Volume Title: The Price Statistics of the Federal Goverment

Volume Author/Editor: Report of the Price Statistics Review Committee

Volume Publisher: UMI

Volume ISBN: 0-87014-072-8

Volume URL: http://www.nber.org/books/repo61-1

Publication Date: 1961

Chapter Title: Staff Papers 1. An Index of Motor Freight Rates

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Chapter URL: http://www.nber.org/chapters/c6490

Chapter pages in book: (p. 103 - 136)

STAFF PAPER 1

AN INDEX OF MOTOR FREIGHT RATES

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I. Introduction [1]

In this study, the index number problem is concerned with the estimation of changes over time in the costs of transporting commodities. Although the relative importance of the transportation industry, as measured by share of national income generated, has been declining over time, it still remains one of the important industries in our economy.[2]

A substantial part of the industry is regulated by various governmental agencies, notably the Interstate Commerce Commission. A large volume of data has been gathered and published by these agencies in conjunction with their regulatory activities. Regulation of freight rates is one of the major functions of these agencies. However, attention has largely been focused on specific rate cases, with very little effort made to estimate changes in the general level of rates. Some indexes for rail shipments of specific commodities and for all Class I rail carload freight have been generated by the I.C.C. and the Agricultural Marketing Service.[3] However, important segments of the industry, such as highways, have been wholly neglected.

The primary objective of this study was to propose a method for constructing an overall freight rate index for the United States. The index formula which was felt to be the most appropriate for this purpose was the familiar Laspeyres formula, used in constructing the Consumer Price Index. Given this formula, the theoretical discussion in Section II also develops an optimal sampling scheme for collection of the rate data. We firmly feel that this method is both conceptually sound and economically feasible.

To demonstrate this latter point, data were collected to generate a motor freight rate index for common carrier truckload freight in the Central States territory. Our method relies on a knowledge of the market organization for the particular kind of transport service;

[1] The authors wish to acknowledge the kind cooperation extended to the Transportation Center by members of the trucking industry. Particularly helpful on this study were Mr. Earl Mizenbach of the Central States Motor Freight Bureau; Mr. Frank Kahovec of the Rogers Cartage Company; and Mr. W. E. Mitchell of the Arco Auto Carriers.

[2] The share of national income, generated by the transportation industry, (as reported in *The Survey of Current Business*) has declined from 7.6 percent in 1929 to 4.7 percent in 1957. These figures exclude the privately produced transportation services provided by vertically integrated firms outside the transportation industry. Hence, the relative decline is overstated by these figures.

[3] Brief descriptions of these freight rate indexes are presented in Appendix B to this study.

in this respect, it is similar to the Wholesale Price Index. A description of the market for highway transportation and the mechanics of rate determination is included in Section III. The next three sections describe the procedures employed in obtaining the weights, price relatives, and final index numbers. The published data, from which weights were estimated, forced us to make some restrictive assumptions. In addition, the number of freight rates sampled was limited by our limited resources. Despite these qualifications, which are explicitly stated in Section VI, we believe that our motor freight rate index is representative of the changes over time in the level of rates for truckload freight in the Central States territory.

Finally, in Section VII, recommendations are made for additional data compilations to implement the method outlined in Section II. These recommendations were made in the light of the available statistics and the urgency of the problems currently facing the transportation industry.

II. Theoretical Framework for the Construction of a Freight Rate Index

The first step in the construction of an index number is to define the set of commodities or services covered by that index. In this study the freight rate index shall refer to the set of all "for hire" transport services; namely, it is an index of the prices paid for the spatial movement of goods excluding all self-produced transport services.

Ordinarily, the set of all commodities covered by an index is classified into subsets or groups such that the commodities in each subset possess certain common characteristics. This step serves two functions. First, it permits the estimation of indexes for various combinations of the subsets. Second, it facilitates the sampling problem encountered in every index number. The characteristics which distinguish various kinds of transport services can be subsumed under four variables of classification.

1. Mode of transportation: e.g., rail, motor, water, air, pipeline
2. Commodity transported
3. Distance transported
4. Geographic region

The stratification by mode of transportation isolates differences in the method of providing transportation as well as certain "service" or quality characteristics such as speed, batch size of individual shipments, portal to portal service, etc. Commodity characteristics such as perishability, density, packaging, etc., also influence the kind of transport service provided. Distance must be explicitly considered since the use of a single measure, such as ton-miles, conceals very real differences in the mix of transport services. The transport service includes both the movement of the goods and the loading and unloading activities. Hence, the relation between distance and either costs or rates is not linear; furthermore, it may differ between different modes. Finally, the classification by geographic region isolates differences in freight rates due to the area of operation.

The basic purpose of a freight rate index is to measure the average change in the prices paid for transporting goods. Initially, assume

that the individual price relatives or average price changes[4] can be accurately estimated for each subset of transport services. The appropriate method of combining these individual price relatives to obtain a single representative average price change constitutes the index number problem. The alternative methods of constructing an index number have been discussed in the literature and, hence, are omitted in the present study.[5] The three formulas which have survived through time and are still employed today are (1) the Laspeyres index, (2) the Paasche index, and (3) the chain link index. All three are weighted averages of the individual price relatives.

Two compelling reasons which favor the Laspeyres index over the other two are (1) minimal data requirements, and (2) ease of interpretation. In the Laspeyres index, quantity data are only required for the base period; in subsequent periods, only price data need be collected. If both price and quantity data are required in each period, as is the case for the other two indexes, publication of the current month's index may be delayed by as much as 2 years.[6] Furthermore, a Laspeyres freight rate index for the current period tells us the cost at current prices of purchasing the same bundle of transport services as that purchased during the base period. Although the Paasche index has an equally succinct meaning, this is not the case for a chain link index.

Where the composition of the bundle of transport services changes drastically over time, the Laspeyres index may yield an erroneous estimate of the true average price change. This fact has been clearly demonstrated in the case of the Consumer Price Index. Under these circumstances, the best alternative appears to be a chain link index. Between any two successive periods, the composition of the bundle cannot change too drastically. Hence, the chain link method estimates the average percent change between two adjacent periods, then cumulates these over time. One disadvantage of the chain link index is that it cumulates errors of measurement. Thus, if there is a serial correlation in the errors of measurement, this index will yield a biased estimate of the true average price change.

Over the past two decades, substantial shifts have been observed in the composition of the transport services consumed by our economy. During this period, the relative importance of highway transportation has increased steadily. Consequently, a fixed weight index would provide an accurate estimate for only a relatively short time span. However, given the mass of quantity data currently collected by the regulatory authorities, revisions could be made in the base period weights at frequent intervals, say each 5 years.

[4] The terms "freight rate," "rate" and "price" shall be used interchangeably through the remainder of this study.

[5] Irving Fisher, *The Making and Using of Index Numbers*, New York: Houghton Mifflin Co., 1923. Wesley Clair Mitchell, *The Making and Use of Index Numbers*, U.S. Bureau of Labor Statistics, Bull. No. 284. Bruce D. Mudgett, *Index Numbers*, New York: John Wiley & Sons, Inc., 1951.

[6] For example, the rail carload freight rate index is usually published approximately 2 years after the date for which it applies.

Of the three indexes, the Laspeyres index was selected as the appropriate one for constructing a freight rate index. The freight rate index in period t, relative to the base period, 0, is denoted by I_t.

$$I_t = \frac{\sum_j W_j X_{jt}}{\sum_j W_j} \tag{2.1}$$

where W_j denotes the weight assigned to the j-th type of transport service [7] and X_{jt} the price relative in period t relative to the base period, 0.

The appropriate weight for each type of transport service or traffic category is the share of total freight revenues generated by shipments in that traffic category during the base period. For rail carload freight, the ICC collects a 1 percent waybill sample from which freight revenues, classified by the kinds of traffic categories described in this study, could be estimated. Currently, class I motor common carriers are only required to report aggregate freight revenue and weight data for truckload shipments, classified by commodity type and territory of origin and destination. For the other sectors of the transportation industry, comparable data are not available. There is some reason to expect that the short-run fluctuations would be greater than the long-run fluctuations in freight revenue.[8] This would suggest the estimation of weights from revenue data for several years rather than for a single year. This was the procedure employed in section IV below.

We turn next to the estimation of the individual price relatives, X_{jt}. The two methods of estimating the price relative are (1) specification, or (2) aggregate value. Under specification value, one would observe the freight rates for particular transport services; e.g., the freight rate for the movement of shingles between two specified points via common carrier trucks in shipments of less than 2,000 pounds. Under this method, a sample of specific transport services would be selected and held fixed, if at all possible,[9] in subsequent periods.

The aggregate value method is currently used in the rail carload freight rate index. Under this method, an aggregate value or average freight rate is estimated for all shipments reported in a given traffic category. For example, a single rate per ton-mile is estimated for all "roofing materials" shipped in carload lots in the southern territory for a particular mileage block. For the rail carload index, the pertinent data can be lifted directly from the 1 percent waybill sample collected by the ICC. Where the variance in freight rates within any traffic category is large, aggregate value can lead to errors of measurement. For example, suppose there was no change in the structure of freight rates between years 0 and 1. However, the sample selected in year 0, by chance, included only those shipments with low freight rates. Use of the aggregate value method would reveal an increase

[7] The type of transport service corresponds to a specific subset or traffic category designating (1) mode of transportation, (2) commodity, (3) distance, and (4) geographic region.

[8] Variations in the spatial distribution of product demands could be satisfied through variations in either the demand for transportation or in the location of firms. Ordinarily, the short-run adjustments would be expected to take place through variations in the demand for transportation. The relocation of firms is usually a long-run phenomenon.

[9] The sample would necessarily change if certain freight services are discontinued in later periods.

in the average freight rate for this traffic category, although no change did in fact occur.

In constructing a motor freight rate index, specification value was employed in estimating the individual price relatives in section V. However, aggregate value may be preferable under other circumstances; specifically, if the data are in a form which makes it difficult, if not impossible, to employ specification value. In addition, differences in the costs of sampling under the two methods may encourage the use of aggregate value.

In the index number literature, relatively little attention is accorded the statistical properties of index numbers. An index number may be viewed as a point estimate of the average price change over a specified time period. Since it is neither possible nor feasible to observe all prices, the index must be based on a sample of prices. Furthermore, the sample size is limited by the costs of sampling and budget considerations.

Given a sample size, an optimal index number should satisfy two conditions. (1) The index is an unbiased estimate of the true average price change. (2) The index is a *best* estimate; namely, the variance of the estimate is a minimum.

In this formulation of the index number problem, prices are treated as if they were stochastic variables. The problem is to find the best unbiased estimate of the true average price change.

In the context of a Laspeyres index, this formulation prescribes an optimal sampling procedure. If the Laspeyres index is strictly applicable, then each price in period t has a corresponding counterpart in the base period. By redefining units of measurement, it is always possible to make the prices of all commodities equal in the base period. Using these redefined prices, there exists a probability distribution of price relatives in period t. Given the sample size, an optimal index number should provide the best unbiased estimate for the mean of this probability distribution.

Suppose the sample size is limited to n observations of individual price relatives. Two unbiased estimates are available: (1) the average of a random sample selected from the entire population of all commodity prices, and (2) a weighted average of the sample means for price relatives stratified into groups. The latter estimate will always possess a smaller variance than the former if the classification of commodities into groups results in either or both of the following conditions:

a. The true average price change for the j-th group, denoted by m_j, is not the same for all groups. That is, $m_j = m$, for some j.
b. The variance of price relatives within the j-th group, σ_j^2, is not the same for all groups.

Under these conditions, the optimal sampling procedure is to stratify the sample.

In this stratified sample, the number of price relatives sampled from the j-th group is determined by (1) the probability of observing a price relative in the j-th group, and (2) the variance of price relatives within the j-th group. The probability that a single price relative, drawn at random, will come from the j-th group is equal to the weight, W_j, for that group. Let σ_j denote the standard deviation of

price relatives within the j-th group. The optimal number of price relatives sampled from the j-th group, n_j, is then given by:[10]

$$\frac{n_j}{W_j\sigma_j}=\frac{n}{\Sigma W_j\sigma_j} \tag{2.2}$$

where $n=\Sigma n_j$. The fixed sample size, n, should be apportioned to the j groups so that the ratio of the sample size, n_j, to the product of the weight times the standard deviation, $W_j\sigma_j$, is the same for all groups. Given that the weights are estimated accurately, this procedure will yield the best unbiased estimate of the true average price relative for the set of all prices.[11]

The sampling procedure outlined in the preceding paragraphs may appear impractical. However, the method employed in collecting the price relatives for the Wholesale Price Index (WPI), resemble this precise procedure. The Bureau of Labor Statistics relies on industry opinions to determine the number and specific prices included in the WPI. In a sense, a priori estimates of the weights and variances by knowledgeable persons are substituted for empirical estimates for these magnitudes.

The procedure is particularly promising for constructing a freight rate index. For example, virtually all less-than-carload and less-than-truckload traffic moves on class rates. The variance of price relatives sampled from class tariffs is extremely small; indeed, a sample of a single rate would probably suffice. At present, a vast amount of rate data are available in the tariffs filed by all common carriers. Preliminary investigations on the variance in price relatives for various traffic categories might indicate rather modest sample size requirements. In this case, a fairly small continuing sample could provide a fairly accurate freight rate index for all common carriers. In this study, the number of rates sampled was determined solely by the weight assigned to each traffic category. Limitations of time and resources prohibited estimation of the variances.

III. The Market for Highway Transportation

A. Role of the Common Carrier in Highway Transportation

The market for highway transportation is divided into two broad sectors—regulated and nonregulated. In the past 11 years, the exempt segment of the motor carrier industry generated over 60 percent of the total intercity ton-miles of freight. The exempt or nonregulated carriers are principally those operating under the agricultural exemption to the Interstate Commerce Act plus the proprietary operations of many individual shippers. Little published data are available on the commodities handled or the rates at which such services are provided. These exempt and private operations are conducted under essentially free market conditions, including competitive rates and freedom of entry.

In a study published by the ICC, utilizing data derived in a 1955 Bureau of Public Roads survey, two interesting facts were revealed

[10] G. U. Yule and M. G. Kendall, *An Introduction to the Theory of Statistics*, New York: Hafner Publishing Co., 1950, p. 533. Paul G. Hoel, *An Introduction to Mathematical Statistics*, New York: John Wiley & Sons, Inc., 1947, p. 226.

[11] An optimal sampling procedure could also be developed by imposing a budget constraint together with different costs of sampling for each of the j groups.

about the North Central Region.[12] First, the East North Central Census Region[13] comprised only 14.1 percent of main rural road mileage, yet this region generated 20.9 percent of the total intercity motor carrier ton-miles. Second, this region accounted for 28.6 percent of the authorized (regulated) ICC intercity ton-miles of freight. For the States of Illinois, Indiana, Ohio, Michigan, and Wisconsin, the percent of exempt to total ton-miles was less than 47 percent as opposed to over 60 percent in all other regions except one. These facts point to a higher utilization of highway transportation in the Central States and an even greater use of the regulated carriers.

Although regulated freight service is provided by both common and contract carriers, an increasing proportion of common carriers is operating in a manner formally attributable to the contract carrier. These include increased use of specialized commodity and equipment service, restriction of service to truckload volume, and devotion to the needs of a limited number of shippers. For our purposes, a distinction should be made between the general commodity and specialized commodity carriers. The latter camp includes both the contract and specialized common carrier.

A brief discussion of the characteristics associated with a special commodity carrier may help to explain their relative growth.

These carriers have (1) minimal terminal facilities, at best parking and servicing facility for the rolling stock, (2) a modest office for billing, and (3) a telephone through which the shipping public makes its contact. In many instances, whole fleets operate without these facilities; equipment is parked on the shipper's property or at the owner-operator's residence. Widely varying loading practices exist, with shippers in some cases performing the loading operation. Although several stops or deliveries might be made to complete unloading, the unit tendered the carrier is a full load, and the charges are based thereon. Labor and other expenses are directly allocable to the line haul movement, with little overhead expense. Often drivers have been specially trained in both the handling of the product and the shipper's or consignee's methods and operation; carrier's personnel may be given keys to enter customer's premises and to load or unload at all hours of the day or night. Higher state size and weight limits, together with technological improvements, have led to greater revenue producing capacity by increasing loads on truckload shipments. Durability and service life of the equipment have also increased over time, tending to offset the secular increase in unit factor costs. For example, the labor input (as measured by man-hours) per ton-mile has declined over time; however, this has been offset by an increase in the wage rate.[14]

The general commodity common carrier is characterized by (1) scheduled service on regular routes, (2) acceptance of all shipments from the public, and (3) wide territorial coverage, either through single line service or joint service with other common carriers. The

[12] Bureau of Transport Economics and Statistics, ICC, *Truck Traffic on Main Rural Roads, 1955, ICC Authorized, Other for Hire and Private Carriers,* Statement No. 5710, (Washington, D.C.) July 1957, pp. 22, 23, 24–28.

[13] This region includes Illinois, Indiana, Michigan, Ohio, and Wisconsin.

[14] See American Trucking Associations, Inc., *American Trucking Trends,* 1959, Washington 6, D.C., p. 30. Also earlier years for regional series of operating costs on vehicle-mile basis, beginning with *Trends,* 1950. See also mileage and hourly scales in *Central States Area Over-the-Road Motor Freight Agreement,* Central States Drivers Council, Nov. 16, 1945, to the present. I.B.T.C.W. and H., A.F. of L. Local 710, Chicago, Ill.

general commodity spectrum for the motor common carrier is narrower than that for the rail due to the exceptions written into every general commodity authorization granted by the regulatory agency. These exceptions read as follows: "General Commodities except those of unusual value, Class A and B explosives, Household Goods as defined by the Commission, Commodities in bulk, and those requiring special equipment." Finally, the physical dimensions of the equipment prohibit the shipment of outsized or extremely heavy pieces of freight via motor carriers.

The equipment roster of the general commodity carrier is substantially larger than the specialized carrier because of the assembly and distribution of small lot freight in the city terminal area. In turn, the small lot freight results in higher terminal and administrative costs. For example, the general commodity carrier requires greater floor space for sorting and assembly, additional freight handling equipment, larger clerical staffs to process more numerous billings, etc.

Many general commodity operators also engage in some activities which closely resemble those of a specialized operator. Thus, where volumes of traffic are particularly heavy, some operators may concentrate on specific commodities which fall within the general commodity description. In some instances, operators have added special rosters of equipment or organized special divisions to service these particular commodities. This is frequently observed in the handling of "Iron and Steel Products," "Packing House Products," "Roofing and Building Materials," etc. In these instances, service and rates tend to be competitive with any completely specialized carriers in the territory.

Frequently, a general commodity carrier may enter into rate competition with other general commodity carriers, private fleets,[15] or contract and specialized carriers. Such competition typically occurs where the movement constitutes the backhaul, coincident with excess capacity. Again, if traffic is available and equipment idle, these carriers can and do handle exempt agricultural items—often at unpublished rates.

Although technological advances in rolling stock accrue to all motor carriers, these cost savings for a general commodity carrier are offset by certain developments in the terminal zone coverage. The increased congestion at rush hours and at shipper facilities, as well as the greater geographic dispersion of shippers in the terminal zone, results in higher costs for the general commodity operator. Furthermore, during the postwar period, labor costs have increased at a faster rate than any of the other cost items. Since the terminal and assembly operations require fairly intensive use of labor, the cost disadvantage of the general commodity carrier is even further intensified. In 1957, total compensation of all employees, expressed as a percent of total revenues for 94 general commodity common carriers, 40 special commodity common carriers, and 9 contract carriers, were respectively 47.8, 23.3, and 35.8 percent.[16] Part of the lower relative labor cost for the specialized carriers is attributable to a larger portion of equipment leased with drivers. A liberal adjustment to re-

[15] Some shippers choose to operate private fleets, thereby satisfying their transportation requirements rather than purchasing them from common carriers.

[16] Bureau of Transport Economics and Statistics, Interstate Commerce Commission. *Transport Statistics, U.S., 1957, Part 7, Motor Carriers*, Washington, D.C., 1958, tables 30, 31, and 32.

flect the same leasing portions as the other two groups results in a relative labor cost between 35 and 36 percent of total revenues for the specialized carriers. Finally, the average revenue per vehicle mile for these three groups—general, special, and contract—were found to be 71.7, 41.7, and 34.8 cents, respectively.

Thus, various types of motor carriers provide substantially different services; part of these differences are reflected in cost differentials. Furthermore, the cost differentials between types of motor carriers are widening for three reasons: (1) differences in relative labor costs, (2) increases over time in the relative employment of labor by the general commodity carriers, and (3) increases over time in the unit cost of labor.

Up to now, the discussion has dealt with the characteristics of various sectors of the highway transportation industry. As measured by ton-miles, in 1957 the nonregulated (exempt) sector was twice the size of the regulated (common and contract) sector; in 1943 the nonregulated sector was slightly smaller than the regulated. Between 1943 and 1957, highway transportation increased by 361 percent as compared to an overall increase in all transportation of only 31 percent.[17] Furthermore, over the same period, substantially different growth rates were observed for various sectors within the motor carrier industry. The exempt or nonregulated carriers experienced the highest annual growth rate of 14.1 percent. Common carriers had an annual growth rate of 7.8 percent, while contract (specialized) carriers showed an intermediate annual growth rate of 9.2 percent.[18] It should be pointed out that these annual growth rates were obtained from the ton-mile data for the initial (1943) and terminal (1957) periods.

The preliminary 1958 data indicate that the growth in common carrier ton-miles has virtually ceased despite two opposing factors: (1) an increase in the number of special bulk commodity authorizations granted by the ICC, and (2) the conversion of many contract carriers to common carrier certificates as a result of 1957 legislation which redefined contract carriers. In its last four annual reports, the ICC has commented at length on the increasing number of specialized commodity applications to serve particular commodities; notably frozen foods, bulk liquids, and bulk cement.

This trend in the relative decline of general commodity traffic is also mentioned in the annual reports of many general commodity carriers. Indeed, those firms which have experienced growth in recent years have done so through either mergers or expansion into the special commodity field. Although there has been substantial growth in all highway transportation, the traffic available to the general commodity carrier has declined for two reasons. First, when the volume of shipments becomes sufficiently large, a shipper may find it profitable to employ his own private fleet. Second, heavy traffic in a specific commodity encourages the formation of specialized carriers, even though this traffic is generated by a large number of shippers. Both reasons point toward an even narrower field in the future for the gen-

[17] U.S., Congress, Senate, Subcommittee of the Committee on Interstate and Foreign Commerce, Hearings, *Problems of the Railroads, Part I*, 85th Congress, 2d Session, 1958, p. 60. *72d Annual Report*, Interstate Commerce Commission, Washington, 1958, p. 12.

[18] Bureau of Transport Economics and Statistics, Interstate Commerce Commission, *Statistics of Class I, II and III Motor Carriers 1939–1956*, Statement No. 589, July 1958, p. 17.

eral commodity carrier. However, the small shipments (less than truckload) still remain in the domain of the general commodity carrier.

Thus, a motor freight rate index confined to common carrier truckload freight applies to, at most, one-third of the market for highway transportation. In addition, if historic trends continue, the common carrier share of the market will decline. These considerations should be kept in mind, both in interpreting the motor freight rate index presented in this study and in any future attempt to estimate a motor freight rate index for all highway transportation.

B. MECHANICS OF RATE DETERMINATION

Each motor carrier certificated as a common carrier must file a tariff with the Interstate Commerce Commission which requires strict adherence to the rates published in this tariff. For both rail and motor common carriers, the majority of these tariffs are prepared by ratemaking bureaus. In the Central States territory, approximately 800 carriers are joined together in a single rate-publishing bureau, the Central States Motor Freight Bureau. The dominant role played by these ratemaking bureaus warranted further investigation. What is the actual procedure followed in effecting a rate change?

The typical motor freight bureau is too large to permit active participation by all member firms on each decision taken by the bureau. Thus, the bureau's bylaws and procedures specify a method of selecting a board of directors from its member firms. In turn, a manager and a staff, answerable only to the bureau, are then employed by the board of directors. All rate decisions are then channeled through two committees: (1) a standing rate committee consisting of employees of the bureau, and (2) an appellate committee, ordinarily selected from the board of directors.

A proposed rate change is initially submitted to the standing rate committee, together with the supporting justification and background data. The proposal is then issued a docket number and publicized in a regularly issued docket bulletin distributed to all member firms. At least fifteen days' notice must be given prior to the scheduled hearing on the proposal; such hearings are scheduled at regular intervals, usually monthly. At the hearing the standing rate committee receives any opposition or additional support for the proposal. Once the matter has been thoroughly investigated and considered, the committee arrives at a disposition. The recommended disposition is then publicized and a reasonable time allowed for member firms to raise objections. Within thirty days of the disposition's publication, all objections must be supported by written statements supplying the reasons for the objection.

After these objections are published, a hearing is scheduled by the appellate committee. If they so choose, the committee may defer action for as long as a year following the first hearing. After due consideration, the committee arrives at a final recommended disposition; however, the committee retains the option to reconsider this "final disposition" at any time within a year. If no additional objections are raised within fifteen days following the final disposition's publication, then the recommendation is incorporated into the organization's tariff. A proposed rate change must pass through these stages

before it is filed with the ICC. Furthermore, it must be filed at least thirty days before the effective date of the proposed change.

An emergency procedure is accorded members for a limited number of reasons; principally (1) to correct errors in the tariff, (2) to satisfy national defense needs, and (3) to meet the competitive practices of other common carriers. Under this procedure, a carrier must file his proposal together with evidence supporting the emergency nature of this proposal. Even then, the standing rate committee has up to fifteen days to pass judgment on the matter; indeed, they can deny emergency action, thereby requiring adherence to the regular procedure. However, if the emergency nature of the proposal is granted, action is usually quite prompt.

Through this entire procedure, the one spur to prompt action is a provision which guarantees independent action by any member firm. A carrier may have a proposed rate change published on his own account either initially or at any stage during the regular procedure. Such action is also publicized and fifteen days allowed to receive requests from any competitors who wish to join in this action. Under the rules of the Commission, the bureau or any of its members may protest the publication and request an investigation by the Commission. If the proposed rate change results in a noncompensatory rate,[19] then the publication may be suspended by the Commission. Such independent action is not encouraged by the bureau and is rarely undertaken by member firms. Where it does occur, protests are frequently filed by either the bureau or member firms with the result, in many cases, of delaying the effective date of the proposed rate change.

In summary, two major features emerge from an investigation of the procedures employed by ratemaking bureaus in effecting rate changes. First, wide publicity is accorded every proposed rate change. Second, a vast amount of time and resources are consumed in making any rate change. Under these circumstances, one would not expect rates to reflect minor fluctuations in the demand and supply of motor carrier services. Indeed, a persistent or substantial change in market conditions must prevail before it elicits an adjustment in freight rates. Consequently, it was not surprising to find that the frequency of rate change in the four years covered by this study was quite small.

IV. The Weights: Commodity Composition of Common Carrier Truckload Freight in the Central States Territory

As discussed in Section II, any index number must refer to some set or universe of commodities or services. In this study the motor freight rate index refers to a subset of all highway transportation services; specifically, the set of all common carrier truckload freight in the Central States territory. All truckload shipments were classified into individual commodity groups; the definition of the groups was dictated by the data.[20]

[19] A noncompensatory freight rate is one which is less than the "out-of-pocket costs" for that particular service. The "out-of-pocket costs" may be estimated by use of a cost formula such as, "Simplified Procedure for Determining Costs of Handling Freight by Motor Carriers," prepared by the Cost Finding Section of the ICC, Bureau of Accounts, Cost Finding and Valuation, August 1959.

[20] *Motor Carrier Commodity Freight Statistics, Class I Common and Contract Carriers of Property for the Years Ending 1956, 1957, and 1958.* Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Statement Nos. 596, 5815, and 5718.

The appropriate weight for each commodity according to the method outlined in Section II is the share of total revenue generated by that commodity.[21] To minimize the year-to-year fluctuations, revenues were averaged for the three years, 1956 to 1958. By eliminating all commodities which generated less than 0.007 percent of total revenues, the list of commodities was reduced to 170. These weights, based on the 1956–58 average revenues, ranged from a low of 0.007 percent for sulfur to a high of 26.662 percent for motor vehicles.

The frequency distribution of the 170 commodities classified by weight reveals a sharply skewed distribution as can be seen in Table 1. The 20 commodities, each of which generated over 1 percent of total revenue, comprise only 12.8 percent of the total number of commodities transported; yet they account for 70.6 percent of total revenues from all commodities. On the other hand, 41.9 percent of the commodities fell into the smallest weight class (0–0.099 percent) and accounted for only 3.3 percent of total revenues. As a result, the motor freight rate index will be dominated by the rate movements for a relatively small number of commodities.

TABLE 1.—*Frequency Distribution of Commodities by Number and Weight for the Central States Territory, 1956–58*

Weight class	Number of commodities	Percent of—	
		Total number	Total weight
0 to 0.099	72	41.9	3.3
0.100 to 0.199	31	18.0	4.4
0.200 to 0.299	16	9.3	4.0
0.300 to 0.399	9	5.2	3.1
0.400 to 0.499	4	2.3	1.8
0.500 to 0.599	5	2.9	2.7
0.600 to 0.699	4	2.3	2.7
0.700 to 0.799	4	2.3	3.0
0.800 to 0.899	3	1.7	2.6
0.900 to 0.999	2	1.3	1.8
1.000 and over	20	12.8	70.6
Total	170	100.0	100.0

SOURCE.—*Motor Carrier Freight Commodity Statistics*, years ending 1956, 1957, 1958. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, statement Nos. 596, 5815, and 5718.

Thus far, the year-to-year fluctuations in the commodity composition of total revenues for the Central States have been neglected. For the major commodity groups and for selected individual commodities,[22] revenue and tonnage data are presented in Table 2 for each of the 3 years included in the average. Although the revenue shares by commodity group fluctuate from year to year, the order of magnitude for each commodity remains fairly stable. The effect of using a single year's weights, rather than the 3-year average weights is demonstrated in Table 11 below. The discrepancy between revenues and tonnages are due to both differences in freight rates per hundredweight and differences in the distance profile of shipments.

[21] Freight revenue and weight data for truckload freight are classified by territory according to the domicile of the reporting carriers. To the extent that a proportionally larger number of interterritorial carriers are domiciled in the Central States Territory, a bias is introduced, overstating revenues for this territory.

[22] The commodities with the highest weights were selected.

TABLE 2.—*Commodity Composition of Common Carrier Truckload Traffic for the Central States Territory, 1956–58*

Commodity class	1956				1957				1958			
	Revenue		Short tons		Revenue		Short tons		Revenue		Short tons	
	Dollars (000)	Percent	(000)	Percent	Dollars (000)	Percent	(000)	Percent	Dollars (000)	Percent	(000)	Percent
Products of agriculture	3,712	0.74	243	0.54	2,921	0.57	182	0.42	3,316	0.67	222	0.55
Animals and products	24,616	4.91	1,215	2.69	21,082	4.14	1,029	2.39	23,479	4.77	1,098	2.71
Meats, fresh, NOS	11,884	2.37	533	1.18	10,143	1.99	459	1.07	12,227	2.49	494	1.22
Products of mines	3,275	.65	766	1.70	3,989	.78	891	2.07	3,406	.69	855	2.11
Products of forests	1,615	.32	158	.35	1,489	.29	117	.27	1,401	.28	104	.26
Manufactures and miscellaneous	465,579	92.84	42,465	94.09	473,271	92.84	40,282	93.70	453,529	92.21	37,832	93.24
Gasoline	9,978	1.99	4,492	9.95	11,144	2.19	5,083	11.80	10,778	2.19	4,818	11.87
Fuel (residual oils)	9,196	1.83	4,224	9.36	8,304	1.63	3,771	8.77	9,079	1.85	4,094	10.09
Chemicals, NOS	13,072	2.61	1,254	2.78	15,287	3.00	1,311	3.05	15,675	3.19	1,442	3.55
Paint, paint material, putty	6,515	1.30	455	1.01	6,558	1.29	446	1.04	6,983	1.42	448	1.10
Plastics	7,763	1.55	466	1.03	7,878	1.55	463	1.08	8,470	1.72	477	1.18
Aluminum	5,426	1.08	365	.81	4,890	.96	315	.73	4,871	.99	296	.73
Copper, brass, bronze	8,123	1.62	573	1.27	7,854	1.54	470	1.09	7,318	1.49	441	1.09
Iron and steel, bar rod slab	8,448	1.68	1,162	2.57	6,064	1.19	857	1.99	4,642	.94	630	1.55
Iron and steel, NOS	25,923	5.17	3,638	8.06	17,654	3.46	2,621	6.10	16,640	3.38	2,351	5.79
Manufacturing iron and steel	27,527	5.49	3,001	6.65	28,261	5.54	2,750	6.40	24,464	4.97	2,530	6.24
Machinery and machines	13,157	2.62	717	1.59	13,665	2.68	664	1.54	11,845	2.41	557	1.37
Machinery parts	6,828	1.36	508	1.13	6,805	1.33	452	1.05	5,561	1.13	308	.76
Autos, passenger	72,809	14.52	2,699	5.98	104,328	20.47	3,673	8.54	97,140	19.75	3,156	7.78
Autos, freight	9,064	1.81	267	.59	8,546	1.68	283	.66	7,626	1.55	227	.56
Vehicles, motor, NOS	7,305	1.47	370	.82	6,427	1.26	305	.71	6,479	1.32	205	.51
Vehicle parts, NOS	39,301	7.84	3,009	6.67	27,224	5.34	2,199	5.11	25,722	5.27	1,899	4.68
Electrical equipment and parts, NOS	13,013	2.59	752	1.67	12,603	2.47	669	1.56	11,697	2.38	612	1.51
Liquors, alcoholic, NOS	8,624	1.72	553	1.23	7,595	1.47	437	1.02	7,421	1.51	413	1.02
Food products, NOS, not frozen	11,915	2.38	890	1.97	10,554	2.07	790	1.84	11,422	2.32	839	2.07
Soap, cleaning and washing compounds	6,443	1.28	495	1.10	6,139	1.20	475	1.10	6,645	1.35	523	1.29
Manufactures and miscellaneous, NOS	22,231	4.43	1,323	2.93	22,645	4.44	1,243	2.89	24,905	5.06	1,302	3.21
All commodities	501,498	100.00	45,133	100.00	509,772	100.00	42,994	100.00	491,836	100.00	40,576	100.00

SOURCE: *Motor Carrier Freight Commodity Statistics*, years ending 1956, 1957, 1958. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, statement Nos. 596, 5815, and 5718.

Finally, a comparison of the commodity composition of common carrier freight was made between the Central States territory and the rest of the United States. The revenue data, classified by major commodity group, are presented in Table 3. Some differences in the commodity composition of freight are evident from an inspection of

TABLE 3.—*Commodity Composition of Common Carrier Truckload Traffic by Revenue for Selected Commodities, Central States, and United States, 1956–58*

	1956			1957			1958		
	United States	Central States	Rest of U.S.	United States	Central States	Rest of U.S.	United States	Central States	Rest of U.S.
Revenue (millions of dollars):									
All commodities	1,454.1	501.5	952.6	1,575.3	509.8	1,065.5	1,526.5	491.8	1,034.7
Agriculture	39.7	3.7	36.0	44.8	2.9	41.9	47.3	3.3	44.0
Animals and products	87.4	24.6	62.8	91.5	21.1	70.4	92.2	23.5	68.7
Mining	26.2	3.3	22.9	28.5	4.0	24.5	26.8	3.4	23.4
Forests	8.6	1.6	7.0	9.1	1.5	7.6	9.5	1.4	8.1
Manufacturing and misc	1,286.3	465.6	820.7	1,390.1	473.3	916.8	1,340.0	453.5	886.5
Percent distribution:[1]									
All commodities	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Agriculture	2.7	.7	3.8	2.8	.6	3.9	3.1	.7	4.3
Animals and products	6.0	4.9	6.6	5.8	4.1	6.6	6.0	4.8	6.6
Mining	1.8	.7	2.4	1.8	.8	2.3	1.8	.7	2.3
Forests	.6	.3	.7	.6	.3	.7	.6	.3	.8
Manufacturing and misc	88.5	92.8	86.2	88.2	92.8	86.0	87.8	92.2	85.7

[1] Percents do not add to 100 due to exclusion of freight forwarder traffic.

SOURCE: *Motor Carrier Freight Commodity Statistics*, years ending 1956, 1957, 1958. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, statement Nos. 596, 5815, and 5718.

this table. The most important major commodity group, "Manufactures," accounts for a slightly higher percentage of total revenues in the Central States than in the rest of the United States. Finally, freight revenues in the Central States comprise roughly one-third of the total freight revenues of all common and contract carriers. Thus, an index for the Central States territory applies to a substantial portion of the entire common carrier motor freight industry.

V. THE PRICE RELATIVES

An individual freight rate or price corresponds to the movement of a given commodity between two specified points. In this study, the universe of all common carrier truckload freight rates for the Central States territory was stratified by commodity into 170 individual commodity groups. Within each commodity group there are a large number of rates representing different point-to-point movements or slightly different commodities within the same commodity group.[23] For each commodity, a sample of freight rates was collected; for many commodities, this sample consisted of a single freight rate.[24] An attempt was made to collect more rates for those commodities with larger weights, as would be indicated by the theory of stratified

[23] For example, within the major group, "Motor Vehicles," different rates are quoted for automobiles, tractors, trucks, etc.

[24] The list of commodities, together with the number of rates sampled, is presented in Appendix A.

sampling. However, a random sample within each commodity group is inappropriate, since some rates have higher probabilities of being observed than other rates. A brief résumé of the institutional framework of the market for highway transportation provides the rationale for the sampling procedure employed in the study.

In the Central States territory, the majority of the general commodity carriers belong to the Central States Motor Freight Bureau.[25] The Bureau assumes the function of publishing and revising the tariffs for all its member firms. Although some carriers may publish independent tariffs, the bulk of the general commodity traffic comes under the jurisdiction of the CSMFB.

The multitude of tariffs published by the CSMFB are of three basic types: (1) the class tariff, (2) the general commodity tariff, and (3) the special commodity tariff. The class tariff has the widest territorial coverage and the lowest priority. If the freight rate for a particular shipment cannot be found in either of the other two kinds of tariffs, then a class rate shall apply. This tariff, for truckload shipments, gives freight rates as a function of the distance shipped for thirteen classes of commodities.[26]

Unlike the class tariff, the general commodity tariff specifies a freight rate per hundredweight for a given point-to-point shipment of a particular commodity. In December 1959, six general commodity tariffs were published by the CSMFB. Each tariff designates different geographic subregions by either points of origin and/or points of destination. For example, Commodity Tariff No. 555 applies to shipments with origins in Chicago-Gary and points along the Mississippi in Illinois, Iowa, and Missouri, to virtually all destinations in the Central States Territory. In some instances, coverage by a commodity tariff is quite narrow; for example, there is a tariff for shipments between Chicago and Milwaukee.

Finally, the special commodity tariffs are published for specific commodity groups. In general, such "special tariffs" occur where volumes of shipments are highest. For example, "special commodity tariffs" are published for "packinghouse products," "flavoring syrups," "iron and steel products," etc.

For general commodity traffic, the price relatives were taken from (1) General Commodity Tariff No. 555, and (2) the class tariff. A specific "commodity point to point" freight rate (or rates where more than one was taken) was attached to each of the 170 individual commodity groups. The starting point was the "555" tariff which was in effect on December 31, 1959. If the commodities included in a commodity group could not be found in the 555 tariff, then they were assumed to move on class rates. As a result, 76 commodities, comprising 15.95 percent of total freight revenues, were assumed to move entirely on class rates.[27]

[25] The Central States Motor Freight Bureau will hereafter be denoted by its initials, CSMFB.

[26] For a commodity moving on a class rate, the first step is the classification of that commodity into one of the 13 classes. The distance of the point-to-point movement then determines the rate per hundredweight.

[27] To the extent that some of these 76 commodities move on other than class rates, this assumption tends to understate the frequency of rate changes and overstates the increase over the 4 years covered by the present study. The magnitude of this error cannot be estimated without additional data on the proportion of these commodities moving on other than class rates. It has also been implicitly assumed that the remaining 80 commodities move entirely on commodity rates. Insofar as some of these 80 commodities are moved on class rates, an offsetting error is introduced.

From January 1956, to December 1959, three increases were effected in the class tariff. In all three, the same percentage increase was applied to all class ratings. The practice of an "across the board" percentage increase was altered in the rate increase which became effective in June 1960. In this last change, all class rates were increased by the same nominal amount of 2 cents per hundredweight. The percentage increases in the entire class tariff were used to generate the price relatives for all 76 commodities moving on class rates. The price relative for each month represented the ratio of the rate in effect at the end of the month relative to the average rate for the year, 1957. This procedure concealed any rate changes resulting from revisions in the commodity classification, included in the "Exceptions" to the class tariff. Lower class ratings correspond to lower freight rates. Hence, a change in the commodity classification, moving commodities to different class ratings, means a change in the freight rates for these commodities. These rate changes were neglected in the present study, since additional waybill statistics would be required to make the appropriate adjustments.

For the remaining 80 commodities, the freight rate for a specific "commodity point to point" movement is found in the General Commodity Tariff by first finding its appropriate "item number." This item number then defines the rate. Thus, the same item number may correspond to different commodities or different point-to-point movements. Between 1956 and 1959, four general percentage increases were found for the 555 tariff. However, individual freight rates may have experienced more or less than four rate changes during this period due to either changes included in the numerous supplements or "flagouts" to the general rate change.[28] The influence of both of these latter two factors is caught by our procedure of tracing the rate histories for each of the 194 individual freight rates. Thus, if our sample of 194 rates is truly random, then the probability of changes included in the supplements or through "flagouts" is the same for both our sample and the universe of all commodity rates.

A major criticism of our sampling procedure is that all of the rates were taken from the 555 tariff, although six general commodity tariffs are published by the CSMFB. A casual inspection indicated that the timing and magnitude of the general rate changes were similar for all six tariffs. To verify this fact, a sample of freight rates for comparable commodities was collected from General Commodity Tariff No. 558. A comparison of the rate histories, obtained from the 555 and 558 tariffs, is presented in table 4. Although some minor discrepancies are revealed, a close similarity is observed in the behavior over time for the rates sampled from these two tariffs. Thus, no systematic error appears to have been introduced by confining the sample to the 555 tariff.

Although "Iron and Steel Products" are nominally included within the general commodity description, a sufficient volume of freight is generated within the Central States to warrant the publication of a special commodity tariff by the CSMFB. Freight rates for steel products may be found in other tariffs; however, relatively few ship-

[28] A "flagout" is a term employed in the trucking industry to designate an exception to a general rate increase.

TABLE 4.—*Comparison of Price Relatives From 2 General Commodity Tariffs*

Commodity	Tariff 555		Tariff 558	
	Date of rate change	Price relative	Date of rate change	Price relative
1. Furniture	May 1956	96.0	May 1956	94.1
	December 1956	95.0	August 1956	100.0
	March 1957	101.6	September 1958	107.3
	September 1958	108.7		
2. Chemicals	May 1956	94.9	May 1956	95.5
	March 1957	101.7	March 1957	101.5
	September 1958	108.4	September 1958	108.6
3. Food products, canned	May 1956	97.2	May 1956	95.9
	August 1956	95.0	March 1957	101.4
	March 1957	101.6	September 1958	109.6
	September 1958	108.2		
4. Packing house products	September 1956	95.1	May 1956	96.4
	March 1957	101.6	July 1956	95.0
	September 1958	109.0	March 1957	101.6
			September 1958	108.2
5. Pulpboard, paperboard	March 1956	95.7	March 1957	101.6
	March 1957	101.4		
	September 1958	109.0		

ments are made at these rates. Consequently, the price relatives for "Iron and Steel Products" were taken from this special tariff.[29]

The transportation of motor vehicles and bulk liquids accounts for 29.113 percent of the total revenue generated by common carrier truckload freight in the Central States territory. These commodities are transported by specialized common carriers who remain outside of the conference of general commodity carriers. The limited number of commodities transported by these carriers permits the publication of independent tariffs. However, a large number of vehicle carriers are joined together in a national ratemaking bureau, the National Automobile Transporters Association.

Freight rate histories for bulk liquid commodities (notably gasoline, fuel oil, asphalt, acids) were obtained from the Rogers Cartage Company—one of the leading bulk liquid carriers in the Central States territory. Freight rates for auto shipments were obtained from the Arco Company for shipments out of Detroit, South Bend, and Kenosha. Vehicle rates were particularly interesting, since they were quoted on either a "per hundredweight" or a "per vehicle" base. Differences resulting from the use of the two bases are discussed in Section VI below. Again, one might criticize the use of a single tariff in the case of bulk liquid commodities. However, industry opinion as reflected by conversations with several truckers indicates a high correlation between rates charged by different firms.

Finally, one might criticize the extremely small sample employed in this study. In any index number, the appropriate sample size depends on the degree of accuracy desired and the variance of price relatives within each commodity group. Indeed, if the variance in price relatives is small, then a sample of as few as one observation may suffice. An experiment was undertaken to ascertain the magnitude of the error introduced through small sample sizes. For some commodities with large weights, several individual freight rates were sampled. The price relative for that commodity was the arithmetic

[29] In the 4 years covered by the index, only one percentage increase was applied to all rates in this tariff. Hence, in Appendix A, the number of rates sampled is not entered The same procedure was employed here as in the case of the class tariff.

average of the price relatives for these individual rates. Random samples of one and two rates were selected and their price relatives computed. The results are summarized in Table 5.

TABLE 5.—*Sampling Variability of the Price Relatives*

Commodity	All rates, average		Sample of 1 rate		Sample of 2 rates	
	Date of rate change	Price relative	Date of rate change	Price relative	Date of rate change	Price relative
1. Autos (hundredweight rates) (19 rates).	October 1956	100.0	October 1956	100.0	October 1956	100.0
	April 1958	104.8	April 1958	104.8	April 1958	104.8
2. Gasoline (7 rates)	May 1958	101.7	May 1958	101.9	May 1958	97.6
	February 1959	111.8	February 1959	118.9	February 1959	109.7
	March 1959	117.1	March 1959	123.8	March 1959	111.5
3. Electrical equipment, parts, NOS (5 rates).	May 1956	95.0	May 1956	95.7	May 1956	95.4
	August 1956	97.0	March 1957	101.4	August 1956	98.0
	March 1957	101.0	September 1958	108.9	March 1957	100.6
	September 1958	107.9			September 1958	107.6
4. Soap and cleaning compounds (4 rates).	May 1956	92.2	August 1956	94.6	May 1956	90.4
	August 1956	94.6	March 1957	101.7	August 1956	94.5
	March 1957	101.8	September 1958	108.8	March 1957	101.8
	September 1958	107.5			September 1958	109.2
5. Machinery and machines (8 rates).	May 1956	90.6	June 1956	95.4	June 1956	94.7
	June 1956	93.4	August 1956	94.9	July 1956	96.8
	July 1956	94.5	March 1957	101.6	August 1956	95.9
	August 1956	95.1	September 1958	108.8	March 1957	101.2
	March 1957	101.6			September 1958	106.1
	September 1958	107.7				
	June 1959	108.1				

In the four years 1956 to 1959 the number of rate changes for a single freight rate was typically quite small; for our sample, the maximum number of rate changes was seven. This is evident for the price relatives of the five commodities selected for Table 5. In addition, the rate changes tend to cluster at certain points in time. Both findings are not surprising in light of the costs and delays involved in effecting rate changes.

The maximum discrepancy between the price relative for "all rates" and the price relative for the sample of either one or two rates was found for "Gasoline." The variance in price relatives indicated by this discrepancy is quite large. The interesting feature of the gasoline rates is that prior to the change in May 1958, the rates had remained fixed for over four years. The observed variance in the price relatives for automobiles is virtually zero; a sample of one rate would have sufficed here. Finally, some of the minor discrepancies in the price relatives are attributable to the rounding of rates to the nearest penny in any general percentage increase.[30]

In summary, an adequate sample size depends on the desired degree of accuracy and the variance in individual price relatives. If the price relative for each commodity is to be estimated to the nearest percentage point, then the actual sample sizes used in this study are clearly inadequate for some commodities. This is obvious in the case of "Gasoline." In retrospect, the sample sizes for commodities such as "Gasoline" and "Soap and Cleaning Compounds" should have been increased, whereas the number of rates sampled for "Automobiles" is clearly too large.

[30] A 6-percent increase applied to a tariff leads to the same 2-cent increase for all freight rates between 25 and 41 cents. In this case, the same 6-percent increase resulted in effective percentage increases of 8 and 5 percent, respectively.

Before turning to the final index numbers, two additional points should be mentioned. First, are the tariff rates truly representative of actual prices paid by shippers, or are they like the list prices for new automobiles? Second, have there been any significant changes in the quality of service provided by motor common carriers?

Actual rates may differ from published tariff rates through either a misclassification of commodities or outright chiseling. The latter method is rarely practiced, since, if it can be proven, both operator and shipper may be held criminally liable.[31] Penalties for chiseling include forfeiture of licenses, as well as fines or imprisonment. Due to the sizable rate differentials by commodities, misclassification of goods can result in significant rate reductions. To guard against such practices, many ratemaking bureaus establish policing staffs, whose sole function is to inspect shipments and waybills for misclassifications. In the absence of data from these policing departments, it is impossible to estimate the extent of such informal rate cutting.

The term "quality," as applied to transport services, connotes various things including reliability, speed, safety, loading and unloading of cargos, and frequency of departures. The two elements which are most readily identifiable are speed and the loading services. In the last decade, improvements in highways have resulted in slightly higher over-the-road speeds for trucks. However, the reduction in transit time, resulting from these improvements, has been offset in many instances by increasing congestion in cities and by geographic constraints.[32]

The loading service is a far more significant item in the quality of transportation provided by an operator. This fact was demonstrated by a recent case in the Midwest. A fairly large shipper negotiated a lower rate with the Bureau by agreeing to perform the loading and stowing functions. In some cases, shippers have been offered an option whereby they could enjoy lower freight rates by performing the loading or turn this function over to the trucker. A similar phenomenon is observed in the allowances granted shippers for pickup and delivery, sometimes called cartage allowances.[33] In cases where rates are negotiated without these services, some adjustments should be made to reflect the deterioration in the service. In summary, for the last ten years no substantial changes are discernible in the quality of the transport services provided by motor common carriers, with the possible exception of the long haul, transcontinental traffic.

[31] Informal rate reductions may be profitable for both shipper and operator. Where the reductions are informal, a given rate reduction is more likely to attract a greater increase in the volume of traffic for an individual operator.

[32] Speed is of value to a shipper only insofar as it affects transit time. The value of reduced transit time to a shipper is not a continuous function of time. For many point-to-point movements, all that is desired by shippers is overnight service. Thus, for routes under 350 miles, time saving from greater truck speeds is of no value to the shipper since earlier arrival of goods must await opening of warehouses and shops in the morning. These short hauls greatly diminish the value of greater truck speeds through improvements in highways or technological advances in rolling stock.

[33] The allowance is granted the shipper if he delivers his goods directly to the terminal rather than have the truck operator perform this function.

VI. An Index of Motor Freight Rates, 1956 to 1959

The motor freight rate index constructed in this study refers to the set of all common carrier truckload freight shipments in the Central States territory. The methods used in estimating the weights and price relatives for the individual commodity groups were described in Sections IV and V above. The price relatives were combined into a single motor freight rate index by substituting the estimated weights, W_j, and the price relatives, X_{jt}, into the Laspeyres formula defined in equation (2.1). The index was benchmarked to a base period of 1957, even though the weights apply to the average quantities shipped during the three years, 1956–58.

Table 6.—*Indexes of Motor Freight Rates for the Central States Territory, Classified by Major Commodity Class*

[1957=100]

Year and month	Products of agriculture	Animals and products	Products of mines	Products of forests	Manufactures and miscellaneous	All products
1956—January	90.4	89.8	89.1	89.1	90.8	90.7
February	90.4	89.8	89.1	89.1	91.5	91.4
March	90.4	89.8	89.1	89.1	91.5	91.4
April	90.4	89.8	89.1	89.1	91.5	91.4
May	90.4	90.5	91.8	89.1	93.3	93.1
June	91.2	91.9	93.7	94.4	95.3	95.1
July	91.2	92.3	93.7	94.4	95.4	95.2
August	91.1	93.7	93.7	94.4	95.8	95.6
September	91.1	93.8	93.7	94.4	95.8	95.7
October	91.1	93.8	93.7	94.4	96.6	96.4
November	91.1	93.8	93.7	94.4	96.6	96.4
December	91.2	94.4	94.5	94.4	96.6	96.5
Average	90.8	91.9	92.1	92.2	94.2	94.1
1957—January	91.2	94.4	94.5	94.4	96.6	96.5
February	91.2	94.4	94.5	94.4	96.7	96.5
March	100.4	101.1	101.1	101.1	100.4	100.4
April	101.9	101.1	101.1	101.1	100.4	100.4
May	101.9	101.1	101.1	101.1	100.6	100.6
June	101.9	101.1	101.1	101.1	100.6	100.6
July	101.9	101.1	101.1	101.1	100.6	100.6
August	101.9	101.1	101.1	101.1	100.6	100.6
September	101.9	101.1	101.1	101.1	100.9	100.9
October	101.9	101.1	101.1	101.1	100.9	100.9
November	101.9	101.1	101.1	101.1	100.9	100.9
December	101.9	101.1	101.1	101.1	100.9	101.0
Average	100.0	100.0	100.0	100.0	100.0	100.0
1958—January	101.9	101.1	101.1	101.1	100.9	101.0
February	101.9	101.1	101.1	101.1	100.9	100.9
March	101.9	101.1	101.1	101.1	100.9	100.9
April	101.9	101.1	101.1	101.1	101.3	101.3
May	101.9	101.1	101.1	101.1	101.6	101.5
June	101.9	101.1	101.1	101.1	101.6	101.6
July	101.9	101.0	101.1	101.1	101.6	101.5
August	100.6	101.0	101.1	101.1	101.6	101.5
September	107.2	106.6	107.6	108.2	105.5	105.6
October	107.2	106.6	107.6	108.2	105.5	105.6
November	107.2	106.6	107.6	108.2	105.6	105.4
December	107.2	106.6	107.6	108.2	105.6	105.7
Average	103.6	102.9	103.3	103.5	102.7	102.7
1959—January	107.2	106.6	107.6	108.2	105.6	105.7
February	107.2	106.6	107.6	108.2	106.1	106.2
March	107.2	106.8	107.6	108.2	107.1	107.1
April	107.2	106.8	107.6	108.2	107.1	107.1
May	107.2	106.8	107.6	108.2	107.1	107.1
June	107.2	106.8	107.6	108.2	107.1	107.1
July	107.2	106.8	107.6	108.2	107.1	107.1
August	107.2	106.8	107.6	108.2	107.1	107.1
September	107.2	106.8	107.6	108.2	107.2	107.2
October	107.2	106.8	107.6	108.2	107.2	107.2
November	107.2	106.8	107.6	108.2	107.2	107.2
December	107.2	106.8	107.6	108.2	107.2	107.2
Average	107.2	106.8	107.6	108.2	106.9	106.9

The index for "All Commodities" is presented in column 6 of Table 6. Next, the set of all 170 individual commodities was classified into five major commodity groups. As a result, freight rate indexes could be constructed for each major commodity group. Since over 92 percent of total freight revenues are generated by "Manufactures," movements in the "Manufactures" index dominates the "All Commodities" index. A finer breakdown was obtained by using the commodity classification employed by the Wholesale Price Index. Freight rate indexes by this latter classification are shown in Table 7.

TABLE 7.—*Indexes of Motor Freight Rates for the Central States Territory, Classified by Major Wholesale Commodity Group*

[1957=100]

Year and month	Farm products	Processed foods	Textile products and apparel	Hides, skins, and leather products	Fuel, power, and lighting materials	Chemicals and allied products	Rubber and rubber products	Lumber and wood products
1956—January	89.4	89.5	88.8	89.1	98.7	89.5	89.1	89.1
February	89.4	89.5	88.8	89.1	98.7	89.5	89.1	89.1
March	89.4	89.5	88.8	89.1	98.7	89.5	89.1	89.1
April	89.4	89.5	88.8	89.1	98.7	89.5	89.1	89.1
May	89.4	92.3	90.5	89.1	99.4	94.0	95.6	89.1
June	91.1	93.3	94.4	94.4	99.4	94.5	95.6	94.4
July	91.1	93.5	94.4	94.4	99.4	94.5	95.6	94.4
August	92.3	94.2	96.0	94.4	99.3	94.9	95.6	94.4
September	92.3	94.3	96.0	94.4	99.3	94.9	95.6	94.4
October	92.3	94.3	96.0	94.4	99.3	94.9	95.6	94.4
November	92.3	94.4	96.0	94.4	99.3	94.9	95.6	94.4
December	92.4	94.7	96.0	94.4	99.3	94.9	95.6	94.4
Average	90.9	92.4	92.9	92.2	99.1	92.9	93.4	92.2
1957—January	92.4	94.7	96.0	94.4	99.3	94.9	95.6	94.4
February	92.4	94.7	96.0	94.4	99.3	95.5	95.6	94.4
March	101.5	101.0	100.8	101.1	100.1	101.0	100.2	101.1
April	101.5	101.1	100.8	101.1	100.1	101.0	100.2	101.1
May	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
June	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
July	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
August	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
September	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
October	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
November	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
December	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
Average	100.0	100.0	100.0	100.0	100.0	100 0	100.0	100.0
1958—January	101.5	101.1	100.8	101.1	100.1	101.0	101.1	101.1
February	101.5	101.1	100.8	101.1	99.9	101.0	101.1	101.1
March	101.5	101.1	100.8	101.1	99.9	101.0	101.1	101.1
April	101.5	101.1	100.8	101.1	99.9	101.0	101.1	101.1
May	101.5	101.1	100.8	101.1	101.9	101.0	101.1	101.1
June	101.5	101.1	100.8	101.1	101.9	101.0	101.1	101.1
July	101.5	101.0	100.8	101.1	101.9	101.0	101.1	101.1
August	100.5	101.0	100.8	101.1	101.9	101.0	101.1	101.1
September	108.0	106.4	108.2	108.2	102.7	107.1	105.1	108.2
October	108.0	106.6	108.2	108.2	102.7	107.1	105.1	108.2
November	108.0	106.6	108.2	108.2	102.7	107.1	108.0	108.2
December	108.0	106.6	108.2	108.2	102.7	107.1	108.0	108.2
Average	103.6	102.9	103.3	103.5	101.5	103.0	102.9	103.5
1959—January	108.0	106.6	108.2	108.2	102.7	107.1	108.0	108.2
February	108.0	106.6	108.2	108.2	111.5	107.1	108.0	108.2
March	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
April	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
May	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
June	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
July	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
August	108.0	106.7	108.2	108.2	115.9	107.1	108.0	108.2
September	108.0	106.7	108.2	108.2	115.9	108.5	108.0	108.2
October	108.0	106.7	108.2	108.2	115.9	108.5	108.0	108.2
November	108.0	106.7	108.2	108.2	115.9	108.5	108.0	108.2
December	108.0	106.7	108.2	108.2	115.9	108.5	108.0	108.2
Average	108.0	106.7	108.2	108.2	114.5	107.6	108.0	108.2

TABLE 7.—*Indexes of Motor Freight Rates for the Central States Territory, Classified by Major Wholesale Commodity Group*—Continued

[1957=100]

Year and month	Pulp paper and allied products	Metals and metal products	Machinery and motive products	Furniture and other household durables	Nonmetallic minerals—structural	Tobacco manufactures and bottled beverages	Miscellaneous products	All commodities
1956—January	88.9	92.8	89.9	89.1	88.7	89.6	89.0	90.7
February	88.9	92.8	91.6	89.1	88.7	89.6	89.0	91.4
March	88.9	92.8	91.6	89.1	88.7	89.6	89.0	91.4
April	88.9	92.8	91.6	89.1	88.7	89.6	89.0	91.4
May	91.1	93.0	92.9	91.0	93.2	90.3	89.6	93.1
June	93.6	98.2	94.0	94.6	94.4	94.8	94.5	95.1
July	93.7	98.2	94.1	94.6	94.4	94.8	94.5	95.2
August	96.0	98.3	94.4	94.9	95.5	95.0	94.9	95.6
September	96.0	98.5	94.4	94.9	95.5	95.0	94.9	95.7
October	96.0	98.5	96.4	94.9	95.5	95.0	94.9	96.4
November	96.0	98.5	96.4	94.9	95.5	95.0	94.9	96.4
December	96.3	98.5	96.4	94.8	95.6	95.0	94.9	96.5
Average	92.8	96.1	93.6	92.6	92.9	92.8	92.4	94.1
1957—January	96.3	98.5	96.4	94.8	95.6	94.9	94.9	96.5
February	96.3	98.5	96.4	94.8	95.6	94.9	94.9	96.5
March	100.7	100.4	100.1	101.0	100.7	101.3	101.0	100.4
April	100.7	100.3	100.1	101.0	100.7	101.3	101.0	100.4
May	100.7	100.3	100.5	101.0	100.7	101.3	101.0	100.6
June	100.7	100.3	100.5	101.0	100.7	101.3	101.0	100.6
July	100.7	100.3	100.5	101.0	100.7	100.8	101.0	100.6
August	100.7	100.3	100.5	101.0	100.7	100.8	101.0	100.6
September	100.7	100.3	101.3	101.0	100.7	100.8	101.0	100.9
October	100.7	100.3	101.3	101.0	100.7	100.8	101.0	100.9
November	100.7	100.3	101.3	101.0	100.7	100.8	101.0	100.9
December	100.7	100.3	101.3	101.0	102.2	100.8	101.0	101.0
Average	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1958—January	100.7	100.3	101.3	101.0	102.2	100.8	101.0	101.0
February	100.7	100.3	101.3	101.0	102.2	100.8	101.0	100.9
March	100.7	100.3	101.3	101.0	102.2	100.8	101.0	100.9
April	100.7	100.3	102.2	101.0	102.2	100.8	101.0	101.3
May	100.7	100.3	102.5	101.0	102.2	100.8	101.0	101.5
June	101.7	100.3	102.5	101.0	103.2	100.8	101.0	101.6
July	100.7	100.3	102.5	101.0	102.1	100.8	101.0	101.5
August	100.7	100.3	102.5	101.0	103.0	100.8	101.0	101.5
September	108.4	102.9	105.6	109.1	107.2	108.5	109.7	105.6
October	108.4	102.9	105.6	109.1	107.2	108.5	109.7	105.6
November	108.4	102.9	105.6	109.1	107.2	108.5	109.7	105.4
December	108.4	102.9	105.6	109.1	107.2	108.5	109.7	105.7
Average	103.3	101.2	103.2	103.7	104.0	103.5	103.9	102.7
1959—January	108.4	102.9	105.6	109.1	107.2	108.5	109.7	105.7
February	108.4	102.9	105.6	109.1	107.2	108.5	109.7	106.2
March	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
April	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
May	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
June	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
July	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
August	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.1
September	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.2
October	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.2
November	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.2
December	108.4	103.0	107.2	109.1	107.2	108.5	109.7	107.2
Average	108.4	103.0	106.9	109.1	107.2	108.5	109.7	106.9

As mentioned in Section V, freight rates were sampled from three kinds of tariffs: (1) class, (2) general commodity, and (3) special. Separate freight rate indexes were constructed for each kind of tariff and presented in Table 8. During the four-year period, the class tariff was increased three times, in June 1956, March 1957, and September 1958. The cumulative increase over the entire period was 21.4 percent. Although more frequent changes are observed for the General Commodity rates, the major increases again occur at three points in time. The cumulative increase of 21.7 percent from January 1956, to December 1959, is roughly comparable to the class tariff. Even though the revisions to the General Commodity Tariff are more

TABLE 8.—*Indexes of Motor Freight Rates for the Central States Territory, Classified by Type of Tariff*

[1957=100]

Year and month	Class rates	Commodity rates	Special rates
1956:			
January	89.1	88.5	93.6
February	89.1	88.5	95.1
March	89.1	88.5	95.1
April	89.1	88.5	95.1
May	89.1	92.7	95.1
June	94.4	93.8	96.9
July	94.4	93.9	96.8
August	94.4	94.9	96.8
September	94.4	94.9	96.8
October	94.4	94.9	98.7
November	94.4	94.9	98.8
December	94.4	95.1	98.8
Average	92.2	92.4	96.5
1957:			
January	94.4	95.1	98.8
February	94.4	95.1	98.9
March	101.1	101.0	99.7
April	101.1	100.9	99.7
May	101.1	101.0	100.0
June	101.1	101.0	100.0
July	101.1	101.0	100.0
August	101.1	101.0	100.0
September	101.1	101.0	100.7
October	101.1	101.0	100.7
November	101.1	101.0	100.7
December	101.1	101.1	100.7
Average	100.0	100.0	100.0
1958:			
January	101.1	101.1	100.7
February	101.1	101.1	100.7
March	101.1	101.1	100.7
April	101.1	101.1	101.6
May	101.1	101.3	101.9
June	101.1	101.4	101.9
July	101.1	101.3	101.9
August	101.1	101.4	101.9
September	108.2	107.5	101.9
October	108.2	107.5	102.0
November	108.2	107.1	102.0
December	108.2	107.7	102.0
Average	103.5	103.3	101.6
1959:			
January	108.2	107.7	102.0
February	108.2	107.7	103.2
March	108.2	107.7	105.3
April	108.2	107.7	105.3
May	108.2	107.7	105.3
June	108.2	107.7	105.3
July	108.2	107.7	105.3
August	108.2	107.7	105.3
September	108.2	107.7	105.6
October	108.2	107.7	105.6
November	108.2	107.7	105.6
December	108.2	107.7	105.6
Average	108.2	107.7	104.9

frequent, in the main the two tariffs, both published by the CSMFB, move together through time. Finally, the special tariffs which apply for the specialized carriers of vehicles, bulk liquids, and steel do not exhibit the same sharp jumps which characterized the other two tariffs. In addition, the cumulative increase over the four years was only 12.8 percent compared to an approximate 21 percent increase for the other two tariffs.

The modest increase in the index of special freight rates can be partially explained by the behavior of vehicle freight rates which accounts for over half of this index. For all makes of autos, other than Fords, rates are quoted on a "per hundredweight" (per cwt.) base, while rates on Fords are quoted on a "per vehicle" base. For

these operators, costs are related to the carrying capacity of the equipment as measured by number of vehicles; indeed, if the number of autos which can be loaded onto a single vehicle carrier remains fixed, variations in the aggregate weight of the autos by as much as 20 percent will have little influence on costs. The secular increase in the average weight of an auto has led to an automatic escalation in revenues for those operators who quote a per cwt. rate. Consequently, the per cwt. rate has increased at a slower rate than the per vehicle rate. This is shown in Table 9 by the first two rows which show

TABLE 9.—*Actual and Implied Freight Rates for Automobiles*

	Average annual index			
	1956	1957	1958	1959
Actual hundredweight rate	95.4	100.0	103.3	104.3
Actual vehicle rate (Ford)	93.0	100.0	110.0	113.0
Implied vehicle rate (all makes)	94.7	100.0	100.0	107.8
Implied vehicle rate (Ford)	93.8	100.0	102.6	107.5

the rate relatives for the two alternative freight rates. An implied per vehicle rate for "all makes other than Fords" was constructed by multiplying the per cwt. rate by the average vehicle weight for the corresponding model year.[34] Finally, an implied per vehicle rate was constructed for Fords in the same manner. This last rate relative, the fourth row of Table 9, tells us the relative freight rate which would have been paid by Ford shippers if they had shipped on a per cwt. base. The two implied per vehicle rates correspond quite closely to the actual per vehicle rate for Fords. Clearly, if all freight rates for auto shipments had been quoted on a per vehicle base, the secular increase in the index of special freight rates would have been substantially greater. In this study, a weighted average of the per cwt. and per vehicle rates was used to obtain the price relative for all "Motor Vehicles."

The behavior of the freight rate indexes, classified by commodity groups (Table 7), is influenced by the relative importance of class rates. Some or all of the commodities included in each commodity group were assumed to move solely on class rates. Hence, the 15 commodity groups differ substantially in the relative weight given to the class tariff. Where the relative importance of the class tariff is greatest, one would expect to find the greatest percentage increases in the freight rate index.[35] For the 15 commodity groups, the rank correlation between these two variables was found to be 0.591.[36]

Finally, the motor freight rate index for the Central States was compared to the rail carload freight rate index for the 3 years for which data were available. This comparison is shown in Table 10. For "All Commodities," the increase in the motor freight rate index was slightly higher than the rail index. The motor freight rate index showed a slightly smaller increase than the rail for only one com-

[34] The implied rate relative was adjusted to make the average for 1957 equal to 100.

[35] Over the 4-year period, the percentage increase in the commodity tariff was slightly higher than that for the class tariff. However, the individual commodity rates ranged from increases of 7.2 to 34.5 percent over the entire period.

[36] Against the null hypothesis of zero correlation, the critical value of the rank correlation coefficient at a 5-percent level of significance is 0.440.

TABLE 10.—*Comparison Between Motor Freight Rate Index and the Railroad Carload Freight Index, by Major Commodity Groups*

[1957=100]

	1956		1958	
	Railroad carload	Motor freight	Railroad carload [1]	Motor freight
All commodities	94.9	94.1	102.5	102.7
Products of agriculture	95.7	90.8	101.7	103.6
Animals and products	94.3	91.9	99.2	102.9
Products of mines	95.6	92.1	102.6	103.3
Products of forests	94.3	92.2	102.4	108.2
Manufactures and miscellaneous	94.1	94.2	103.4	102.7

[1] Preliminary estimates.

modity group, "Manufactures." However, this group accounted for over 92 percent of all truckload freight revenues in the Central States territory.

TABLE 11.—*Indexes of Motor Freight Rates for 21 Important Commodities Using Single-Year and Three-Year Average Weights*

[1957=100]

Month and year	1956–58 average weights	1957 weights	Difference
January 1956	91.34	91.39	0.05
July 1956	95.59	95.59	.00
January 1957	97.03	97.46	.43
March 1957	100.54	100.48	−.06
May 1957	100.76	100.73	−.03
July 1957	100.76	100.73	−.03
September 1957	101.19	101.21	.02
November 1957	101.19	101.21	.02
January 1958	101.19	101.21	.02
July 1958	102.11	102.17	.06
January 1959	105.33	105.19	−.14
July 1959	107.09	107.02	−.07
December 1959	107.09	107.02	−.07

Thus far, the discussion has focused on the estimation of the price relatives and their impact on various motor freight rates. The accuracy of the index also depends on the accuracy with which the weights are estimated. In Section IV, an inspection of the data in Table 2 suggested that the share of revenue generated by each commodity remained fairly stable—at least for the 3 years for which data were available. For all 170 commodities, the average share of total revenue, for the 3 years 1956 to 1958, was correlated with the share of total revenue for a single year, 1957.[37] The correlation coefficient was 0.9894. Since the weights varied widely, from 0.007 to 26.662, one would expect an extremely high correlation. The sensitivity of the index to variations in the weights is more clearly demonstrated in Table 11. Here the motor freight rate indexes for the 21 most important commodities[38] were constructed by using (1) the 3-year average weights, 1956–58, and (2) the single-year weights, 1957. The indexes were computed to two decimal points to demon-

[37] Since the first variable includes the second, some positive correlation will be induced.
[38] Each commodity included in this index generated over 1 percent of total freight revenues.

strate the differences. The maximum deviation was 0.43 points. Thus, use of single-year weights would have generated roughly the same index as that obtained by using the 3-year average weights.

In conclusion, the primary purpose of this study was to propose a method for the construction of a freight rate index. The proposed method was applied in the construction of a motor freight rate index for common carrier truckload freight in the Central States territory. The validity of the index has not been checked.[39] The shortcomings of the motor freight rate index presented in this study are evident to the authors. These include:

1. In obtaining the freight rate data, it was often necessary to exercise personal judgment in assigning commodities to tariffs. Logically, the tariff from which the rates are sampled should apply for the majority of the shipments of that commodity. This element of judgment could be avoided by an analysis of waybills, classified by commodity and type of tariff.

2. The waybill statistics from which the weights were estimated are only applicable to truckload shipments. In the Central States Motor Freight Bureau, approximately 60 percent of all freight revenues are generated by less than truckload shipments. This omission makes it impossible to extend the index to all common carrier traffic. However, since virtually all L.T.L. shipments are moved on class rates, the estimation of the price relatives should be relatively simple.

3. The effect of distance on the behavior of freight rates was completely neglected in the present study. For those commodities moving on class rates, this omission is not serious, since the same percentage increase was applied to all rates. If all rates are increased by the same nominal amount, as was done in June 1960, then the distance variable must be explicitly considered. The importance of distance is further emphasized by the changes over time of the differentials in the costs per ton-mile as a function of the distance of shipments.

4. The rates published by the Central States Motor Freight Bureau were assumed to be representative for all general commodity common carriers. This assumption would be appropriate if either (1) the independent carriers as a whole are extremely small relative to all common carriers in the territory, or (2) the rate changes by the independents mirror the rate changes by the Bureau.

5. The index was based on a sample of 240 individual freight rates, together with the overall increases in the class tariff and the special commodity tariff for "Iron and Steel Products." Perhaps too little attention was given to the other special commodity tariffs. However, in the absence of waybill data of the kind suggested in point (1) above, this question cannot be resolved. The dangers from the small sample size as well as use of Tariff 555 were described in Section V.

Despite these shortcomings, we feel that the index is representative of the movements in motor freight rates for the Central States ter-

[39] The index could be checked against a sample of waybills. A random sample of waybills at one point in time could be coupled with the waybills for identical shipments at a second point in time. The average rate change, estimated from the waybills, could then be compared to the index.

ritory. If these shortcomings could be corrected, then we believe the method employed in estimating this index is the appropriate method for the construction of a freight rate index.

VII. Recommendations for the Compilation of Freight Rate Indexes

In Section II of this study, a conceptual framework was developed for the construction of a freight rate index of all "For Hire" transport services. The implementation of this method would involve the following steps:

1. The set of all "For Hire" transport services must be classified into traffic categories where each category designates (1) mode of transportation, (2) commodity, (3) distance transported, and (4) geographic region.

2. According to this method, the weight for each traffic category is equal to the share of total freight revenues generated by shipments in that traffic category. These weights must be estimated from a waybill sample for all "For Hire" carriers.

3. The average rate change or price relative for each traffic category must be estimated from a sample of freight rates. The proposed method also outlined an optimal sampling scheme. This sampling scheme requires one additional piece of information, the variance of price relatives within each traffic category. An intimate knowledge of the market for transportation services may provide fairly accurate a priori estimates of these variances.

If the method were adopted, it would be possible to construct a number of freight rate indexes by taking different combinations of the individual traffic categories. For example, indexes, by each mode of transportation, could be constructed for "short-haul" and "long-haul" traffic by classifying the traffic categories by distance and mode.

The proposed method would require the collection of a substantial volume of additional data which are not currently collected by the regulatory authorities. At present, two acceptable freight rate indexes are published. The rail carload freight rate index, published by the ICC, provides separate freight rate indexes for (1) commodity groups, (2) territories, and (3) interstate versus intrastate movements. Second, the Agricultural Marketing Service publishes freight rate indexes for the rail shipments of various agricultural commodities. The other so-called freight rate indexes are simply indexes of the average revenue per ton-mile.

The problems currently facing the transportation industry place higher demands on certain subindexes of an all-inclusive freight rate index. The specific problems which we have in mind are (1) the decline of the railroads, and (2) the rapid growth of private carriage in highway transportation. An analysis of these problems would be aided by the following additional freight rate indexes.

1. Rail Carload Freight Rate Index by Mileage Blocks: Given the present ICC rail carload freight rate index, all the data required to construct this index are available. The traffic categories need only be classified by mileage blocks and the indexes computed. These in-

dexes would reveal the relative changes in "short-haul rates" versus "long-haul rates."

2. Motor Freight Rate Indexes for all Common and Contract Carriers by (a) Commodity, (b) Mileage Block, and (c) Territory: If the method outlined in Section II is followed, waybill statistics would be required at only periodic intervals—say each 5 years. The waybill sample would first be classified by commodity, mileage block, and territory to estimate the weights for the index. Second, within each traffic category, the waybills can be classified by the type of tariff from which the freight rate was taken. This second step reveals the source from which subsequent freight rates should be sampled. Although the number of operators in highway transportation is substantially greater than in rail, the presence of the ratemaking bureaus greatly reduces the number of pertinent tariffs. This procedure eliminates the necessity for a continuing waybill sample. Furthermore, if the weights are adjusted at periodic intervals, the index can be adjusted to reflect shifts in the composition of highway transport services.

3. An Implicit Index of Self-Produced Truck Transport Services: For those shippers who choose to produce their own transport services with private fleets, the relevant freight rate is some measure of user costs. Specifically, it is the cost per ton-mile of operating the private fleet.

The cost studies for common and contract carriers can be extended to private carriers. Some modifications would be required to account for differences in utilization or load factors, possible use of nonunion drivers, commodities transported, etc.

Additional freight rate indexes would be desirable for other current problems in transportation. For example, an index of airfreight rates, together with an index of railway express rates, would be useful in analyzing the rapid growth of air cargo. Also, relatively little work has been done in the area of freight rates for waterborne transportation. However, rail and highway transportation still account for the bulk of the transportation industry. Hence, we feel that priority should be given to the highway area, where data are presently meager.

APPENDIX A

COMMODITY COMPOSITION FOR THE INDEX OF MOTOR FREIGHT RATES

Commodity	Weight [1] (1956–58 average)	Weight [1] 1957	Percent rate change, January 1956 to December 1959	Number of rates sampled	Tariff classification
CLASS TARIFF					
Products of agriculture, seeds	0.029	0.039	21.4	[2]	1
Animals and products:					
Dairy products NOS	.089	.111	21.4	[2]	1
Wool and mohair in grease	.068	.012	21.4	[2]	1
Wool and mohair NOS	.011	.007	21.4	[2]	
Hides, skins and pelts	.060	.077	21.4	[2]	1
Leather NOS	.086	.086	21.4	[2]	1
Poultry, dressed and frozen	.166	.148	21.4	[2]	1
Poultry, live	.010	.002	21.4	[2]	1
Margarine NOS	.251	.222	21.4	[2]	1
Products of mines:					
Stone, rough NOS	.034	.062	21.4	[2]	1
Stone and rock, crushed	.019	.021	21.4	[2]	1
Stone, finished NOS	.058	.082	21.4	[2]	1
Aluminum ore and concentrate	.011	.012	21.4	[2]	1
Ores and concentrates	.038	.042	21.4	[2]	1
Clay and bentonite	.049	.049	21.4	[2]	1
Sand, industrial	.021	.027	21.4	[2]	1
Products of forests:					
Rosin and turpentine	.014	.019	21.4	[2]	1
Lumber shingles and lath	.102	.116	21.4	[2]	1
Box crate	.028	.027	21.4	[2]	1
Veneer plywood	.092	.069	21.4	[2]	1
Manufacturing and miscellaneous:					
Sewer pipe and drain tile	.127	.116	21.4	[2]	1
Artificial stone	.023	.030	21.4	[2]	1
Brick, NOS and building tile	.181	.165	21.4	[2]	1
Brick, common	.042	.508	21.4	[2]	1
Cement, NOS	.164	.167	21.4	[2]	1
Cement, natural and portland	.091	.119	21.4	[2]	1
Manufacturing tobacco NOS	.049	.056	21.4	[2]	1
Building, houses fabricated, portable	.244	.194	21.4	[2]	1
Guns, small arms NOS	.039	.023	21.4	[2]	1
Airplanes, craft and parts	.077	.068	21.4	[2]	1
Ammunition and explosives	.332	.262	21.4	[2]	1
Refractories	.178	.211	21.4	[2]	1
Newsprint paper	.032	.015	21.4	[2]	1
Printed matter	1.013	.944	21.4	[2]	1
Insulating materials	.282	.272	21.4	[2]	1
Building woodwork and millwork	.071	.083	21.4	[2]	1
Building materials	.539	.272	21.4	[2]	1
Asbestos articles	.084	.110	21.4	[2]	1
Furnaces, heaters, parts	.562	.510	21.4	[2]	1
Bathroom, lavatory fixtures	.360	.387	21.4	[2]	1
Floor covering	.662	.676	21.4	[2]	1
Woodenware	.030	.034	21.4	[2]	1
Chinaware, crockery	.113	.126	21.4	[2]	1
Household utensils	.067	.063	21.4	[2]	1
Refrigerators, freezers, parts	.281	.260	21.4	[2]	1
Stoves, ranges and parts	.091	.083	21.4	[2]	1
Laundry equipment	.182	.159	21.4	[2]	1
Copper, ingot, matte, pig	.044	.039	21.4	[2]	1
Copper, brass, bronze NOS	1.641	1.642	21.4	[2]	1
Aluminum NOS	1.069	1.022	21.4	[2]	1
Aluminum, bar, slab	.323	0.305	21.4	[2]	1
Magnesium metal and alloys	.060	.056	21.4	[2]	1
Alloys for steel manufacturing	.080	.069	21.4	[2]	1
Containers, wooden	.040	.035	21.4	[2]	1
Containers, NOS	.366	.356	21.4	[2]	1
Containers, fiberboard, K.D	.749	.750	21.4	[2]	1
Waste materials NOS	.097	.103	21.4	[2]	1
Waste materials for remelting NOS	.234	.236	21.4	[2]	1
Agricultural parts	.268	.261	21.4	[2]	1
Agricultural implements NOS	.127	.125	21.4	[2]	1
Food products, frozen NOS	.472	.395	21.4	[2]	1
Syrup and molasses, refined	.124	.082	21.4	[2]	1
Wallboard	.093	.088	21.4	[2]	1
Cloth and fabrics NOS	.167	.194	21.4	[2]	1
Rope cordage and binder twine	.028	.031	21.4	[2]	1
Boots, shoes and findings	.144	.119	21.4	[2]	1
Athletic, gym, NOS	.144	.143	21.4	[2]	1

See footnotes at end of table, p. 133.

Commodity Composition for the Index of Motor Freight Rates—Continued

Commodity	Weight [1] (1956–58 average)	Weight [1] 1957	Percent rate change, January 1956 to December 1959	Number of rates sampled	Tariff classification
CLASS TARIFF—continued					
Manufacturing and miscellaneous—continued					
Games and toys	.051	.044	21.4	[2]	1
Liquor, alcoholic NOS	1.665	1.581	21.4	[2]	1
Wine	.055	.052	21.4	[2]	1
Tools and parts NOS	.122	.117	21.4	[2]	1
Cotton factory products	.069	.072	21.4	[2]	1
Blacks, NOS	.309	.366	21.4	[2]	1
Synthetic fiber and yarns	.068	.070	21.4	[2]	1
Tanning materials	.028	.028	21.4	[2]	1
Food animals and poultry NOS	.164	.115	21.4	[2]	1
COMMODITY TARIFF					
Products of agriculture:					
Fruits, dried NOS	.010	.007	13.0	1	2
Rice	.020	.014	20.0	1	2
Peanuts	.008	.006	20.0	1	2
Vegetables, fresh frozen	.059	.061	7.2	1	2
Beans and peas, dried	.013	.007	21.9	1	2
Vegetables, fresh, not frozen	.012	.010	22.2	1	2
Potatoes, not sweet	.011	.005	22.2	1	2
Coffee	.126	.107	20.1	3	2
Fruits and berries, fresh	.043	.029	21.6	1	2
Cereal food preparations NOS	.030	.033	20.0	1	2
Flour, edible NOS	.113	.100	20.0	3	2
Flour, wheat	.022	.020	20.0	1	2
Vegetable and nut oil	.026	.026	14.0	1	2
Animals and products:					
Meats, cooked, cured	.347	.357	13.0	3	2
Fish and animal oil	.031	.007	22.2	1	2
Sea food NOS	.072	.051	14.0	1	2
Butter	.455	.475	11.6	2	2
Eggs	.146	.152	23.3	2	2
Packing house products, edible NOS	.333	.214	16.6	3	2
Cheese	.288	.251	16.0	3	2
Meats, fresh NOS	2.361	2.120	20.6	8	2
Products of mines:					
Salt	.115	.128	13.0	2	2
Asphalt	.281	.284	21.8	3	2
Sulphur	.007	.008	20.7	1	2
Petroleum, crude	.017	.016	21.3	1	2
Manufactures and miscellaneous:					
Fertilizers	.104	.144	23.4	1	2
Oils NOS	.058	.056	21.3	1	2
Food products NOS (cans, not frozen)	2.387	2.205	21.3	6	2
Cigarettes	.253	.256	12.3	3	2
Starch	.056	.053	15.9	1	2
Gases, other than petroleum	.107	.142	21.4	2	2
Cotton cloth and cotton fabric NOS	.157	.172	17.3	2	2
Bagging, burlap NOS	.028	.034	13.0	1	2
Chemicals NOS	2.435	3.197	20.8	7	2
Drugs, medicines and toilet preparations	.810	.756	20.8	3	2
Liquors, malt	.085	.079	20.0	1	2
Beverages	.046	.037	14.7	1	2
Sugar	.215	.148	13.6	1	2
Candy and confectionery	.754	.711	13.4	1	2
Lead, zinc, bar ingot, pig	.096	.108	21.2	1	2
Lead and zinc NOS	.120	.124	20.8	1	2
Metals and alloys NOS	.287	.268	18.3	3	2
Paper bags	.158	.169	13.0	2	2
Scrap paper and rags	.046	.043	22.2	1	2
Printing paper NOS	.432	.388	18.5	3	2
Wrapping paper	.289	.275	22.2	1	2
Paper and paper articles	.686	.597	34.5	2	2
Glass	.705	.706	14.0	4	2
Plastics	1.696	1.647	20.8	4	2
Lubricating oils and greases	.560	.551	19.3	4	2
Insecticides and fungicides	.129	.129	22.0	1	2
Paint varnish and putty	1.412	1.370	18.8	5	2
Tar pitch and creosote	.140	.180	20.3	2	2
Cellulose articles	.181	.099	16.7	2	2
Sodium (Soda) products	.455	.511	15.1	3	2
Rubber, crude, natural, synthetic	.793	.833	21.5	4	2
Soap, cleaning and washing compounds	1.354	1.283	20.9	4	2

See footnotes at end of table, p. 133.

Commodity Composition for the Index of Motor Freight Rates—Continued

Commodity	Weight [1] (1956–58 average)	Weight [1] 1957	Percent rate change, January 1956 to December 1959	Number of rates sampled	Tariff classification
COMMODITY TARIFF—continued					
Manufacturers and Miscelaneous—Continued					
Abrasives, not crude	.168	.169	23.0	1	2
Furniture and parts	.097	.100	21.4	1	2
Furniture, NOS	.260	.231	21.6	3	2
Containers, metal	.221	.200	21.6	3	2
Containers, returned empty	.125	.137	21.7	2	2
Matches	.062	.065	13.9	1	2
Rubber goods NOS	.350	.392	19.7	3	2
Tires, tubes, rubber	.852	.850	21.6	1	2
Paperboard, fiberboard, pulpboard	.502	.487	16.1	4	2
Building paper, NOS	.665	.609	16.1	4	2
Electrical equipment, parts NOS	2.628	2.633	21.2	5	2
Hardware NOS	.248	.236	19.5	2	2
Glass bottles and glassware	.989	.753	24.4	6	2
Cast iron and pipe fittings	.160	.159	13.8	2	2
Iron and steel pipe and fittings NOS	.891	.965	7.6	4	2
Machinery and machines	2.723	2.855	21.5	8	2
Machinery parts	1.352	1.422	21.3	4	2
Vehicle parts	6.497	5.690	22.3	9	2
Railroad equipment, parts	.023	.023	15.8	1	2
Plaster, stucco	.018	.018	21.6	1	2
Vehicles, not motor	.328	.262	20.9	3	2
Tanks, NOS	.079	.080	21.3	1	2
Oil foot sediment	.013	.001	21.7	1	2
SPECIAL TARIFFS					
Manufacturing iron and steel	5.865	5.902	6.0	[3]	3
Iron and steel NOS	4.241	3.689	6.0	[3]	3
Iron, pig	.026	.027	6.0	[3]	3
Iron, steel, billot, bloom ingot	.221	.223	6.0	[3]	3
Iron and steel, bar rod slab	1.349	1.357	6.0	[3]	3
Scrap iron and steel	.056	.050	6.0	[3]	3
Iron and steel borings and turnings	.050	.040	6.0	[3]	3
Iron and steel nails and wire NOS	.697	.668	6.0	[3]	3
Petroleum products, refined NOS	.915	.919	15.0	4	3
Fuel, petroleum, residual oils NOS	1.874	1.736	18.5	6	3
Gasoline	2.350	2.329	17.1	7	3
Acids	.580	.544	34.6	3	3
Oils, vegetable	.165	.146	25.6	2	3
Motor vehicles	7.743	8.874	14.9	8	3

[1] Weights denote percent of total revenues as taken from *Motor Carrier Freight Commodity Statistics; Class I Common and Contract Carriers of Property*. Years ended 1956, 1957, 1958. Interstate Commerce Commission, Bureau of Transport Economics and Statistics.
[2] Class rates.
[3] Iron and steel tariff.

Appendix B

Published Freight Rate Indexes

A search of the available statistics revealed that two acceptable freight rate indexes are currently published. Brief descriptions of these indexes are included below. The other so-called freight rate indexes uncovered in this search were found to be indexes of the average revenue per ton mile. These average revenue indexes are presented in Table B-1. In addition, the Consumers' Price Index includes a component for the transportation of household goods as well as components for the movement of persons. These CPI indexes were neglected in the present study since they do not directly relate to the movement of goods. Finally, several studies concerned with freight rate indexes are listed in the bibliography to this Appendix.

TABLE B-1.—*Indexes of the Average Revenue Per Ton-Mile by Mode of Transportation*

(1949=100)

Year	Class I rail	Class I motor carriers			Pipelines	Domestic water [1]
		Weighted average	Common carriers	Contract carriers		
1946	73.0	82.1	81.8	90.5	X	X
1947	80.4	92.5	92.5	90.4	X	X
1948	93.4	97.5	98.3	88.4	X	X
1949	100.0	100.0	100.0	100.0	100.0	100.0
1950	99.2	96.1	95.6	99.5	92.2	104.6
1951	99.7	98.8	98.8	96.9	100.5	X
1952	106.8	106.7	107.2	103.7	102.8	106.2
1953	110.4	109.7	109.4	113.8	100.9	105.9
1954	106.1	111.2	111.2	111.5	100.3	112.4
1955	102.4	110.7	110.7	115.2	101.7	116.5
1956	103.3	113.8	113.9	117.7	98.8	112.2
1957	107.9	118.4	117.1	137.0	97.0	118.5
1958	109.3	118.8	118.1	129.3	96.9	120.8

[1] This index is confined to domestic inland and coastal water transport. It is simply a revenue per ton of freight transported. The data did not permit estimation of ton-miles or other comparable output measure.

SOURCE: ICC Transport Statistics. Statistics of Class I motor freight carriers, statement 589.

A. THE RAIL CARLOAD FREIGHT RATE INDEX [40]

The rail carload freight rate index published by the ICC refers to all carload freight movements on Class I railroads. Separate freight rate indexes are available by (1) major commodity groups, (2) territory, and (3) interstate v. intrastate movements.

The index is an annual chain link index based on the 1 percent waybill sample collected from all Class I rail carriers. The waybill sample is classified into approximately 30,000 individual traffic categories where each traffic category designates (1) commodity, (2) mileage block, and (3) territory. From the waybills included in each traffic category, two quantities are computed: the total ton-miles of freight, q_0, and the average revenue per ton-mile, p_0.[41]

The index is a chain link index using the method of "constructive revenues." Thus, the index in year 1, relative to year 0, is given by:

$$I_{10}=\frac{\Sigma p_1(q_1+q_0)}{\Sigma p_0(q_1+q_0)}. \tag{B-1}$$

The numerator gives the "constructive revenue" in year 1 or the total revenues which would have been realized by Class I railroads if the average quantities shipped in years 1 and 0 (q_1+q_0) were shipped at year 1 prices, p_1. Similarly, the denominator gives the "constructive revenue" for year 0.[42] The formula, given by equation B–1, is employed in estimating the percent increase in freight rates between any two adjacent years. For example, the index in year 2, relative to year 1, I_{21}, is given by:

$$I_{21}=\frac{\Sigma p_2(q_2+q_1)}{\Sigma p_1(q_2+q_1)}. \tag{B-2}$$

[40] *Indexes of Average Freight Rates on Railroad Carload Traffic, 1948–56.* Interstate Commerce Commission, Bureau of Transport Economics and Statistics, March 1958, Washington, D.C. Statement RI–1.

[41] The subscript 0 denotes the base year 0. For the waybill sample in the i-th year, the quantities would be designated by q_i and p_i.

[42] Equation B–1 could be rewritten as the product of two terms. The first term is simply a Laspeyres price index using year 0 quantities, q_0, as weights. The second term is the ratio of (a) one plus a quantity index using year 1 prices as weights to (b) one plus a quantity index using year 0 prices as weights.

The index in year 2 relative to the base year, 0, is obtained by linking the two percentage changes.

(B-3) $$I_{20}=I_{21}I_{10}.$$

Using this method, the ICC has constructed annual rail carload freight rate indexes for the postwar period. These indexes for the major commodity groups are presented in Table B-2.

TABLE B-2.—*Rail Carload Freight Rate Indexes by Major Commodity Groups (1950=100)*

Item	Index										
	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958[1]
All commodities	93	99	100	102	109	111	109	108	112	118	121
Group I—Products of agriculture	93	98	100	102	108	110	110	109	112	117	119
Group II—Animals and products	93	99	100	102	110	113	112	112	116	123	122
Group III—Products of mines	91	98	100	102	108	109	108	107	110	115	118
Group IV—Products of forests	93	98	100	102	110	113	113	113	117	124	127
Group V—Manufacturers and miscellaneous	94	101	100	102	110	112	110	108	112	119	123
Group VI—Forwarder traffic	101	106	100	103	113	114	112	112	115	124	130

[1] Preliminary estimates.

SOURCE: *Indexes of Average Freight Rates on Railroad Carload Traffic, 1948–56*, Bureau of Transport Economics and Statistics, Interstate Commerce Commission, statement RI–1, Washington, March 1958, pp. 5–6.

The rationale for classifying the waybills into 30,000 traffic categories is to minimize the variation in freight rates between waybills in the same traffic category. However, some variance remains and is particularly large in the various "NOS" commodity groups. The ICC recognizes these residual variances by estimating a standard error of estimate for the index number. By this method, it is impossible to trace the freight rate for a specific "commodity-point-to-point" shipment through time since the waybill samples in each year are random samples.

The primary advantage of the chain link method is that it adjusts for the changing composition of rail carload traffic. The weight assigned to each traffic category is determined by the ton-miles reported on those waybills which fall into that traffic category. Variations in the weights can result from either the sampling variability inherent in the 1 percent waybill sample or actual shifts in the composition of rail carload traffic.

The danger in the use of a chain link index is that errors of measurement are locked into the index and carried in subsequent periods. If the errors of measurement are serially correlated, the index will yield a biased estimate. For any two adjacent years, the index provides an unbiased estimate of the true percentage change in freight rates; however, this need not be the case for two separated years.

In summary, the rail carload freight rate index provides a measure of the change in freight rates independent of the changes in the composition of rail carload traffic. A comparison of this index with the index of the average revenue per ton-mile reveals that the decline in the latter index is largely attributable to the loss of "high revenue" freight rather than a reduction in freight rates.

B. RAIL FREIGHT RATE INDEXES FOR FARM PRODUCTS [43]

Since 1913 the Agricultural Marketing Service has published an annual rail freight rate index for farm products as well as separate indexes for (1) wheat, (2) cotton, (3) fresh fruits and vegetables, (4) meats, and (5) livestock. The index in year t relative to the base year 0 is given by the formula:

$$(B\text{–}4) \qquad I_{t0}=\frac{\Sigma AR_t W_0}{\Sigma AR_0 W_0}$$

where AR_t and AR_0 denote the annual average freight rates [44] in years t and 0, and W_0 the weight assigned to each traffic category in the base year. Again, each traffic category designates a "commodity-point-to-point" movement. The weights are adjusted at periodic intervals to reflect shifts in the composition of rail freight movements. In the latest revision, the weights represented the average ton-mile shipments between 1947 and 1949.

The basic Laspeyres formula employed in this index was also used in our proposed method outlined in Section II of this study. Between 1948 and 1952 the movements in this fixed weight index were almost coincident with the movement of the chain link rail carload freight rate index for "Products of Agriculture." Finally, the index for farm products is the only continuous freight rate index extending over forty years.

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[43] U.S. Department of Agriculture, Agricultural Marketing Service, *Methods Used in Computing Rail Freight Rate Indexes for Farm Products*, AMS–209, Oct. 1953, pp. 3–7 (by Robert B. Reese).

[44] In estimating the annual average freight rate, adjustments are made for the seasonal variations in both shipments and rates.