up under future traffic strains. The concept of deficiency is based on the hypothesis that in the period prior to 1930 the railroads were not spending an excessive amount in replacements of rails and ties.

⁴ Association of American Railroads, *Railways of the United States*, Washington, D. C., 1940.

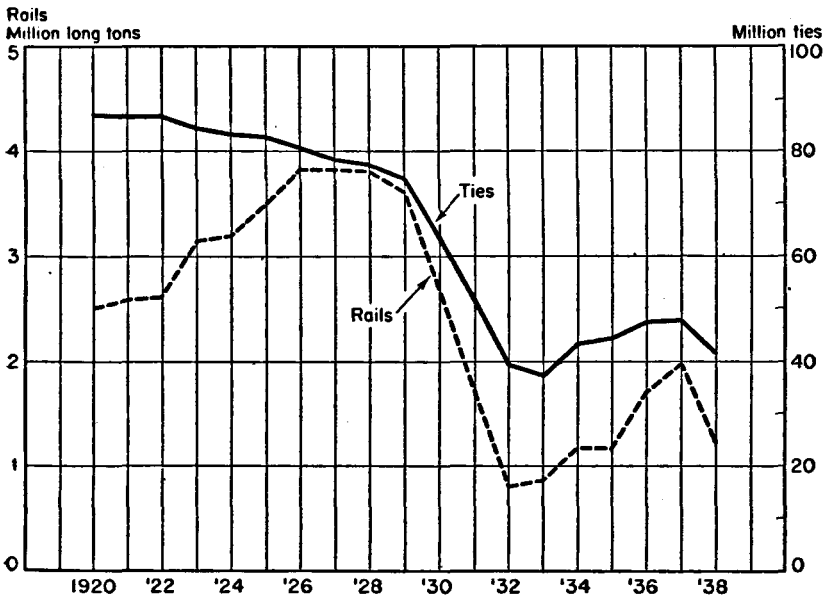
TABLE 38

Number of rails (new and second-hand) and number of ties laid in replacement, Class I railroads, 1920-38

Year	Rails (thousands of long tons)	Ties (thousands)		Year	Rails (thousands of long tons)	Ties (thousands)	
		All ties	Treated ties			All ties	Treated ties
1920	2,507	86,829		1930	2,674	63,354	49,720
1921	2,586	86,522	36,072	1931	1,715	51,502	39,828
1922	2,619	86,642	40,630	1932	1,797	39,191	29,435
1923	3,139	84,435	41,656	1933	862	37,296	26,340
1924	3,185	83,073	44,490	1934	1,165	43,306	31,808
1925	3,485	82,717	50,090	1935	1,159	44,326	33,281
1926	3,818	80,746	55,558	1936	1,701	47,361	36,772
1927	3,819	78,340	57,083	1937	1,975	47,730	38,075
1928	3,806	77,371	59,157	1938	1,203	41,453	33,763
1929	3,610	74,679	59,047				

Source: Interstate Commerce Commission, *Statistics of Railways in the United States*.

Chart 17 - RAILS AND TIES LAID IN REPLACEMENT IN CLASS I RAILROADS, 1920-1938



Source: Table 38

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Maintenance Expenditures.

Another indication of the condition of the existing structure is the expenditures on maintenance of way and structures over the past two decades. In table 39 are given total annual expenditures on maintenance of way and structures, revenue ton-miles, and expenditure per revenue ton-mile for Class I railroads. These data are not perfect

because: (1) Maintenance expenditure is chargeable to passenger service as well as to freight service; (2) The dollar series is partially distorted by changes in prices and wages of railway labor. The basic facts, however, are very clear—expenditure per ton-mile has been steadily decreasing since the beginning of the period studied, but, as seen in table 39 and chart 18, has been decreasing much faster since 1930 than it did prior to that date. Since 1933, it has been rising slightly, but is still well below either the levels or projected trend of the 1920–29 period.

Possibly the best indication of the fact that existing facilities of the railroads are not capable of handling a large increase in traffic without substantial expenditures lies in statements made by the railroads themselves. This problem has been a vexing one since 1931, and in 1938 the Interstate Commerce Commission decided to poll the railroads in order to obtain their opinions as to necessary expenditures to handle future traffic. The answers to this survey have been published in a release entitled "Financial Requirements of Railways."⁵ Some of the highlights of the answers are as follows:

1. Assuming traffic as large as that of 1937 to be in prospect (360 billion ton-miles of revenue freight), as of the end of 1938 deferred maintenance amounted to \$283,820,066, and that an additional \$495,757,106 should be expended on additions, betterments, and extensions—a total of \$779,577,172.

2. Assuming traffic 19 percent larger than that of 1937 to be in prospect (396 billion ton-miles) as of the end of 1938, deferred maintenance amounted to \$378,671,796, and that \$515,747,931 should be expended on additions, betterments, and extensions—a total of \$894,419,727.

3. "The figures given in answer to the questions are nothing more than a guess to attain a standard of maintenance reasonably satisfactory, yet falling far short of a desirable standard and somewhat above a standard of safety alone. They imply no under-maintenance so far as handling present traffic safely is concerned, or the desirability of raising the standard of maintenance under the existing outlook for the railroad industry; they are much short of the amount necessary to bring the property to a high engineering standard."⁶

⁵ Interstate Commerce Commission, Bureau of Statistics, Statement #3911, File No. 333-A-1.

⁶ *Ibid.*, p. 10. Statement of Louisville and Nashville R. R. Co.

TABLE 39

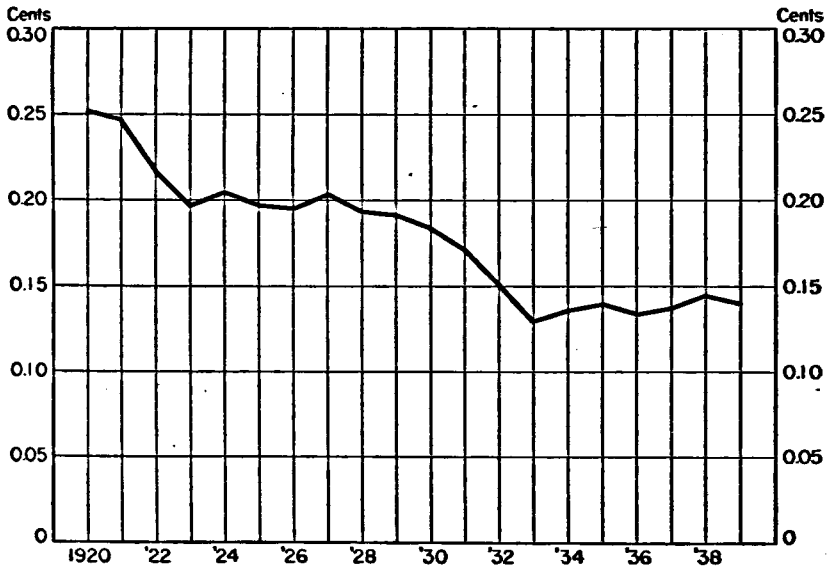
Railroad maintenance and traffic on Class I Steam Railroads, 1920-39

Year	Revenue ton-miles	Maintenance of way and structures	Maintenance per revenue ton-mile	Year	Revenue ton-miles	Maintenance of way and structures	Maintenance per revenue ton-mile
	<i>Millions</i>	<i>Millions of dollars</i>	<i>Cents</i>		<i>Millions</i>	<i>Millions of dollars</i>	<i>Cents</i>
1920	410,306	1,033	0.2518	1930	383,450	705	0.1840
1921	306,840	756	0.2465	1931	309,225	531	0.1717
1922	339,285	729	0.2148	1932	233,977	351	0.1501
1923	412,727	814	0.1971	1933	249,223	322	0.1293
1924	388,415	793	0.2041	1934	268,711	365	0.1359
1925	413,814	816	0.1973	1935	282,037	394	0.1397
1926	443,746	867	0.1953	1936	339,246	455	0.1341
1927	428,737	869	0.2026	1937	360,620	496	0.1374
1928	432,915	838	0.1935	1938	290,084	420	0.1448
1929	447,322	855	0.1912	1939 ¹	333,444	467	0.1400

¹ Preliminary.

Source: Interstate Commerce Commission, *Statistics of Railways of the United States*.

Chart 18 - RAILROAD MAINTENANCE OF WAY AND STRUCTURES PER REVENUE TON-MILE, CLASS I STEAM RAILROADS, 1920-1939



Source: Table 39

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Section 3

NECESSITY OF EXPANSION OF RAILROAD CAPACITY

The discussion in Section 1 above would seem to indicate that capacity of rolling stock as it existed at the end of 1938 would have been sufficient to meet average traffic requirements of the decade of 1920-29. This was due to improved operating speeds which compensated for reduced freight car capacity and aggregate tractive power of steam locomotives. This conclusion, however, is based upon a comparison of average traffic requirements over a period of decades. Traffic does not move in average figures; actual movements fluctuate considerably above and below the averages, due to seasonal factors within each year, and cyclical forces over the period of a decade. Hence future requirements must be recast by superimposing upon the estimates of average traffic requirements, a pattern of seasonal and cyclical fluctuation. In doing this, it will be assumed that the amplitudes of fluctuations around the average in the future will be comparable to the experience of the past two decades.

If tonnage of railroad freight originating in the decade 1950-59 was to fluctuate around the previously estimated average of 1,099,180,000 tons in the same degree as it did in the period 1920-29, ranging between 77 percent and 110 percent of the average, annual tonnage of freight originating would fluctuate between 848,500,000 tons and 1,209,100,000 tons. If the fluctuations were the same as that of the period 1930-39, from 75 percent to 135 percent of the average, tons originating would range between 826,580,000 tons and 1,480,100,000 tons. In either of these cases, maximum future traffic under very conservative estimates would be well above existing capacity, and expansion in railroad capacity would be required.

Since railroad facilities are not completely flexible, capacity must be geared to the peak demand for transportation within the period in which capacity is fixed. In a period as short as a single year, excess capacity must be measured by the number of freight cars which are available for service, but are not in use, at the time of annual peak. The Car Service Division of the Association of American Railroads has weekly figures on the number of such surplus cars for a number of years. The greatest excess capacity in the recent history of the railroads was in 1932, when there were 772,565 surplus cars in June. In 1929, the maximum surplus was 447,141 cars in December and the minimum was 107,361 cars in October, the peak of the year. In 1937 the maximum surplus was only 283,248 cars in December and the minimum was 101,630 cars in October. The minimum surplus condition has always occurred during the fall when the Seaway would be open. The situation which existed in 1937—one of the smallest surplus conditions since 1920—would seem to indicate that even now there is but little excess capacity during peak periods.

Section 4

THE ALTERNATIVE PROGRAM FOR FUTURE
TRANSPORTATION CAPACITY

In order to handle the possible traffic of the future with reasonable safety and economy, the railroads of the country will have to expand their rolling stock, and perhaps even their fixed plant. At least, a considerable amount of money will have to be spent on way and structures.

If the railroads have to increase their capacity, then they are offered a choice of two alternative programs—one being that which would be required if there is no St. Lawrence Seaway; the other being that which would be required if there were a Seaway carrying 10 million tons of freight more than now passes through the St. Lawrence canals. Therefore, there would be no real diversion of traffic from rails to the Seaway—the nation is afforded a choice between building two different transportation systems to handle traffic for which carrying capacity now in existence will not be adequate.

The St. Lawrence Seaway in Relation to Seasonal Peak in Traffic.

In considering these alternatives, it is important to remember that there is seasonal variation in railroad traffic. How the St. Lawrence Seaway fits into this seasonal pattern vitally affects the question of total cost of alternative increments of transportation facilities. Since the Seaway is not open to navigation between the first of December and the first of May, if the peak of railroad traffic comes during those 5 months, then there would be spare rail capacity during the summer and the Seaway would not be required. Indeed this is one of the arguments advanced by the Association of American Railroads.

In table 40 are given data on average weekly revenue carloadings for the period 1933–37. The peak occurs in October (14 percent above average), September (10 percent above average), and August (6 percent above average). The months when the Seaway is closed are also the lowest months in railroad traffic.

It will be observed that the data presented in table 40 cover all railroads, rather than only those roads which operate in the area contiguous to the Seaway. The reason for selecting the broader basis is that since railroad cars and locomotives are readily transferred from one road to another, and since capacity is here measured in terms of cars and locomotives, the freight load upon the entire railroad system rather than individual members must be considered. However, a test check of the business on the railroads of the Eastern area revealed that here, also, peak loads occurred in September and October.

Now since railroad capacity must be geared to peak conditions, and since the Seaway is open when the peak occurs, it is clear that the construction of the Seaway would enable the railroads to prepare for

a lower peak than they would have to do if there were no seaway, and the average load factor, the extent of utilization of peak capacity, would be improved. In table 41, average weekly carloadings are presented in five principal categories: agriculture, coal, coke and ore, forest products, and miscellaneous. In each of these classes except coal, the peak occurs when the seaway would be open. The peak in coal transportation occurs in February, but this is counterbalanced with a larger in-season peak (in numbers of cars) in ore and coke, which utilize the same type of car, thus creating no problem of car shortage.

TABLE 40
Average weekly revenue carloadings 1933-37—Class I railroads

Month	Average weekly carloadings	Percent of 1933-37 average	Month	Average weekly carloadings	Percent of 1933-37 average
January.....	565, 479	88. 8	August.....	676, 903	106. 3
February.....	595, 870	93. 5	September.....	698, 422	109. 6
March.....	608, 234	95. 5	October.....	725, 564	113. 9
April.....	608, 331	95. 5	November.....	640, 342	100. 5
May.....	634, 968	99. 7	December.....	579, 001	90. 9
June.....	651, 885	102. 4	Weekly average, 1933-37.....	637, 022	100. 0
July.....	649, 112	101. 9			

SOURCE: *Statistical Abstract of the United States, 1938, p. 393.*

TABLE 41
Average weekly revenue carloadings 1933-37—Class I railroads, by types of freight

Month	Products of agriculture	Coal	Ore and coke	Products of forests	Misc. and L. C. L.
January.....	43, 145	136, 284	13, 099	21, 448	351, 996
February.....	41, 168	150, 410	14, 486	24, 443	365, 363
March.....	41, 621	129, 645	13, 040	26, 478	397, 450
April.....	44, 182	100, 883	18, 315	26, 897	418, 074
May.....	43, 990	104, 106	40, 098	28, 645	418, 128
June.....	45, 735	108, 180	47, 781	30, 227	419, 962
July.....	59, 423	101, 435	50, 729	29, 533	408, 992
August.....	57, 624	112, 674	52, 695	31, 377	422, 533
September.....	55, 926	125, 079	52, 462	30, 059	434, 896
October.....	50, 630	139, 508	43, 725	26, 883	455, 814
November.....	50, 762	132, 423	21, 652	26, 632	408, 823
December.....	43, 563	133, 085	13, 521	24, 161	364, 872
Weekly average, 1933-37.....	48, 678	122, 783	32, 180	27, 528	405, 853

SOURCE: *Statistical Abstract of the United States, 1938, p. 393.*

The St. Lawrence Seaway in Relation to Cyclical Variations of Traffic.

The condition of general business and rail traffic immediately before and after the completion of the St. Lawrence Seaway will affect the smoothness with which the St. Lawrence takes its place in the national transportation system; it will also affect, for a brief period, the relative costs of the alternative methods. Obviously the railroads will have to be geared to take care of the highest possible peak of traffic just prior to the induction of the St. Lawrence Seaway. This will probably come in the fall of the year previous to the opening of the seaway. If the seaway should carry its maximum capacity, say 10 million tons,

the very first season it is opened, then there may be a temporary excess capacity in rail facilities. This condition would be accentuated, and would last a longer period, if the seaway came into use on the down swing of a business cycle.

That these eventualities are not likely to occur, and if they do occur, will be only temporary, is indicated by several considerations. In the first place, it is very unlikely that the Seaway will accommodate its maximum additional traffic in the very first year. As new shipping facilities and services will have to be established it will take some time before full use is made of the new route. The increase of St. Lawrence traffic to full capacity will come gradually. This has been the experience on other canals. The railroads will therefore have time to absorb their peak capacity of the pre-seaway era over a longer period than a year.

In the second place, the increase of traffic from one year to the other, (assuming, not a depression period, but one in which industrial conditions are gradually improving), will certainly provide as much as ten million tons of traffic (less than 1 percent of total tons of freight originated) between the pre-seaway year and the succeeding 4 or 5 years. This will certainly absorb any capacity that the railroads may have had to assign to the St. Lawrence traffic before it was available.

The country is then faced with a choice in the selection of the incremental transportation facilities which will be needed in the future. That mode of transportation should be chosen which will yield the greatest advantage. Among the considerations which should influence this choice is the relative cost of supplying this additional transportation service. If the Government owned the railroads of the country, surely the relative cost of railroad expansion as against the construction of the seaway would have to be carefully weighed. Precisely the same kind of analysis must be applied now, for regardless of the ownership of the railroads by private companies, an expansion of rail facilities will absorb physical and human resources. We must weigh these real costs against those involved in the construction of the seaway.

The cost of supplying the incremental transportation services is not the only criterion which must enter into the selection of the medium. There are other vital considerations which must be studied, some of which are not amenable to measurement in dollars and cents. Among these the strategic aspects of the project from the point of view of national defense are the most important. In order to permit a complete evaluation of the alternative modes of incremental transportation facilities, the question of relative costs is considered, along with other aspects of the project, in Part VII, the Summary report of the Survey.