THE CHANGING MARKET FOR RAIL FREIGHT TRANSPORT

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This paper examines the changing markets that characterize the American economy and their effects on rail freight transport. As an economy matures, the volume of freight normally fails to grow in proportion to the rate of economic growth. The geographic distribution of economic activity also changes over time, partially in response to the changing composition of economic activity and partially in response to the changing character of the transport system. To compound the problems of the established modes, the emergence of new modes of freight transport and of transport alternatives circumscribes the freight markets in which the older modes enjoy cost and service advantages. This paper discusses two categories of freight traffic: bulk commodities and manufactures. Competition for bulk commodity traffic is principally among railroads, water carriers, and pipelines, although the relatively high-cost truck mode has made inroads into this traffic in certain cases. Manufactures typically move in packages or discrete units; shipments tend to be of lower volume than bulk-commodity flows, smaller, and less regular. The number of segments of the freight market in which the railroads hold a commanding economic advantage has diminished during the postwar period. The newer modes—the truck, the pipeline, the airplane—have been developed to satisfy specialized transport needs, traffic that the railroads served only so long as these other modes were nonexistent. The evolution of transport technology has in fact paralleled the evolution of freight demands. Trucking in particular is consistent with almost all important changes in the freight market described. The final discussion in this paper looks to the futures of the railroad and trucking industries and outlines a number of opportunities to be gained by changes in policy and practice.

•CHANGING markets characterize the American economy, and the success of an industry depends in no small way on its ability to adapt the product it offers to changing demands. The freight market is no more sheltered from change than any other, and the challenge to the freight industries is to respond to these changes with alacrity.

As an economy matures, the volume of freight normally fails to grow in proportion to the rate of economic growth. The evolution of consumption patterns and technological progress diminish the relative importance of materials in the economy. The geographic distribution of economic activity also changes over time, partially in response to the changing composition of economic activity and partially in response to the changing character of the transport system. This relocation of industry and markets transforms the spatial pattern of freight flows, generally in ways that lessen the relative volume of long intercity freight movements. To compound the problems of the established transport modes, the emergence of new modes of freight transport and of transport alternatives circumscribes the freight markets in which the older modes enjoy cost and service advantages.

Intercity freight transportation, for the past 25 years at least, has been a slow-growth market. Aggregate domestic intercity freight traffic, measured in revenue ton-miles, has grown during the period 1947-1972 at an average annual rate of 2.8 percent, compared to an average rate of growth of 3.8 percent per year in real gross national product (1958 dollars). If aggregate intercity freight ton-mileage is measured exclusive of oil pipeline ton-mileage, then the average rate of freight growth is only 2.2 percent per year or only 58 percent as fast as real GNP (Tables 1, 2).

Aggregate intercity freight revenues also reveal the sluggish growth in this market. For example, the total freight revenues of the principal modes (truck, rail, inland water, air, pipeline, freight forwarders, and bus) grew at an average rate of 4.6 percent per year between 1958 and 1970, or only two-thirds as fast as the 6.7 percent growth in GNP (measured in current dollars) during this same period (1; 2, Chapter 3). Not only is the total volume of intercity freight traffic growing slowly, but the composition and character of that traffic are also changing in a number of ways that suit the traffic less and less to the older modes of rail and water.

BULK COMMODITY TRAFFIC

It is useful to divide freight traffic into two categories, bulk commodities and manufactures. Bulk commodities are raw materials or "intermediate" (producers') goods, in transit from raw-material origin to factory or between factories. They share a number of characteristics that are pertinent to determining their transport demands. Bulk commodities tend to be handled in flows rather than in discrete, packaged units, and they tend to move in large volumes. The commodities themselves tend to increase in market value with time. Competition for bulk-commodity traffic is principally among railroads, water carriers, and pipelines although the relatively high-cost truck mode has made surprising inroads into this traffic in certain special cases.

The economic consumption of bulk commodities has not kept pace with the growth of the GNP. The growth of annual domestic consumption, measured in tons, of all raw materials (other than air and water) is given in Table 3. Total consumption of raw materials other than primary construction materials (sand, gravel, and stone for direct use in construction) and air and water has grown at an average rate of only 1.9 percent per year during the postwar period, about half the 4.0 percent growth rate of real GNP (2, Chapter 5). Furthermore, the long-run trend is for the growth rate of raw material consumption to decline relative to the growth rate of real GNP.

The explanation of this trend seems to lie in part in evolving consumption patterns and in part in advancing industrial technology. To begin, increments to per capita income are increasingly devoted to the purchase of services such as health care, personal services, education, entertainment, travel, and communication rather than goods. Services typically require a lesser weight of physical materials per unit of output than manufacturing and construction. The shift away from the goods-type sectors toward the services is revealed in the redistribution of GNP among the 12 major industrial sectors (Table 4). The shares of agriculture, mining, and construction are declining while the shares of communications, finance, insurance, real estate, and wholesale and retail trade are rising. The total share of real GNP allocated to goods as opposed to services fell from 60.8 percent in 1945 to 48.1 percent in 1970 (Table 5).

Among manufactured goods themselves, incremental personal income is increasingly devoted to goods relatively more labor- and capital-intensive than material-intensive. As personal incomes rise, consumers typically spend smaller fractions of their incomes on such basic commodities as food, clothing, furniture, shelter, and fuel, and larger fractions on such highly fabricated products as televisions, stereo sets, cameras, watches, jewelry, toiletries, and cosmetics, for which weight is much lower in relation to value. The 50 manufacturing industries among the 417 four-digit SIC (Standard Industrial Classification) manufacturing industries exhibiting the highest rates of growth from 1958 to 1966 have freight input coefficients averaging only one-half the weighted average for all 417 manufacturing industries. [The freight input coefficient of an industry is the fraction of the industry's revenues that are spent on transporting the material inputs of the industry. The freight coefficient of all 417 manufacturing industries is 0.02204, which means that manufacturing spends 2.2 cents of every dollar of revenues on freight transport for its material inputs.] In fact, as Table 6 reveals, only 4 among the 50 fastest-growing industries have freight coefficients equal to or exceeding the average for all manufacturing, 0.02204.

Another change in consumer expenditure patterns with similar effect on material consumption is the tendency of consumers to substitute more expensive brands, models,

Table 1. Aggregate domestic intercity freight by mode.

	Amount of Freight (billions of ton-miles)						
Year	Rail	Truck	Oil Pipeline	Inland Waterways	Air	Total	Real GNP (1958 dollars)
1947	665	102	105	147	0.11	1,019	309.9
1952	623	195	158	169	0.34	1,145	395.1
1957	626	254	223	232	0.68	1,336	452.5
1962	600	309	238	223	1.30	1,371	529.8
1967	731	389	361	281	2.59	1,765	675.2
1972	785	470	457	325	3.80	2,041	789.7 (prelim.)

Source: Transportation Facts and Trends (1), 10th Ed., July 1973, p. 8.

Table 2. Average annual rate of growth, percent.

	Total Intercity Freight Ton-Miles		
Years	Including Oil Pipeline	Excluding Oil Pipeline	Real GNP
1947-1972	2.8	2.2	3.8
1947-1952	2.4	1.5	5.0
1952-1957	3.1	2.4	2.7
1957-1962	0.5	0.4	3.2
1962-1967	5.2	4.4	5.0
1967-1972	2.9	2.4	3.2

Table 3. Weight of raw materials consumed in the American economy.

	Weight Consumed (millions of tons)				
Raw Material Category	1939	1947	1957	1967	Average Annual Rate of Growth (percent), 1947-1967
Construction materials (sand, gravel, and stone)	334	459	1,058	1,573	6.4
Fuel materials for energy	743	1,027	1,155	1,506	1.9
Fuel materials for petrochemicals	12	22	40	64	5.5
Nonmetallic minerals (other than fuels)	83	182	217	298	2.5
Metallic ores and scrap metal	71	119	152	168	1.7
Food materials for manufacture	121	138	168	211	2.1
Food materials for direct consumption	47	56	61	62	0.5
Feed materials for direct animal consumption	169	189	225	257	1.5
Industrial roundwood and waste paper	117	153	169	200	1.3
Natural fibers and rubber, etc.	4	4	4	4	0.0
Total[a]	1,699	2,349	3,245	4,342	3.1

Source: Morton (2), Chapter 5.

[a]Columns may not add to total because of rounding.

Table 4. Percentage distribution of gross national product originating by industry for selected years.

Industrial Sector	1950	1955	1960	1965	1970
1. Agriculture, forestry, and fisheries	5.74	5.04	4.73	4.03	3.48
2. Mining	3.01	2.92	2.68	2.38	2.37
3. Contract construction	4.56	4.75	4.44	3.79	3.17
4. Manufacturing	29.70	30.49	28.85	30.68	29.89
5. Transportation	5.55	5.02	4.61	4.61	4.71
6. Communications	1.46	1.71	2.05	2.34	3.00
7. Electric, gas, and sanitary services	1.66	2.08	2.54	2.59	2.92
8. Wholesale and retail trade	17.01	16.34	16.85	16.88	17.50
9. Finance, insurance, and real estate	11.54	12.03	13.12	13.38	13.36
10. Services	9.32	8.72	9.56	9.29	9.45
11. Government	10.11	10.50	10.07	9.34	9.62
12. Rest of the world	0.37	0.41	0.47	0.66	0.55

Source: Statistical Abstract of the United States (6), Table 511.

Table 5. Percentage of gross national product contributed by major types of product.

Product	1945	1950	1955	1960	1965	1970
Goods output	60.8	57.02	54.37	51.54	50.69	48.08
Services	36.1	30.55	33.32	37.19	38.39	42.12
Structures	3.1	12.43	12.31	11.28	10.92	9.80

Source: Statistical Abstract of the United States (6), Table 506.

Table 6. Low freight intensities of the 50 fastest growing manufacturing industries.

SIC Code	Industry	Growth Ratio (value of 1966 shipments ÷ value of 1958 shipments)	Direct Freight Input Coefficient, 1963
1929	Ammunition, N. E. C.	5.80	0.00611
3672	Cathode-ray picture tubes	5.10	0.00764
3674	Semiconductors	4.49	0.00739
3571	Computing and related machinery	4.38	0.00383
1914	Guns, mortars, ordnance, N. E. C.	4.15	0.00551
2272	Tufted carpets and rugs	3.80	0.01256
1951	Small arms	3.46	0.01802
3679	Electronic components	3.35	0.00814
3339	Primary nonferrous metals, N. E. C.	3.33	0.00861
3831	Optical instruments and lenses	3.23	0.00603
3392	Nonferrous forgings	3.16	0.01055
3742	Railroad and street cars	3.02	0.01842
3537	Industrial trucks and tractors	2.94	0.01481
3399	Primary metal industries, N. E. C.	2.83	0.00777
1961	Small arms ammunition	2.79	0.01274
3841	Surgical and medical instruments	2.76	0.01143
3861	Photographic equipment	2.73	0.01005
3953	Marketing devices	2.71	0.01317
3541	Metal-cutting machine tools	2.69	0.00787
3663	Radio, TV, communication equipment	2.65	0.00373
3651	Radio and TV receiving sets	2.64	0.01177
2262	Textile finishing plants, synthetic	2.61	0.01558
2519	Household furniture, N. E. C.	2.55	0.02669
3622	Industrial controls	2.54	0.00740
3357	Nonferrous wire drawing	2.53	0.01393
3693	X-ray and therapeutic apparatus	2.53	0.00616
2282	Throwing and winding mills	2.51	0.01875
3799	Transportation equipment, N. E. C.	2.50	0.02679
3499	Fabricated metal products, N. E. C.	2.50	0.00945
3079	Plastics products, N. E. C.	2.49	0.01368
2295	Coated fabric, not rubberized	2.41	0.01035
3545	Machine tool accessories	2.41	0.00598
3479	Metal coating, engraving, etc.	2.39	0.01071
3715	Truck trailers	2.38	0.01641
3565	Industrial patterns	2.37	0.00359
3536	Hoists, cranes and monorails	2.37	0.01127
3791	Trailer coaches	2.36	0.01865
3341	Secondary nonferrous metals	2.36	0.05940
3351	Copper rolling and drawing	2.35	0.02630
2256	Knit fabric mills	2.35	0.00919
3713	Truck and bus bodies	2.33	0.01420
358X	Service industry machines, N. E. C.	2.33	0.01302
2327	Separate trousers	2.30	0.00511
2844	Toilet preparations	2.29	0.01295
3542	Metal-forming machine tools	2.29	0.00894
3559	Special industry machinery, N. E. C.	2.27	0.00927
3572	Typewriters	2.24	0.00821
3569	General industry machinery, N. E. C.	2.23	0.00684
3451	Screw machine products	2.23	0.01246
3694	Engine electrical equipment	2.21	0.01068

Source: U.S. Department of Commerce, Industry Profiles, 1958-1966 (1968), and Input-Output Structure of the U.S. Economy, 1963 (1969).

Table 7. Growth of primary raw-material inputs in tons compared to growth of output.

Sector or Industry (ranked in order of declining weight of primary raw-material inputs)	Average Annual Growth in Weight of Primary Raw-Material Inputs, 1947-1967 (percent)	Average Annual Growth in Outpu[t] 1947-1967, FRB Industrial Prod. Index, (percent)
New construction	2.2[a]	3.6
Energy	1.9	2.8
Manufacturing	2.2	4.5
Petroleum refining	3.3	3.8
Clay, glass, and stone products	2.9	3.7
Food products	2.1	2.5
Chemicals and products	4.1	8.3
Primary ferrous metals	1.0	1.5
Primary nonferrous metals	2.8	3.4
Fabricated metal products, machinery, transportation equipment, and instruments and related products	2.1	5.5[b]
Lumber and products	0.7	1.4
Paper and products	2.7	4.6
Rubber and plastics products	7.6	6.4
Textiles	1.7	2.6
Apparel	1.9	3.5
Leather	-1.6	0.7

Source: Morton (2), Chapter 5.

[a]The index used is the Composite Index of (Ten) Construction Materials, published by the Construction and Building Materials Division of the U.S. Department of Commerce. The ten materials are weighted in relation to value, so that the rapid growth of sand gravel, and stone consumption affects the index less sharply than otherwise.

[b]Simple average of the FRB production indexes of the four categories.

and styles within individual product categories as their personal incomes rise. The weight of materials used in producing more expensive brands, models, and styles of such commodities as food, clothing, cars, furniture, appliances, and housewares rarely rises in proportion to the value of these products; in some products weight does not rise with value at all.

Progress in industrial technology also retards the growth of material use. Economies in material use are achieved in diverse ways, among them the substitution of lighter materials; development of synthetics; creation of more durable materials; miniaturization; improved product design; improved process design; new uses for by-products, waste, and scrap; and improved inventory and distribution systems that reduce inventory "shrinkage". Plastics displace far heavier weights of metal, wood, paper, rubber, leather, fiber, and stone, clay, and glass products. Even innovations less directly motivated by a desire to economize on materials and their transport often have such an effect—e.g., nuclear energy replaces heavier fuels; radio, television, telephones, and computers are substitutes for "paper" forms of communication; airplanes and communication satellites require fewer ground structures, less construction, and lighter equipment than their predecessors.

The extent to which material-economizing innovations as well as the shifts to more highly fabricated products and to more expensive brands and styles have retarded the growth of material use within individual industries is given in Table 7. The table contrasts the average annual growth of primary raw-material inputs (in units of weight) for each of 16 major industries with the growth of each industry's output (as measured by the respective FRB index of industrial production or some other index of industry output). In every case but one, output has grown more rapidly than the physical weight of inputs and, by implication, the physical weight of outputs.

When the effects of the shifts in consumer expenditures toward services, toward more highly fabricated manufactures, and toward more expensive product styles and models are combined, it appears that raw-material consumption rises little with increments in per capita income. Indeed, the growth of bulk-commodity consumption may be more nearly correlated with the growth of population than with real GNP. Consumption of all raw materials other than construction materials, air, and water rose from 13.1 tons per capita in 1947 to only 14.0 tons per capita in 1967, even as real GNP per capita rose 114 percent from 1947 to 1967 (2, Chapter 5). If so, the recent decline of birth rates presages even further declines in the growth of raw-material consumption from its already low growth rate of 2 percent on average during the postwar years.

A partial or limited offset, however, may be materializing in the continuing specialization of the American economy in the production of coal, grains, lumber, and other raw materials for international trade, trends that would stimulate the growth of commodity production. The total effect of this offset, however, is likely to be small; while rising exports of coal, lumber, grains, soybeans, cotton, and fertilizers have been causing aggregate export tonnages to grow slightly faster than domestic consumption, exports still account for only about 3 percent of domestic production in tonnage terms.

In short, the tonnage of bulk commodities consumed in the United States is growing rather sluggishly compared to the GNP. To make matters worse for railroads in particular, those commodities that traditionally move by rail are expanding output less rapidly than others. Coal, iron ore, lumber, and grains, for example, are growing less rapidly than such substitutes as petroleum and natural gas, nonferrous metals, plastics, and meat that often tend to move by nonrail modes. Similarly, synthetics, produced from a negligible weight of petroleum and natural gas, are steadily displacing such rail-prone natural fabrication materials as metals, lumber, wood pulp, natural fibers, and stone, clay, and glass.

Not only is the volume and composition of bulk-commodity traffic changing, but the spatial pattern of these flows is changing as well. The geographic organization of economic activity adapts itself to the economy's changing dependence on raw materials and the changing character of the transport system, and in so doing transforms the spatial pattern of bulk-commodity movements.

The most important changes to occur are the increasing length and density of bulk-commodity movements. Numerous factors are at work tending to make both the origins and the destinations of bulk shipments more distant and the origins more geographically concentrated. First, manufacturing is becoming more market-oriented (3, pp. 114-115; 4). The reasons for this are many. For example, the lower freight rates for transporting bulk commodities than their fabricated equivalent commonly encourages manufacturers to substitute the transport of bulk commodities for the movement of the finished goods (3, pp. 119-120). Similarly, the shift in competitive emphasis from price to style and service encourages producers to locate as close to markets as possible. The concentration of people, and therefore of demand, in large metropolitan areas makes it easier to achieve economies of scale in manufacture in more and more regions, thus making decentralization and market-orientation increasingly feasible.

Another factor tending to lengthen hauls of bulk commodities is increasing geographic specialization in the production of raw materials. The regions of the country are not uniformly endowed with all natural resources. As freight rates decline, it becomes economical for a market to draw on more distant raw-material sources that enjoy a production-cost advantage. This is, the increasing taper of freight rates with distance has encouraged the use of more distant low-cost raw-material sources. The United States has thereby progressed from an economy in which local areas were nearly self-sufficient in producing their own raw-material needs to one of regional self-sufficiency (in which there was considerable trade within regions, but regions themselves tended to be self-sufficient) to one of considerable regional interdependence (in which many raw materials are produced in whatever areas of the country have a comparative advantage). Indeed, many important commodities, including citrus and other fresh fruits and vegetables, grain, meat, lumber, iron ore, coal, and petroleum, are supplied throughout the nation from the one or two regions in which they are produced most cheaply.

The exhaustion of supplies of natural resources proximate to historical population centers also causes markets to turn to more distant sources of supply, thereby lengthening hauls of bulk commodities. This process of exhaustion and discovery of new sources at more remote locations is or has been operative in the case of coal, petroleum, iron ore, lumber, and soil fertility. Increasing geographic specialization and the exhaustion of older sources of supply have generally pushed production of raw materials into the West and the South. Most of the intercity traffic growth arising from this lengthening of hauls has therefore occurred in these regions of the country.

For those commodities already produced in but one or two areas of the United States, the limit of regional specialization within the boundaries of the United States has largely been reached, so that further growth in the length of domestic haul of these commodities is improbable. Further geographic specialization, if it occurs, will be on an international scale. While the effect of expanding international trade on domestic intercity freight demand will depend on the types of goods and services exchanged, it may be generally negative. Bulk commodities for export have only to reach the nearest port. As for imports, to the extent that the population is increasingly concentrated in metropolitan belts extending along the Atlantic, Pacific, and Gulf coasts and around the Great Lakes, all accessible by ship, imports of bulk commodities and manufactured goods received in trade can be delivered to an increasing proportion of American markets without a long domestic intercity haul.

While intercity hauls of bulk commodities generally seem to be growing longer, intercity movements of some commodities can become shorter or even be eliminated altogether. This occurs in several ways. For example, the construction and energy sectors, both major sources of freight demand, substitute among materials so as to reduce distribution costs, including transport costs. The construction industry switches among concrete, metals, lumber, and synthetics as structural materials, as insulating materials, and as facing or surfacing materials, and these substitutions are rather sensitive to freight costs. Electric utilities are extremely sensitive to price differentials among fuels, so that a small difference in freight rates may alter the choice among nuclear power, fuel oil, pipelined natural gas, rail-transported coal, or hydroelectric and mine-mouth generation of electricity with high-voltage transmission. Obviously, not only the total transport outlay but the modal choice will be sensitive to which of these choices is made. The packaging, furniture, and chemical industries have also substituted locally available materials for distant materials when freight charges have risen.

Recycling of used materials presents industry with another opportunity to eliminate or abbreviate some intercity freight hauls, because recycled materials substitute for virgin materials that typically must be brought to the market from some distance. Recycling is presently limited to minor amounts of metals, paper, rubber, and industrial chemicals. It appears probable, however, that the proportions of these materials that are recycled will expand, and that recycling will be extended to other commodities, particularly heat energy, as the technology is developed. Rising prices of virgin materials as resources become depleted and increasing concern over the environmental impact of waste disposal are likely to encourage this recycling.

It is important to observe from the foregoing discussion and examples that the long-run price elasticity of intercity freight demand is almost certainly greater than is commonly thought. The aggregate tonnage of commodities consumed in the economy is relatively insensitive to changes in the price of freight, it is true. But the economy possesses a considerable ability to substitute longer or shorter hauls of bulk commodities as the price of freight falls or rises. The total freight market, therefore, will be preserved and enlarged only by continuing innovation and productivity growth in the transport industry.

TRAFFIC IN MANUFACTURES

The other major category of freight traffic—manufactures—consists primarily of finished goods or parts moving from factory to assembly plant, warehouse, or retail outlet. Manufactures typically move in packages or discrete units; shipments tend to be of lower volume than bulk-commodity flows, smaller, and less regular. The goods themselves tend to be of lower density (i.e., lighter) and of higher value per unit of weight. They are frequently fragile or perishable and subject to loss of market value as a function of time. Traffic in manufactures constitutes the bulk of truck cargo. Although the railroads have already lost much traffic in manufactures to trucking, this traffic still accounts for 25 to 40 percent of railroad ton-miles (depending on definition) and a still larger proportion, it is thought, of revenues and profits. It is important, therefore, to understand how the demand for the transport of manufactures has been changing.

Whereas the weight of manufactured goods must bear some reasonably constant relation to the weight of raw-material inputs, it is apparent that traffic in manufactures is also growing more slowly when measured in weight units than in real GNP. Aggregate intercity freight tonnage in bulk commodities and manufactures combined has been growing only about 60 percent as fast as real GNP during the postwar period, as Table 1 indicated. Traffic in manufactures is growing faster than bulk-commodity traffic, however, particularly when measured in terms of freight revenues. The primary causes of this relatively faster growth of traffic in manufactures are an increase in number of shipments and an increase in the quality of freight service demanded. As per capita incomes rise, there is a shift in consumer expenditures toward more highly fabricated products. To produce these, commodities often must pass through more stages of fabrication. Increasing specialization or "division of labor" in manufacturing industry also contributes to a rising number of interplant shipments. Hence, the total tonnage of manufactured goods shipped tends to rise more rapidly than bulk-commodity tonnage. The proliferation of distinct brands, models, and styles of manufactures tends to reduce the size of individual shipments and to require a more elaborate system of distribution. All these effects tend to increase the number of shipments of manufactured goods.

Another fundamental change in the freight market is the higher standards of freight service that shippers of manufactures are demanding. The shift toward higher standards of freight service parallels—and, in large part, derives from—a shift in most markets toward higher-quality products and services. As the economy evolves toward production of more highly fabricated goods and more expensive brands, models, and styles, the value of manufactures per unit of weight tends to rise because of the relatively greater inputs of labor and capital. As the amount and cost of working capital tied up in goods rise, there is a tendency to opt for speedier, more reliable deliveries as a way of controlling this carrying cost. Growing sophistication among shippers concerning the trade-offs between transport and other components of the total distribution bill (e.g., inventory) is also partially responsible for the gradual shift to higher-quality freight service.

Highly fabricated and expensive goods are inclined to be fragile, perishable, or otherwise damage-prone, prompting the use of premium transport service. Greater styling causes many products to lose market value rapidly as a function of time, which also stimulates demand for speedy, reliable delivery. Increasingly, products compete in the market on the basis of quality and service rather than price. The reliability, speed, and convenience of deliveries is part of the product quality or service that the buyer looks for. This, too, has been a powerful force in causing shippers to shift toward higher standards of freight service. For all these reasons freight demand has become more service-elastic and less price-elastic. The most compelling evidence of the degree to which freight demand is shifting toward higher standards of freight service is the comparatively rapid growth of trucking, a mode well-suited to providing premium service. The monetary value to shippers of swift, reliable delivery may be rather surprising. In Great Britain, by way of illustration, trucking firms have begun to specialize in offering guaranteed seventh-day delivery, guaranteed second-day delivery, or guaranteed one-day delivery. Freight rates for guaranteed second-day delivery are roughly 40 percent greater than those for seventh-day delivery, and rates for overnight delivery are about twice as high as those for second-day delivery (5).

Changes are also occurring in the spatial pattern of traffic in manufactures, changes that severely handicap the railroads in competing for this traffic. The most important change is the urbanization of the American population. The rural population of the United States has declined as a percentage of the total population from 85 percent in 1850 to 60 percent in 1900, 36 percent in 1950, and 25 percent at present. The trend is expected to continue, with the percentage falling to 15 percent in 2000 (6, 7). A rural population, geographically dispersed about its manufacturing and distribution centers, requires intercity hauls for distribution of its consumer goods. Much of the rural rail network was constructed to provide both freight and passenger transportation to rural communities which, at the time, had no suitable alternative means of transport. The delivery of consumer goods to a rural population supplies the railroads with traffic that is doubly valuable: first, because manufactures tend to be relatively high-rated traffic relative to cost; second, because the manufactures offer a backhaul to the raw materials moving out of rural areas. As the population has migrated to the cities, this flow of manufactures has diminished and has been diverted to truck, helping to render much of the rural rail network superfluous.

The growth of large urban markets encourages the decentralization and market-orientation of manufacturing, another factor that tends to shorten or do away entirely with intercity hauls of manufactures. The preceding section suggested a number of reasons why shippers have desired to decentralize production, substituting longer hauls of bulk commodities for intercity hauls of manufactured goods. In addition to those factors, there is some evidence that the minimum efficient scale of production for many manufacturing processes has not grown as rapidly as the size of the market in most metropolitan areas (8). Hence, an increasing proportion of the total market for specific products is concentrated in cities of a size sufficient to support efficient factories; this appears true for an increasing representation of the manufacturing spectrum. In short, more and more metropolitan areas are becoming more and more self-sufficient in their local manufacturing capacities. A diminished flow of manufactured goods among cities results.

The decentralization or regionalization of manufacturing in concert with the migration of population to the West and the South is also having an effect on the interregional balance of traffic in manufactures. Even after the discovery and development of abundant natural resources in the West and during the early westward migration of markets, manufacturing remained highly concentrated in the "industrialized Northeast". This generated long hauls of raw materials into the Northeast and long hauls of manufactures back to the West and the South. It could only be a matter of time until some manufacturing capacity migrated in order to eliminate this roundaboutness. The dispersion of manufacturing from the Northeast now in evidence contributes to lower traffic volumes and the redundancy of fixed rail plant in the Northeast.

The decentralization of manufacturing is attenuated or offset to some extent, though, by the trend toward increasing differentiation of products. As incomes rise, consumers seem to prefer—and are willing to pay the additional cost of distributing and merchandising—an increasing variety of brands, models, and styles from which to choose. If the total market for any given type of product is regarded as fixed, then the larger the number of individual brands and varieties of that product, the fewer the number of factories (each of minimum efficient scale) that can produce any one brand or variety, and hence the larger the market area each factory must serve. [This assumes that each factory is limited to producing one brand or a limited fraction of the total variety of models and styles.] Thus, the greater the degree of product differentiation, the greater the amount of cross-hauling and long-hauling that occurs in the economy.

The potential for greater product differentiation increases the price elasticity of aggregate freight demand and presents the transport industry with one of its few major growth potentials. As freight rates fall, specialization of production occurs, with products distributed ever more widely. Among the major trends in location and logistics affecting the spatial pattern of traffic in manufactures, the trend toward increasing product differentiation is virtually alone in affecting the demand for intercity freight service favorably. While intercity shipments of differentiated products are suited to rail transport by their relatively long length, such traffic has two characteristics that tend to adapt it to truck movement. With so many competing brands, styles, and models, the shipments of any one brand or model tend to be smaller in size. Also, competition among differentiated products tends to be more on the basis of quality and service than on straight price. This greatly favors transport modes that can deliver shipments swiftly, reliably, conveniently, and without damage. These factors, as well as others, help to explain the substantial penetration of trucks into the long-haul, intercity transport of manufactures.

Concurrent with the migration from rural to urban areas there is a migration of population and industry from the central cities to the suburbs. The population residing in the "outside-central-city" areas of the standard metropolitan statistical areas (SMSA's) grew at a rate half again as great as the growth rate of the central cities between 1930 and 1950 and three times as great between 1950 and 1960. Growth in the suburbs is estimated to be six times as great as central-city growth between 1965 and 1975 (9). Commerce and industry are suburbanizing at about the same rate as the population (10, 11).

Suburbanization also has favored the growth of trucking relative to railroading. Railroads were built at about the same time as cities were expanding or forming, and cities in most cases either grew up around the rail facilities or else rail terminals were built near the industrial cores of the newly forming cities. As long as cities remained dense and compact, clustered around the rail facilities on which they were so dependent, traffic readily moved by rail. Rail lines have not been extended in most cities to serve emerging suburban areas as completely and efficiently as they serve the central business district, and indeed probably could not be for reasons of efficiency and technology. Suburbanization, therefore, tends to carry consumers, warehouses, and factories away from efficient rail services. Furthermore, in choosing among possible suburban locations, factories, warehouses, and shopping centers are usually more concerned today with locating beside highways for ease of access by employees and customers than they are with locating along rail lines.

Not only does suburbanization reduce the proportion of shipments with origins and destinations having efficient direct access to rail, but it also transforms the pattern of movements to a pattern for which the highway network and truck are better suited than the rail network and conventional train operations. Formerly, the distribution pattern for manufactured goods tended to be radial, outward from urban manufacturing cities to satellite cities and towns, thus paralleling the rail network. The present trend is toward movements of manufactured goods that originate at one suburban point and terminate at other suburban points scattered about the metropolitan area. This emerging distribution pattern is less radial, more dispersed and "random", with an increasing number of shipments moving over trans-suburban routes not paralleled by rail lines and lacking the density for conventional train operations. The network of high-speed, limited-access suburban highways gives the trucks an important advantage in the suburban traffic.

IMPLICATIONS OF FREIGHT EVOLUTION FOR RAILS AND TRUCKS

The evolution of the freight market described in the foregoing has had a distinct bearing on the fortunes of the railroad and trucking industries during recent decades. The changes in freight demand noted in preceding sections have been (with a few exceptions) almost uniformly unfavorable to the growth of rail traffic and almost uniformly conducive to the growth of truck traffic: the sluggish growth in consumption of bulk commodities, particularly those that typically move by rail; the trend toward more highly fabricated manufactures and toward freight of a higher value per unit weight; the trend toward product differentiation and competition among products on the basis of quality and service rather than price; the urbanization of the population and growing self-sufficiency of metropolitan areas in manufacturing capacity, with the consequent decline in the use of intercity transport to distribute goods to rural consumers and to exchange goods among cities; and the suburbanization of urban population and industry and consequent removal of an increasing proportion of markets and industries from convenient rail access.

The number of segments of the freight market in which the railroads hold a commanding economic advantage has diminished a pace during the postwar period. The newer modes—the truck, the pipeline, the airplane—have been developed to satisfy specialized transport needs, traffic that the railroads served only so long as these other modes were nonexistent. As each of these newer technologies has advanced and matured, it has diverted to itself more and more of those segments of the transport market for which it has natural cost and service advantages. The extension of the highway and inland waterway networks has also permitted these competing modes to penetrate ever more deeply into bulk commodities and traffic in manufactures. The reallocation of traffic on the basis of comparative advantage has caused the railroads to depart almost entirely from the passenger transport market, the small shipment (LCL) market, and the local or short-haul freight market.

The evolution of transport technology has in fact paralleled the evolution of freight demands. Trucking in particular is consistent with almost all the important changes in the freight market described in the preceding sections. Trucking has been a natural beneficiary of the faster growth of highly fabricated, high-value manufactures, of the shift toward more sophisticated inventory control and the consequent demand for speedier, more reliable delivery, of the suburbanization of industry and markets, and so on. Not only is new transport technology responsive to changing freight demands, as would be expected, but new transport technology has also been instrumental in causing such changes in freight demands. The truck, to use that example again, has spurred product differentiation by making small shipments economical; it has spurred the decentralization of manufacturing and the redesign of distribution systems to take advantage of the high standard of service it is capable of providing; and it has spurred the suburbanization of industry and population.

The trucks' share of the intercity freight ton-mileage rose from 10 percent in 1940 to 22 percent in 1971, while the railroads' share fell from 61 percent to 39 percent over the same period (1, 9th Ed., p. 8). That such a change in shares should have occurred is not surprising in view of the rather thoroughgoing changes in the character of freight demand detailed here. Indeed, one can probably conclude that the single greatest cause of the stagnation in rail traffic during the postwar period is not the loss of competitive traffic to trucks but rather the failure of the economy to generate new traffic of a type suited to conventional rail transport.

What does the future hold for the railroad and trucking industries? As already noted, aggregate intercity freight tonnage and ton-mileage are growing only about two-thirds as fast as real national product, and even this fractional growth rate appears to be declining as the economy matures. Thus both railroads and trucks participate in what will probably continue to be a sluggish market overall. Most of the trends in the volume of materials consumed and in the location of economic activity will presumably continue to adversely affect the growth of rail traffic. The specialization of the United States as a world supplier of raw materials—as during the past few years—may provide some offset to these trends; on the other hand, the railroads may lose some of their bulk-commodity traffic to new transport modes and transport alternatives (e.g., loss of coal traffic to alternative energy sources, mine-mouth generation of electricity, or pipeline transport) just as they have lost much of their traffic in manufactures to trucks.

Much of the growth in truck traffic during recent periods has come at the expense of the railroads. Indeed, in view of the sluggish growth of aggregate intercity freight volumes, the diversion of traffic from rail is almost a necessary explanation of the rather ebullient growth in truck volumes. It appears that the trucking industry has by now diverted most of the high-value freight from rail that demands the premium service provided by truck. [Several general managers of general-commodity trucking concerns have stated to the author that they no longer regard the railroads either as major competitors or as potential sources of traffic growth.] If the "easy pickings" from rail traffic have in fact disappeared, trucking may face a future of slower traffic growth at a rate closer to the overall rate of economic expansion.

It would be a mistake to end on such a pessimistic note concerning the traffic opportunities for rails and trucks in the years ahead. Although the aggregate volume of freight may continue to grow sluggishly, there are two important opportunities for both railroads and motor carriers to enhance their growth—performance and profits.

The first opportunity is to be found in a more rational apportionment of traffic among modes. For the rails this means rediverting from trucks the long-distance shipments of manufactures and the short-haul but high-volume shipments of bulk commodities for which the rails possess a latent comparative advantage. Roughly 74 percent of all common-carrier truck shipments exceeding 10 tons move 200 miles or more, and 57 percent of all such shipments move 300 miles or more, a distance beyond which rails are usually regarded as possessing a latent cost advantage. It is estimated that the revenue received by motor carriers and private trucking operations for the transport of truckload shipments exceeding 200-250 miles was nearly $5 billion in 1968, equal to 50 percent of total railroad freight revenues in that year (12, 13). Motor carriers can likewise find a growth opportunity in traffic presently moving by private trucks. Private truck traffic equals or exceeds the present volume of motor-carrier freight. An efficient and unfettered motor carrier industry should have cost and service advantages for enough of this traffic to more than offset the loss of long hauls of manufactures to railroads.

The second major opportunity for both railroads and motor carriers to improve performance and profits is found in a greater reliance on containerization and intermodalism. The railroads possess cost and service advantages over trucks in long, line-haul movement. At the same time, trucks possess cost and service advantages for performing short-haul, light-density pick-up and delivery operations. Both railroads and motor carriers can benefit from a rearrangement of the work load in which the rails specialize as wholesalers of freight transportation and the motor carriers as retailers.

In short, the evolution of the intercity freight market poses a considerable challenge to railroads and trucks alike. Despite the sluggish rate of overall growth in aggregate intercity freight that is projected, however, profit opportunities for both modes exist in a more rational division of labor within the industry.

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