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The Feasibility of a Nationwide Network for Longer Combination Vehicles

WORKING PAPER

IMPACTS OF LONGER COMBINATION VEHICLES ON RAILROADS

PREPARED BY

U.S. DEPARTMENT OF TRANSPORTATION
TRANSPORTATION SYSTEMS CENTER
KENDALL SQUARE
CAMBRIDGE, MA 02142

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STAFF STUDY

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IMPACTS OF LONGER COMBINATION VEHICLES ON RAILROADS

by

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EXECUTIVE SUMMARY

The truck productivity improvements derived from the 1982 Surface Transportation Assistance Act (STAA'82) and the possible introduction of a Longer Combination Vehicle (LCV) network will have a negative impact on the U.S. railroad industry, trucking's primary competitor. This report presents the likely effects on the railroad industry of both the STAA'82 and an LCV network. The major findings are:

- Truck productivity improvements will cause a reduction in the railroad industry's gross revenues, through diversion of traffic to trucks (roughly 75% of the effect) and as a result of lower rail rates on the truck competitive traffic retained.

- Aggregate losses from an LCV network would be roughly five times the losses from STAA'82:

  - o Ton-mile losses would be 8.5% of the industry total from LCV's; 1.9% from STAA'82;

  - o Gross revenue losses would be 14.0% of the industry total from LCV's; 2.7% from STAA'82.

- The impacts will be substantially different among commodity groups (see Table Ex-1):

  - o In the STAA'82 scenario, the loss in Mixed Shipments (TOFC/COFC) actually exceeds the total loss in traffic (some non TOFC/COFC traffic is diverted to railroads due to higher user taxes in STAA'82);

  - o In the LCV scenario, Construction Materials (Wood, Clay, Glass, Stone, and Concrete), Mixed Shipments, and Chemicals account for over 60% of total traffic losses.

  - o The greatest traffic losses due to a Longer Combination Vehicle network would be for traffic originating in the Pacific Coast states. The analysis forecasts a 30% diversion of ton-miles from this region. The second greatest change would be for traffic originating in New England where the model predicts an 18% traffic loss;

TABLE EX.1. PROJECTED RAILROAD INDUSTRY TON-MILE AND REVENUE LOSSES AS A RESULT OF THE SURFACE TRANSPORTATION ASSISTANCE ACT, 1982 AND THE INTRODUCTION OF LONGER COMBINATION VEHICLES.

	TON MILES IN BASE CASE (MILLIONS)	BASE REVENUE (MILLIONS)	PERCENT TM DIVERTED STAA'82	PERCENT REV DIVERTED STAA'82	PERCENT TM DIVERTED LCV*	PERCENT REV DIVERTED LCV*
CROPS	148,713	7,168	0%	0%	0%	0%
PRODUCE	6,138	345	-31%	-29%	-73%	-66%
MINING	409,547	19,723	0%	0%	0%	0%
FOREST	14,261	1,178	2%	3%	-3%	-5%
FOOD	85,626	6,289	-0%	-0%	-7%	-12%
TEXTILES	734	95	-23%	-29%	-53%	-57%
CONSTRUCT MAT	71,090	4,615	5%	13%	-35%	-37%
FURNITURE	1,079	217	-12%	-17%	-13%	-25%
PAPER	60,357	4,312	3%	5%	-9%	-16%
CHEMICALS	121,904	8,362	-1%	-1%	-8%	-16%
PETROLEUM	22,349	1,824	-5%	-9%	-23%	-35%
PRIM MET	52,371	3,945	7%	13%	-12%	-20%
FABR MET	2,061	246	9%	16%	-16%	-21%
MACHINERY	3,007	395	17%	22%	-28%	-32%
ELEC MACH	2,574	449	-19%	-27%	-59%	-73%
TRANSP	21,255	4,069	-4%	-7%	-10%	-14%
SCRAP	17,080	1,456	0%	0%	0%	0%
MIXED	62,780	5,028	-38%	-49%	-60%	-76%
OTHER	4,157	561	-25%	-30%	-40%	-49%
TOTAL	1,107,083	70,276	-2%	-3%	-9%	-14%

FOR EXPLANATION OF COMMODITY GROUPS, SEE TEXT.

REVENUE IS MEASURED IN 1990 DOLLARS.

*- LCV DIVERSIONS ARE FROM STAA'82 TRAFFIC LEVELS.

- Railroad earnings reductions may exceed the losses in either ton-miles or revenues:

  - o The analysis yields an estimated 25% loss in "contribution" (revenue less variable costs) for the railroad industry as a result of an LCV network;

  - o The greatest losses in railroad earnings potential (based upon contribution measures) is associated with Chemicals, Primary Metal Products, and Construction Materials.

- The effect of a Longer Combination Vehicle network would not be felt evenly across railroads:

  - o In a test case on seven railroads, where each move was costed, the individual carrier's loss in contribution from an LCV network ranged from 7% to 58% of base case contribution;

  - o Table Ex-2 shows that, using 1984 data:

    - The projected gross revenue losses ranged from a minimum of less than one percent of pre-LCV revenues to a maximum of 32%. Eight railroads had revenue losses that equalled or exceeded 20% of their pre-LCV total;

    - Eight of the 28 Class I railroads were projected to lose 50% or more of existing Return on Net Investment while five railroads were projected to lose less than 20%.

- The competitive nature of the Mixed Shipments (TOFC/COFC) market presents special problems for the rail industry:

  - o This study is consistent with the findings of other studies that have found that railroads carry this traffic at relatively low margins;

  - o Despite the existing rate/cost structure, the railroad industry expects to compete vigorously for this traffic, partly by cutting rates where necessary;

  - o Although expected diversions of this traffic are high, the overall impact on earnings is less substantial due to the existing low margins;

  - o The increases in Mixed Shipments during the period 1981-84 exceeded those projected by this study and may make the railroad industry even more vulnerable to the effects of a Longer Combination Vehicle network.

TABLE EX.2 RANKING OF CLASS I RAILROADS, 1984, BY ESTIMATED LOSS IN RETURN ON NET INVESTMENT DUE TO LCV NETWORK.

RAILROAD	PERCENT OF GROSS REVENUE LOST	LOSS IN RETURN ON NET INVESTMENT	PERCENT OF 1984 RETURN LOST#	INCREASE IN OPERATING RATIO	LOSS IN MARGIN OF SAFETY
U.S. TOTAL	-19%	-1.5	-29%	0.02	-3.0
1	-0%	-0.0	NA *	0.00 *	-0.1 *
2	-3%	-0.4	-7%	0.01	-1.1
3	-32%	-0.6	-13%	-0.09	8.8
4	-7%	-0.8	NA *	0.05 *	-7.1 *
5	-6%	-0.8	-19%	0.02	-1.8
6	-10%	-1.0	-18%	0.01	-1.2
7	-14%	-1.0	-11%	-0.01	0.3
8	-32%	-1.0	-29%	-0.00	-0.9
9	-25%	-1.2	-35%	0.02	-2.6
10	-8%	-1.3	-100%**	0.04	-3.8
11	-16%	-1.3	-39%	0.03	-3.1
12	-18%	-1.3	-34%	0.04	-4.6 **
13	-19%	-1.4	-22%	0.01	-2.4
14	-15%	-1.6	-54%	0.06	-6.5 **
15	-18%	-1.7	-37%	0.03	-4.7 *
16	-17%	-1.7	-28%	0.03	-3.4
17	-19%	-1.7	-100%**	0.06 **	-8.1 *
18	-20%	-1.8	-21%	0.03	-3.5
19	-17%	-1.9	-45%	0.05	-5.7
20	-29%	-1.9	-70%	0.05	-5.9
21	-19%	-2.0	-92%	0.05	-5.4 **
22	-28%	-2.1	-100%**	0.07 **	-8.7 *
23	-16%	-2.1	-36%	0.04	-5.3 **
24	-26%	-2.1	NA *	0.11 *	-15.6 *
25	-16%	-2.2	-33%	0.04	-4.7
26	-20%	-2.9	-100%**	0.06 **	-6.8 **
27	-18%	-6.6	NA *	0.09 *	-9.6 *
28	-19%	-6.7	-72%	0.07 **	-7.5 **

#- MAXIMUM LOSS ALLOWED = 100%. RAILROADS WITH NEGATIVE PRE-LCV RETURN ON NET INVESTMENT APPEAR WITH "NA" IN PERCENT OF NET INVESTMENT LOST.

*- INDICATES RR WITH RATE OF RETURN OR MARGIN OF SAFETY LESS THAN ZERO, OR OPERATING RATIO GREATER THAN ONE IN 1984.

**- INDICATES RR WOULD HAVE RATE OF RETURN OR MARGIN OR SAFETY FALL BELOW ZERO, OR OPERATING RATIO RISE ABOVE ONE, AS RESULT OF LCV NETWORK.

RETURN ON NET INVESTMENT = NET RAILWAY OPERATING INCOME / NET ASSET BASE.

OPERATING RATIO = RAILWAY OPERATING EXPENSES / RAILWAY OPERATING REVENUE.

MARGIN OF SAFETY = (NET REVENUE FROM OPERATIONS - FIXED CHARGES) / OPERATING REVENUE.

1.0 Introduction

Sections 138 and 415 of the Surface Transportation Act of 1982 (STAA'82) require a detailed report on the various impacts of establishing a national intercity network for Longer Combination Vehicles (LCV's). Among the impacts of the proposed higher payload trucks are changes in the economics of truck-rail competition for freight. The proposed LCV's constitute a new advantage to the trucking industry in its competition with railroads for freight traffic. This report describes the mechanisms by which the market for freight transportation would be altered, and presents estimates of the sizes of some of the more relevant railroad impacts.[1/]

The rail impacts arise because of the productivity improvement inherent in the operation of LCV's.[2/] This productivity improvement will result in truck rate reductions that will give the truck mode an opportunity to compete for freight traffic that would otherwise be moved by railroads. Faced by this changed competitive environment, railroads will either lose traffic, lower their own freight rates in order to retain

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1/ This is one of three working papers prepared by the Transportation Systems Center (TSC) in support of the final report submitted to Congress by the Federal Highway Administration entitled "The Feasibility of a Nationwide Network for Longer Combination Vehicles" dated June, 1985. The summary report made use of the information about railroad impacts presented here. The other supporting staff studies prepared as part of the overall effort are "The Highway Traffic Forecasting System -- User's Guide" by M. Nienhaus (SS-42-U6-36), hereinafter referred to as "Nienhaus," which documents the mode shift model that is a prime source of data presented in this report; and "Effects on Truck Traffic and Transportation Costs" by Domenic J. Maio (SS-42-U1-30, May, 1986) hereinafter referred to as "Maio," which reviews the truck cost changes used in analyzing the impacts of LCV's and presents detailed scenario results for the truck mode.

2/ Section 138 also required an analysis of the STAA'82 effects. Both the STAA'82 and LCV impacts on the railroad industry are discussed in this study.

their business, or experience some combination of the two effects, i.e. lose some traffic and continue to carry other traffic at reduced rates.

If railroads reduced their rates to match reductions in truck rates, there would be no change in the demand for rail services, and consequently no reduction in the railroads' costs. Revenue losses resulting from the reduced rates, therefore, would be reflected as dollar-for-dollar reductions in net operating revenues and earnings. Conversely, if railroads maintained their rates when faced with reductions in truck rates, there would be a substantial diversion of traffic from rail to truck. In that case the railroads would lose both the revenues and the variable costs associated with the diverted traffic. However, the impact on net operating revenues of this pricing strategy is less clear. A smaller traffic base means lower average densities on the rail lines and that provides a strong incentive for railroads to reduce overall plant size.

The analysis of this report assumes that even in the short run, railroads will not attempt to match all truck rate reductions, but instead will selectively cut rates in the most competitive markets. Rail rate reductions will be based on the profitability of the moves and the demand for each service faced by individual carriers. The ton-mile losses will be less than the amounts that would be lost assuming no price response, while the revenue losses will be less than those of a full price response scenario.

No matter what rate response the railroads make (full response, no response, or a mixed strategy),they would have to consider seriously a two-pronged long run strategy of plant size reduction and a change in their rate <u>structure</u>. Both elements have important implications for rail shippers. The reduced physical plant would mean a complete loss of service for some shippers and reduced levels of service for others.

At the same time, railroads would, in a regulatory environment that encourages differential pricing but limits a railroad's overall rate of return, seek to change their rate structure by increasing rates in their less competitive markets. Shippers for whom trucking does not present a realistic alternative would, in all likelihood, be forced to pay a higher portion of the nation's railroad bill.

Should impacts on other transportation industries and their shippers be considered in the public debate over the introduction of LCV's? In general, good economic policy should encourage technological change and promote vigorous competition. If Longer Combination Vehicles imposed no other societal costs, the government might depend entirely on free market forces to achieve an appropriate solution. However, the joint use of publicly provided highways by trucks and passenger vehicles raises questions of safety, congestion, and cost allocation. Within that context an assessment of the impacts on trucking's closest competitor is also relevant. In response, this paper provides estimates of traffic and revenue losses for the railroad industry and shows what this might mean to the industry as a whole, to the levels of shipments of specific commodities, and to individual rail carriers.

The models used will not "track" the actual changes in truck and rail traffic that would be observed if an LCV network is approved. The introduction of this network would be only one element in a broader range of technological change in both the rail and truck industries, as well as in all of the other factors affecting equilibrium in transportation markets. Railroads will certainly attempt to match or exceed truck productivity increases in order to maintain both traffic and earnings. In the analysis that follows, no attempt is made to consider any of these factors, including the amount of (induced or non-induced) productivity improvements in the railroad industry. We believe that this is an appropriate procedure, since the pressures of competition will exist with or without a government decision to allow a National Network for Longer Combination Vehicles. This study is an attempt to measure the incremental effect of such an LCV network.

The paper is divided into six subsequent parts. In Section 2, the study methods are outlined. Section 3 reports on a series of interviews held between the Department and railroad officials, in which the officials were asked for their assessment of the impacts. Section 4 contains estimates of revenue losses and traffic diversions for the rail industry as a whole. In Section 5, the issue of rail profitability is addressed by introducing cost estimates for seven randomly selected Class I railroads. Section 6 applies the results of 5 to all Class I railroads, using information on the commodity distribution of revenues for each carrier. Finally, Section 7 summarizes the results and presents the study's conclusions.

2.0 Study Method

The analysis of this report relied on the estimates of tonnage diversions and revenue losses which were generated by the Highway Traffic Forecasting System (HTFS) model. However, since HTFS did not contain carrier specific information necessary to measure the impacts on individual carriers,[3] a second source of information had to be used. The ICC's 1981 Waybill Sample (augmented for this study) provided the necessary data. The Waybill Sample contains 208,000 records of freight moves with each record having information on the commodity shipped, tonnage, origin, destination, mileage, revenue, etc., as well as all railroads involved in the movement.

For this research, it was necessary to add additional items to each record in the Waybill Sample:

- a commodity and origination region specific growth rate that, when applied to the 1981 data, would yield 1990 estimates of commodity flows;
- estimates of the fraction of rail tonnage (given the commodity, origination and distance-moved characteristics of the record) that would shift to trucks (estimates were made both with and without railroad price responses);
- equivalent estimates for the loss of rail revenue as a result of the STAA'82 and LCV changes;[4]
- for seven case study railroads, estimates of variable costs.

These additional items are discussed in more detail below.

3/ The HTFS model used the 1977 Truck Inventory and Use Survey applied to the 1977 Census of Transportation, which had shipments of manufactured commodities by both truck and rail. This was augmented by various sources on shipments of bulk commodities (see Maio, p. 7).

4/ Tonnage and revenue diversion coefficients for both STAA'82 and LCV were appended to the records.

The growth rates, developed by Jack Faucett Associates,[5] are estimates of the increase in traffic from 1981 to 1990 by commodity group and region of origin. Adding the growth rate at the record level, rather than introducing it in subsequent portions of the analysis, offered a great deal of flexibility. Traffic could be analyzed for any set of selection criteria, such as commodity group, origin-destination pair, or individual railroad. These selection criteria need not correspond directly with the attributes defining the growth rates. The analysis could also focus on any unit of measure simply by multiplying the appropriate unit by the growth rate, e.g. tons, ton miles, revenue,[6] etc. For example, forecasting 1990 chemical tonnage for Southern Pacific required three steps: (1) select all SP chemical records from the data base,[7] (2) multiply the tonnage on each record by the growth rate, (3) sum the product of tonnage and growth rates for all records in the group.

The tonnage and revenue loss rates were derived from the HTFS. In HTFS, diversions were calculated for traffic subsets that were identified by their commodity group, shipment size and BEA origin-destination region pair. The commodity groups used in the HTFS model are listed in Table 2.1. This study used the same groups, except that in reporting the results, crops and produce were separated into separate categories, and the categories "Personal Use" and "Household Goods" were not used. The amount of diversion depended on a specific shift coefficient for each traffic subset,[8]

5/ Maio, p. 9.

6/ Revenue is expressed in 1990 dollars.

7/ When rail shipments involved more than one railroad, it was necessary to know the distance traveled on each carrier and the revenues received by each. The distances were available in the data. Revenues were estimated using a divisions formula that considered the originating and terminating carrier and distance carried in blocks of 50 miles.

8/ The shift coefficients were derived using a logit specification based on existing shares of freight traffic carried by the truck and rail modes. See Nienhaus, Section 2.5.5.

TABLE 2.1 COMMODITIES USED IN THE HTFS MODEL.

COMMODITY GROUP:	STCC*
FIELD CROPS AND FRESH PRODUCE**	011,012,013
MINING PRODUCTS (COAL, ORES, MINERALS)	10,11,12
FOREST PRODUCTS	08,241
FOOD PRODUCTS	20
TEXTILE PRODUCTS	22,23
CONSTRUCTION MATERIALS (WOOD, CLAY, GLASS,STONE,CONCRETE)	240,242-249,32
HOUSEHOLD GOODS	NA***
FURNITURE AND HARDWARE	25
PAPER AND PRINTED MATTER	26,27
CHEMICAL PRODUCTS	28
PETROLEUM AND COAL PRODUCTS	13,29
PRIMARY METAL PRODUCTS	33
FABRICATED METAL PRODUCTS	34
MACHINERY (EXC. ELECTRICAL)	35
ELECTRICAL MACHINERY	36
TRANSPORTATION EQUIPMENT	37
SCRAP/GOVERNMENT#	40
MIXED SHIPMENTS (FREIGHT FORWARDER, SHIPPER ASSOCIATION TRAFFIC, MISC. MIXED SHIPMENTS, SMALL PACKAGED FREIGHT)	44-47
PERSONAL USE	NA##
OTHER (ORDINANCE, TOBACCO, RUBBER OR PLASTIC, LEATHER, INSTRUMENTS, MISC. MANUFACTURING PRODUCTS)	19,21,30,31,38,39,41

*- STANDARD TRANSPORTATION COMMODITY CODE, USED IN THE WB90 ANALYSIS, HTFS MODEL USED COMMODITIES AS DEFINED IN 1977 TRUCK INVENTORY AN USE SURVEY.

**- IN WB90 ANALYSIS, FIELD CROPS AND PRODUCE WERE TREATED AS TWO SEPARATE COMMODITIES.

***- DISTRIBUTED AMONG SEVERAL STCC'S; WB90 ANALYSIS PICKED UP THESE COMMODITIES ELSEWHERE.

#- WB90 ANALYSIS USED SCRAP AS SEPARATE COMMODITY GROUP, GOVERNMENT SHIPMENTS PICKED UP IN VARIOUS OTHER STCC'S.

##- TRUCK INVENTORY AND USE SURVEY INCLUDED "TRUCKS USED FOR PERSONAL USE", NOT APPLICABLE TO RR TRAFFIC.

the base truck share, and the change in truck price, net of any change in the rail price.

The estimated changes in truck prices were developed for the HTFS model as reported in Maio.[9/] Changes in truck costs were calculated, based upon the productivity and tax impacts of STAA'82 and the productivity impacts of an LCV network. These were then translated into truck price changes. It was assumed that the truck industry is highly competitive so that changes in truck prices to shippers are the same as the operators' changes in truck costs.

The STAA'82 productivity improvements were derived from the Federal mandate overriding state prohibitions against Western Doubles (tractor plus 28 foot semi-trailer and 28 foot full trailer) and establishing uniform nation-wide standards on trailer length (48 feet), trailer width (8.5 feet), and a gross combination weight limit (80,000 pounds) over a designated highway system. The reduction in freight charges that these productivity improvements permitted was offset somewhat by higher user taxes for some trucks. The average over the road freight rate reduction from all STAA'82 effects was 5.2%.[10/] Not all trucks in all traffic lanes were able to lower freight rates as the result of STAA'82. Specifically, shipments of high density freight (where weight and not size was the load limiting factor) moving outside the "barrier" states (states whose weight limitation had been below 80,000 pounds) moved by truck at higher rates because of increased taxes in the model's STAA'82 scenario. As a result the STAA'82 results show some diversion <u>from</u> truck <u>to</u> rail stemming from the higher user taxes.

The LCV productivity improvements were the result of increased payloads made possible by permitting double combinations

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9/ Maio, Section 3.3.

10/ Maio, p. 62.

using longer trailers and 28 foot triple combinations over a designated highway system. Because not all truck traffic would be susceptible to shipments in LCV's (i.e., it would not pay to use LCV's), the net additional reduction in overall truck freight service charges from the level established by the STAA-82 would average only 3.4%.[11/] Despite the roughly equal reductions in total national freight charges for the STAA and LCV cases, the rail to truck diversions were much larger for LCV changes. This was due to the fact that railroad traffic was assumed to be included in those markets where trucking firms could take advantage of the 26 to 36% productivity improvements that LCV's provide. For railroads, the introduction of a national LCV network poses a far greater competitive threat than would be indicated by the average freight rate reduction on truck traffic as a result of the longer vehicles.

Railroads were assumed to respond to competition from LCV's by lowering their rates. Information gathered from interviews with the rail industry was used to help establish probable levels of commodity specific rail price reactions (i.e. the amount of the truck price reduction railroad executives estimated the railroads would meet). The derivation of the price response estimates and a list of their values is presented in Section 3 below. The values used in HTFS ranged from 0% for several commodity groups, including coal and other mining products, field crops,[12/] and scrap, to 60% for Construction Materials (Wood, Clay, Glass, Stone and Concrete).

11/ Ibid. Maio points out (p. 66) that Longer Combination Vehicles can lead to productivity improvements of 26% to 36% in those markets where they would represent a realistic alternative.

12/ The application of the HTFS model throughout the series of truck studies assumed that Field Crops would not be diverted to trucks when larger combination vehicles were allowed. This assumption was based in part on the result of the interviews with railroad representatives reported in Section 3. In certain geographic areas, however, trucks do present a competitive alternative. Since the methods of this report use the HTFS outputs, the effects of the STAA'82 and LCV may be understated for some grain carrying railroads.

For many shipments, the resulting price response estimates seemed unrealistically large. Consequently, two additional pricing constraints were imposed. If a truck rate reduction was large, the projected response might lead to a rail rate reduction so large that it would make many of the movements unprofitable for the railroad(s). To reduce the likelihood of this illogical model result, the magnitudes of the rail rate reductions were limited to 20 percent of the base rail rate.[13/] A second constraint was introduced because the industry's estimated price responses appeared to apply only to those subsets of markets which were perceived by the railroad personnel interviewed to be highly rail/truck competitive. Since the commodity origin region-distance block tonnages used in the HTFS were in fact aggregates of market subsets with varying degrees of rail/truck competition as reflected in price elasticities, the actual price responses used by HTFS for the aggregated tonnages were constrained by the algorithm:

$$\Delta P_A / \Delta P_F \leq \text{own-elasticity of demand for rail service (absolute value)}$$

where ΔP_A = the actual rail price response, ΔP_F = the "full" price response (one that would match the truck rate reduction), and the elasticities were derived from the logit model developed by Nienhaus (see Footnote 8).

For seven selected railroads, movement information such as tonnage, distance, and car type were used to develop cost estimates using the Interstate Commerce Commission's (ICC) Uniform Railroad Costing System (URCS). The costed traffic base involved about one-half of the WB90 records and one-third of WB90 revenues. The smaller revenue share occurred because only the portions of multi-carrier movements carried by the seven selected railroads were costed. The cost estimates were made using 1981 railroad specific cost factors rather

13/ The 20 percent factor was based on the cost analysis described in Section 3.1.

than the ICC's published regional average cost factors. The resulting cost estimates were subjected to reasonableness checks and a small number of records were eliminated. In most such cases the out-of-range data was traced to input data on the original waybill record that also was unusual.

A railroad's willingness to offer rate concessions because of truck rate changes is limited by the existing profit margins or "contribution" of the traffic in question. A shipment's "contribution" is the amount by which its revenue exceeds the direct cost of handling the shipment and is thus the amount that particular shipment contributes to fixed costs and profits. In this analysis, URCS variable costs have been used as the measure of direct cost. An examination of the industry's contribution-to-revenue ratios shows an aggregate value of 20% with most commodities (14 of the 19 groups studied) between 10% and 30%. As explained above, 20% was used in the HTFS as a constraint on the size of the rail price response.

In addition to augmenting the Waybill Sample with the Faucett growth factors, the HTFS diversion rates and, for seven railroads, URCS variable costs, a structural modification was made to the Waybill Sample to make it easier to identify the impacts on individual railroads. As originally developed, each record in the Waybill data base recounts the details for a single freight move. Many moves involved more than one railroad however. When examining the effects of STAA'82 or the LCV network on a specific railroad, it was necessary to identify every freight shipment involving that railroad. Consequently, each multi-railroad move was divided into a set of records. Every record in that set identified the railroad, its position in the move, and the number of railroads involved in the move; all original attributes (e.g. tonnage, origin) were retained. To prevent double counting, summary tables for the entire industry used only the information contained on the first railroad in the movement.

The constructed 1990 Waybill Sample was compared to 1981 industry results (the year on which the sample was based). These checks produced results within reasonable tolerance limits. Because the model output reported in Sections 4 and 5 is based on 1990 traffic levels and denominated in 1990 dollars, simple comparisons with the actual performance of the railroad industry in 1981 are not possible. Using 1981 dollars however, the model projects rail revenue per ton mile at $.032, an amount equal to the reported revenue per ton-mile for 1981 in the AAR's Railroad Facts, 1985 (p. 30). In addition there are only small differences in revenue shares for those commodities where comparisons are possible.

Since aggregate railroad data were available for 1984, the WB90 estimates of revenue and tonnage losses could be applied to the 1984 information to measure the potential impacts of an LCV network on the 28 Class I railroads operating in that year. A technique was developed for measuring the contribution loss (difference between gross operating revenues and URCS variable costs) that could be attributed to the introduction of LCV's (Section 6.1 describes this technique in detail). This is turn made it possible to measure the impacts on the individual railroads by estimating the likely changes in each carrier's return on net investment, operating ratio, and margin of safety.

3.0 Railroad Company Viewpoints on National LCV Network Impacts

Interviews with the railroad industry were an integral part of the research for this study. The interviews had two major objectives. First, the information obtained could be used in the determination of likely rail rate responses to changes in truck freight rates. Second the results of this study's model analysis could be compared to the industry's own estimation of likely traffic diversions.

Seven Class I railroads were selected so as to cover all regions of the U.S. and also to span the size of Class I rail companies from small to very large. Nonetheless, five of the railroads fall into the very large category using any conventional measure of size. The effect of this sample selection pattern is to weight heavily the input from railroads that account for the bulk of U.S. rail shipments. The set of seven railroads interviewed overlaps the set of seven railroads for which cost data were developed (Section 5 below), but the two sets were not identical.

The contact process involved identifying an interested party at a railroad, explaining the issues, sending a written description of the issues and some question areas, and then meeting with a group of the railroad's staff to obtain their views and estimates regarding the likely impacts on their railroad of a hypothetical network for LCV's. The railroad representatives at these meetings typically involved persons from marketing, pricing, corporate planning, economic forecasting, intermodal marketing and operations, and government relations. The railroad officials were told to assume that the longer combination vehicles would have payloads about equal to rail cars and would operate with cost and rate savings of about 25 percent relative to existing trucks. They were then asked how this would affect their business and how they might respond to such changes. They were strongly encouraged to differentiate in their answers among commodity groups, length of haul, car type, and type of shipment.

3.1 Rail Rate Responses

Because the HTFS model assumes railroads will reduce rates in response to truck price changes, it requires information on the relative size of the rail price adjustment. The set of adjustment factors, R_i, used in the HTFS are defined as the percent of the truck price change matched by railroads for each commodity group i. The R_i were developed using information obtained in the railroad interviews, modified by independent estimates of commodity revenues and costs.

The percentages discussed in this section are the percentages of the truck price changes that railroads would meet. They are not a measure of the change in the rail rate itself. For example suppose that railroads charge $10 a ton for shipping commodity X and that the response rate for this commodity is 50%. If the truck price were lowered $2.00 per ton, the rail price response rate estimates that railroads would drop their price by 50% of $2.00 or $1.00. The rail rate change then represents a reduction in the rail rate of 10%.

3.1.1 Estimates of Probable Rate Adjustments by the Interviewed Railroads

Railroad officials were asked about the size of their rate adjustments for different commodity groups. Their responses indicated that there would be substantial differences among commodity groups, and, for a given commodity, among railroads. There were several considerations that seemed to guide decisions about rate changes, the most important being existing profit margins ("contribution" was the term often used). Price concessions would be large and more frequent if the traffic could continue to be moved at a profit, but there were also some secondary, subjective factors at work. Some railroad officials expressed the view that they might not have to make price concessions in order to retain some customers, and in other situations felt that it might be better to lose some potentially profitable traffic because rate reductions cannot always be made selectively, i.e., if one rate is reduced other rates for that customer may also have to fall. Rate reductions might also spread to other rail shippers so that their delivered products remain competitive with the products from the shipper who was offered the first rate reduction. The point made by several persons was that there is a "structure" or interdependency among railroad rates, and changes to one rate generally lead to further changes in other rates. Traffic or market share maximization also were mentioned as non-profit factors that would be considered in making rate adjustments.

In discussing specific commodities railroad officials often became circumspect so as to protect sensitive information regarding perceived market power and existing profit margins. Still, the views offered were consistent regarding a number of points that are of interest to this study.

First, coal and, to a lesser extent, grains are commodities for which truck competition for current rail traffic is not usually a factor. Even with higher payloads and lower rates, little diversion from rail to truck is likely, and hence rail rate reductions would not be necessary. It was, however, pointed out that there are special situations involving short hauls and low volumes that are potential exceptions to the general rule for these commodities. There are also some movements of these commodities at rates that are so low that railroads would be reluctant to reduce them further even if new lower truck rates were to divert the business. (The low, non-compensatory rate problem was mentioned more frequently in discussions of other commodity groups.)

Second, a few commodity groups have low average profit margins and thus little room for further rate reductions. The examples most often cited were TOFC/COFC, Furniture, Textiles, and Fresh Produce, but two railroads characterized most of their traffic as low profit or non-compensatory. Many railroad officials offered the view that there are or were non-negligible portions of traffic in virtually every commodity group that can at best be described as marginally profitable and the railroad would certainly not offer rate concessions to prevent this traffic from shifting to truck. One railroad stated that it was taking advantage of the post-Staggers regulatory environment to eliminate the unprofitable traffic and had already had considerable success in this regard.

There was an apparent inconsistency in the comments regarding rate reductions for TOFC traffic. On the one hand railroads gave the impression that TOFC traffic was moved at rates that provided little profit or contribution. On the other hand, in considering possible rate responses to truck rate reductions they reported that they would reduce TOFC freight rates in order to retain the traffic. The latter view was often part of a stated opinion that TOFC was part of the "future wave" for railroads as evidenced by the substantial recent investments in special yards and equipment. It was also clear from the discussions that railroads have attracted TOFC business by competing with trucks on the basis of rates; in this environment it was virtually a reflex action to assume that any truck rate reduction would be countered by a rail rate reduction. Possible rail cost reductions for TOFC movements would have a role in determining the amount of any such TOFC rate adjustments, but it seems likely that these rate reductions would be limited.

Rail rate adjustments by commodity group were discussed from two viewpoints, that of the shipper and that of the railroad. The issue from the shipper viewpoint was one of sensitivity, i.e., how sensitive to changing modal rate differentials shippers of a given commodity group were perceived to be. The issue from the railroad's viewpoint was the extent to which the railroad would make a price adjustment given their profit margins and the perceived sensitivity of the shipper. A discussion at this level of detail occurred with six of the seven railroads and a synthesis of their comments is presented in Table 3.1 with "High, Medium, and Low" effects assigned to each viewpoint-commodity group combination. It should be emphasized that this is subjective information intended only as a general indication of relative rankings of the commodity groups.

Most values in Table 3.1 seem reasonable, for example the "Low" rail response for Produce, which is a marginally profitable commodity. The higher sensitivity values for shippers occur for the low density, high value commodity groups, and the higher rail response values correspond to commodity groups with higher contribution-to-revenue ratios. Also note the high rail response rate for three important commodity groups, Processed Food, Construction Materials, and Paper, that are largely shipped in box cars where rate competition is thought to be intense.

3.1.2 Other Cost Evidence

The URCS costing procedures described in Section 2 were used to supplement the information provided by the railroads. Revenue, cost, and contribution data are presented in Table 3.2 along with two measures of the relative importance of contribution for each commodity group. The data are for projected 1990 traffic levels measured in 1990 prices. The importance of Mining Products and Chemicals to these railroads is obvious since together they account for over half of total contribution (Column 5). The negative contribution for Mixed Shipments is also notable. This suggests that railroads might be more

TABLE 3.1 SUMMARY OF RAILROAD INFORMATION ON RATE CHANGES.

COMMODITY GROUP:	SHIPPER SENSITIVITY:	RAIL RESPONSE:
CROPS	LOW	LOW
PRODUCE	MEDIUM	LOW
MINING	LOW	LOW
FOREST PRODUCTS	MEDIUM	MEDIUM
PROCESSED FOOD	MEDIUM	HIGH/MEDIUM
TEXTILES	HIGH	MEDIUM
CONSTRUCTION MATERIALS	MEDIUM	HIGH
FURNITURE	HIGH	MEDIUM
PAPER	MEDIUM	HIGH
CHEMICALS	MEDIUM	HIGH
PETROLEUM	MEDIUM	HIGH
PRIMARY METALS	HIGH	HIGH
FABRICATED METALS	MEDIUM	HIGH
MACHINERY	MEDIUM	LOW
ELECTRICAL MACHINERY	MEDIUM	LOW
TRANSPORTATION	HIGH/MEDIUM	MEDIUM
SCRAP	MEDIUM	HIGH
MIXED SHIPMENTS	HIGH	HIGH
OTHER	HIGH	MEDIUM

SOURCE: INTERVIEWS WITH SELECTED RAILROADS.

TABLE 3.2 1990 RAILROAD REVENUE, COST AND CONTRIBUTION MEASURES.

COMMODITY	REVENUE (MILLIONS) (1)	VARIABLE COSTS (MILLIONS) (2)	CONTRI-BUTION (MILLIONS) (3)	CONTRIB. AS PERCENT OF REVENUE (4)	% OF TOTAL CONT. (5)
CROPS	792	701	91	11.53%	4.03%
PRODUCE	57	78	(20)	-35.34%	-0.90%
MINING	2,716	1,967	749	27.59%	33.09%
FOREST	169	149	20	11.85%	0.89%
FOOD	1,113	888	224	20.17%	9.91%
TEXTILES	23	19	4	16.12%	0.16%
CONSTRUCT MAT	741	604	137	18.48%	6.04%
FURNITURE	48	40	8	16.21%	0.35%
PAPER	728	617	111	15.27%	4.91%
CHEMICALS	1,439	946	493	34.27%	21.78%
PETROLEUM	330	242	88	26.79%	3.91%
PRIMARYMET	772	583	189	24.44%	8.33%
FABMET	34	30	4	12.78%	0.19%
MACHINERY	65	45	21	31.38%	0.91%
ELECTRICAL	77	48	28	37.07%	1.25%
TRANSPORT	788	699	90	11.36%	3.95%
SCRAP	266	228	39	14.50%	1.70%
MIXED	1,036	1,073	(37)	-3.60%	-1.65%
OTHER	121	96	26	21.22%	1.14%
TOTAL	11,317	9,053	2,265	20.01%	100.00%

profitable if they did not carry this commodity group.[14] A more disaggregated examination of the Mixed Shipments records revealed that over half of the individual movements moved below URCS variable costs indicating a pervasive condition that is not the consequence of some extreme values on a small subset of the traffic.

An examination of the contribution-to-revenue ratios (Column 4) shows an aggregate value of 20% with most commodity groups within 10 percentage points of the average. Of the six commodity groups outside this range the two with significant portions of total rail revenue are Mixed Shipments with a -3.6% contribution rate, and Chemicals with a +34.3%.

The data in Table 3.2 indicate that based on profitability levels, the rate responses should be smallest for Produce,

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[14] The finding that a given rate is below a calculated value of average variable costs, as defined in URCS, does not however, mean that necessarily, the traffic is moving at a loss. The ICC has recognized that rates set below Rail Form A variable costs (RFA variable costs are roughly equal to URCS variable costs) can be remunerative and contribute to a carrier's "going concern value." In its decision of June 9, 1980, the Commission proposed a definition of "directly variable costs" (DVC) designed to establish a minimum reasonable rate level equal to the sum of line-haul cost of lading, applicable switching costs, and station clerical costs. The Commission acknowledged that "this formula may show a level of cost that is substantially below what would be shown by a traditional application of Rail Form A. This is a desirable feature to the extent that the previous use of Rail Form A may have impaired the carrier's rate-making flexibility on the downward side." (362 ICC 808) In a subsequent decision, the Commission renamed its initially defined DVC as the "presumptive cost floor" (PCF) and redefined DVC to include PCF plus all other cost elements that could be shown to vary with the service in question. It still recognized that renumerative rates could be set below average costs: "It may occur that the protestant relied on Rail Form A or other average cost data in framing its protest [that a rate is below a reasonable minimum level], but the proponent produces movement-specific data showing actual DVC to be less than or equal to the [disputed] rate." (364 ICC 902) Special circumstances could apply in the case of TOFC dedicated trains and other movements included in the Mixed Shipments category.

Mixed Shipments, Field Crops, Forest Products, Transportation Equipment, and Fabricted Metal Products. Chemicals, Mining, Petroleum Products, and Primary Metal Products are among the commodity groups that could have the largest rate reductions without eliminating their contribution to railroad profitability.

3.1.3 Derivation of the HTFS Response Rates

A number of considerations went into the final specification of values for the percentage of truck price changes met by railroads -- R_i, by commodity group. Since the response would vary depending on the absolute size of the truck rate changes it was assumed that R_i should be specified for small changes in truck prices. Then if the resulting rail price changes in the HTFS became improbably high in response to larger truck rate reductions they would be constrained. As described in Section 2, two constraints were introduced. The first, limiting rail rate reductions to a maximum of 20%, was based on the information presented in Table 3.2.

The low values of the R_i can be set at 0 to 10 percent of truck rate changes with little chance of seriously distorting the results, but values for the upper end of the distribution are not as easily specified. For a commodity group with high rail rate responses what would be a realistic value for R_i? The railroad representatives offered some information on this question. They explained that even for a commodity group with a High rate response there would be a distribution of responses: a truck rate reduction would be fully met for some shipments, partially met for others, and ignored for the remainder. It is very unlikely that railroads could match as much as 80 percent of truck rate changes for any sizable group of shipments and thus for analytical purposes the upper bound was arbitrarily set at 70 percent. Given these considerations and assumptions it remained to examine the relevant information for the different commodity groups and then assign each an

R_i value. The first column of Table 3.3 presents the R_i values used in the HTFS and the other two columns restate information from Tables 3.1 and 3.2 that was used in assigning these values. For the three commodities with a response rate of "Not Applicable" (NA) it was assumed that there would be no loss in rail traffic and that no rail price "response" was necessary.

The general principle used was to examine the contribution rate data to see if the response levels could be reasonably accommodated. The biggest problem in this regard was the Mixed Shipments group for which the negative contribution rate would seem to preclude a High response; an R_i of 20 percent was the compromise value. High contribution rates (greater than 15 percent) were assumed to be consistent with R_i of 50 percent if a High response was specified by the railroads. Two other factors were considered in this assignment process, namely the type of rail equipment (car type) and the importance (share) of the commodity group to total rail traffic. Regarding car type, the railroad representatives often noted that boxcar traffic was more vulnerable to truck competition than other car types and thus Building Materials and Paper were assumed to have a higher R_i than would otherwise be expected. The virtual insignificance of Textiles and Furniture in total rail traffic suggested low R_i values since the railroads would not compete vigorously for this business. The converse case was made for the Transportation group where the 30 percent response level is justified because of the railroads' desire to retain this traffic even though the contribution rate is relatively low.

3.2 Railroad Estimates of Likely Traffic Diversions

The railroad representatives were also asked to give estimates, by commodity group if possible, of the size of traffic diversions after rail rate adjustments for an LCV case in which truck rates declined 25 percent. For the five

TABLE 3.3 PORTION OF TRUCK PRICE CHANGE MATCHED BY RAILROADS.

COMMODITY GROUP:	RAIL RESPONSE:	CONTRIB. AS % OF REV.	RESPONSE LEVELS:
CROPS	NA	11.5%	LOW
PRODUCE	0.0%	-35.3%	LOW
MINING	NA	27.6%	LOW
FOREST PRODUCTS	20.0%	11.9%	MEDIUM
PROCESSED FOOD	40.0%	20.2%	HIGH/MEDIUM
TEXTILES	20.0%	16.1%	MEDIUM
CONSTRUCTION MATERIALS	60.0%	18.5%	HIGH
FURNITURE	10.0%	16.2%	MEDIUM
PAPER	50.0%	15.3%	HIGH
CHEMICALS	50.0%	34.3%	HIGH
PETROLEUM	40.0%	26.8%	HIGH
PRIMARY METALS	50.0%	24.4%	HIGH
FABRICATED METALS	30.0%	12.8%	HIGH
MACHINERY	20.0%	31.4%	LOW
ELECTRICAL MACHINERY	20.0%	37.1%	LOW
TRANSPORTATION	30.0%	11.4%	MEDIUM
SCRAP	NA	14.5%	HIGH
MIXED SHIPMENTS	20.0%	-3.6%	HIGH
OTHER	40.0%	21.2%	MEDIUM

railroads providing this information the aggregate traffic loss estimates ranged from about 3% to 40%. The wide range of results suggests that they should be treated as imprecise bounds for values derived using other methods. Representatives at one railroad (RR-H: the railroad reporting High diversons) expected losses of 50 percent or more for all commodity groups except Mining (10%) and Mixed Shipments (33%) that represented more than one percent of their traffic base (see Table 3.4). Another railroad (RR-L: Low diversions) reported expected losses of 0 to 10 percent for all commodity groups except Mixed Shipments (46%). The other three railroads (Mid-Three) fell between these two extremes, reporting expected losses between 5% and 50% for most commodity groups. Note that not every railroad provided estimates for every commodity group as indicated by the NA's (Not Available) in Column 1 of Table 3.4, and the single values in Column 2.

Although the estimates by commodity groups contain sizable variations, the information from a particular railroad was internally consistent. For example, if a railroad reported high shipper sensitivity it also projected large diversions.

The variations across railroads makes it difficult to generalize about expected traffic losses for most commodity groups, but a few such generalizations from the data in Table 3.4 are possible. First, the expected diversions for Mining products are lower than other commodity groups and are essentially zero for three of the five railroads; the fourth projects a loss of 2% and the fifth a loss of 10%. Expected losses for three commodity groups (Textiles, Furniture, and Fabricated Metal) are reported in the 20 to 60 percent range by all railroads except RR-L, the railroad expecting only minimal effects outside the Mixed Shipments groups. Expected losses from the Paper group were put in the 10 to 50 percent range by all five railroads with 30% the rough average.

TABLE 3.4 SUMMARY OF RAILROAD INFORMATION ON DIVERSIONS.

	PERCENT DIVERTED WITH PRICE RESPONSE:	
COMMODITY GROUP:	RR-L AND RR-H	MID-THREE RAILROADS
CROPS	10-60	1-3
PRODUCE	NA-80	3
MINING	0-10	1-2
FOREST PRODUCTS	5-60	5
PROCESSED FOOD	0-50	5-7
TEXTILES	0-NA	20-55
CONSTRUCTION MATERIALS	5-50	5-20
FURNITURE	0-NA	40-62
PAPER	10-50	11-30
CHEMICALS	0-50	3-10
PETROLEUM	0-NA	3-30
PRIMARY METALS	0-NA	4-11
FABRICATED METALS	0-50	22-40
MACHINERY	3-NA	20-40
ELECTRICAL MACHINERY	0-NA	11-35
TRANSPORTATION	10-50	7-34
SCRAP	0-80	5-12
MIXED SHIPMENTS	46-33	2-31
OTHER	3-NA	20-30

The data in columns one and two of Table 3.4 can be used to make elasticity estimates since the columns report estimates of the percent change in quantity due to a change in rates. The actual interpretation is made difficult since both truck and rail prices are assumed to have changed. The easiest approach is to use the data in Table 3.4 as a lower bound on cross-price elasticities (without a rail price response, the percentage diversion due to the 25% truck price change would be even higher).15/ The low elasticity commodities include Crops, Mining, Forest Products, Processed Food, and Scrap. Textiles, Furniture, Fabricated Metals and Machinery are high elasticity commodities. The relative rankings are consistent with the parameter estimates used in the HTFS model.

15/ The railroad representatives also provided some information on traffic losses if no price responses were made, but it is not reported because of its sparseness and high variability. As expected, these responses were higher than the price response case.

4.0 Modal Shift Impacts

As discussed above, the net cost reductions for truck freight anticipated under both STAA'82 and the LCV cases are expected to result in shifts of freight traffic from the rail mode to the truck mode. The changes in trucking size and weight limits enacted as part of the 1982 STAA are projected to cause a 1.9% loss in rail ton-miles and a 2.7% drop in rail gross freight revenues. If an LCV network were created, railroads would lose an additional 8.5% of ton-miles and 14.0% of revenues. The larger potential harm to railroad interests associated with the creation of a national LCV network occurs because the LCV's would become more competitive at distances and shipment sizes that currently have sizable amounts of rail traffic. These estimated impacts on railroads are not uniform across commodities, regions, or companies, and are thus described in more detail below.[16]

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[16] The tonnage and revenue losses reported in this section differ from those implicit in the HTFS scenario analyses. The two analyses are based on independent estimates of the initial rail traffic. Consequently, the application of a common method will necessarily result in differences between the model outputs. The selection of the appropriate data depended upon the task at hand. In the HTFS scenario runs, the focus was upon the trucking sector and therefore a rail traffic set as comparable to the truck traffic data as possible was desired. Hence, rail traffic estimates were based upon Census of Transportation data. For the present analysis, the focus was upon rail impacts, and these impacts were estimated from detailed subsets of rail traffic. As a result, the best rail-specific information was used, one derived from the Waybill Sample. At the aggregate level, the rail losses implicit in the application of HTFS reported in Maio are:

1.6% ton-mile diversion, STAA'82
3.7% revenue loss, STAA'82
4.2% ton-mile diversion, LCV Network
10.2% revenue loss, LCV Network.

Given the level of precision associated with large scale models, the differences between the HTFS and WB90 results are reassuringly moderate. The specific results used in each of the analyses might, from a policy perspective, be considered the more conservative set for the particular analysis. The benefit estimates for the trucking industry are based on rail traffic shifts using the lower diversion rate, while the negative impacts upon the rail industry are based on rail traffic shifts using the higher diversion rates.

4.1 Modal Traffic Diversions by Commodity

Table 4.1 gives estimates of 1990 base level rail ton-miles and the changes expected due to provisions of the 1982 STAA. Most commodity groups have either small relative or small absolute changes, some of which are positive and some negative. The major exception is Mixed Shipments which has a 38 percent drop that reflects a decline of about 23.7 million ton-miles. This traffic loss offsets the 2.3 million net ton-mile gain registered by the other 18 commodity groups[17/] and thus largely accounts for the aggregate 21.3 million drop resulting from the STAA'82. The Mixed Shipment category includes many less than truck load (LTL) and TOFC/COFC movements so the truck rate reductions made possible by the larger limits on size and weight (including the nationwide use of 28 foot double trailers) explains why a significant portion of this freight may be diverted. Since the 38% drop in Mixed Shipments is an average across all railroads and regions, the decline would obviously be more severe for some carriers.

The 1990 traffic changes due to the introduction of a Longer Combination Vehicles network is presented in Table 4.2.[18/] While the impact on Mixed Shipments is once again large, there are other commodities with sizable traffic declines (see Column 3). Construction Materials is projected to have the largest absolute traffic loss, some 25.8 million ton-miles or about 35 percent of its STAA'82 level. Other important rail shipment groups, Food Products, Paper, Chemicals, Petroleum, and Primary Metals are also lost in large amounts to trucks. Column 4 in Table 4.2

17/ The 2.3 million ton-mile gain for the other commodities is the result of higher truck rates for some shipments due to higher user fees mandated by the 1982 STAA (see Section 2). Two commodity groups, Building Materials and Primary Metal Products account for most of railroads' gains.

18/ The LCV impacts are measured using the post STAA-82 traffic and revenue levels as a base.

TABLE 4.1 EXPECTED 1990 TRAFFIC IMPACTS FROM THE 1982 STAA'82.

	TON MILES IN BASE CASE (MILLIONS)	TON MILES IN STAA'82 (MILLIONS)	DIVERTED TON MI (MILLIONS)	PERCENT DIVERTED
CROPS	148,713	148,713	0	0.00%
PRODUCE	6,138	4,213	(1,925)	-31.36%
MINING	409,547	409,547	0	0.00%
FOREST	14,261	14,521	260	1.82%
FOOD	85,626	85,313	(313)	-0.37%
TEXTILES	734	562	(172)	-23.49%
CONSTRUCT MAT	71,090	74,427	3,337	4.69%
FURNITURE	1,079	953	(126)	-11.64%
PAPER	60,357	61,882	1,525	2.53%
CHEMICALS	121,904	121,141	(763)	-0.63%
PETROLEUM	22,349	21,161	(1,188)	-5.32%
PRIM MET	52,371	55,828	3,457	6.60%
FABR MET	2,061	2,244	183	8.86%
MACHINERY	3,007	3,506	499	16.61%
ELEC MACH	2,574	2,077	(497)	-19.33%
TRANSP	21,255	20,344	(911)	-4.29%
SCRAP	17,080	17,080	0	0.00%
MIXED	62,780	39,125	(23,655)	-37.68%
OTHER	4,157	3,131	(1,026)	-24.68%
TOTAL	1,107,083	1,085,768	(21,315)	-1.93%

TABLE 4.2 EXPECTED 1990 TRAFFIC IMPACTS FROM LCV NETWORK.

	TON MILES IN STAA'82 (MILLIONS)	TON MILES IN LCV (MILLIONS)	DIVERTED TON MI (MILLIONS)	PERCENT DIVERTED	DIVERSION/ TOT DIV (PERCENT)
CROPS	148,713	148,713	0	0.00%	0.00%
PRODUCE	4,213	1,158	(3,055)	-72.52%	3.31%
MINING	409,547	409,547	0	0.00%	0.00%
FOREST	14,521	14,056	(465)	-3.21%	0.50%
FOOD	85,313	79,553	(5,761)	-6.75%	6.24%
TEXTILES	562	265	(297)	-52.87%	0.32%
CONSTRUCT MAT	74,427	48,618	(25,810)	-34.68%	27.94%
FURNITURE	953	826	(127)	-13.32%	0.14%
PAPER	61,882	56,562	(5,320)	-8.60%	5.76%
CHEMICALS	121,141	110,877	(10,264)	-8.47%	11.11%
PETROLEUM	21,161	16,259	(4,902)	-23.16%	5.31%
PRIM MET	55,828	48,898	(6,930)	-12.41%	7.50%
FABR MET	2,244	1,895	(348)	-15.52%	0.38%
MACHINERY	3,506	2,507	(999)	-28.49%	1.08%
ELEC MACH	2,077	848	(1,228)	-59.14%	1.33%
TRANSP	20,344	18,253	(2,091)	-10.28%	2.26%
SCRAP	17,080	17,080	0	0.00%	0.00%
MIXED	39,125	15,600	(23,525)	-60.13%	25.47%
OTHER	3,131	1,889	(1,243)	-39.68%	1.35%
TOTAL	1,085,768	993,403	(92,365)	-8.51%	100.00%

shows which commodities are expected to have the largest relative declines. Eight commodity groups have losses in excess of 20% thus indicating the areas where truck competition will become most intense. These results should be interpreted carefully in light of the fact that some commodity groups account for very little rail traffic. The last column in Table 4.2 is a better measure of a commodity's overall impact on railroad diversions since it has the same base for all percent calculations. More than half of the overall diversion is accounted for by the Construction Materials and Mixed Shipment groups while five other commodity groups account for another 36 percent of the diverted ton-miles. In contrast, for the remaining 12 commodity groups the diversions to truck have little impact on aggregate rail ton-miles.

4.2 Regional Traffic Impacts

The estimates of rail traffic changes derived from the waybill sample can be calculated for different geographical regions. Table 4.3 reports traffic changes by 10 origin regions for the STAA case. The regions are those used by the U.S. Census Bureau (and are defined in a footnote to Table 4.3). While the rail traffic changes are relatively small under the STAA case (as noted above), they are concentrated in East North Central (ENC) and Pacific (Pac) states. Since Mixed Shipments is the main commodity group losing rail traffic under the STAA case, it follows that Mixed Shipments comprise much of the diverted traffic in the ENC and Pac regions. In fact, the higher diversion rate for these two regions is due to the high share of Mixed Shipments in their traffic base as indicated by the data in Table 4.4. Over 60% of the Mixed Shipments ton-miles originated in these two regions and Mixed Shipments were a sizable portion of total regional traffic originations.

The regional pattern of rail traffic diversions for the LCV case is also uneven with regional diversion rates

TABLE 4.3 EXPECTED REGIONAL TRAFFIC IMPACTS FROM STAA'82.

	BASE TON-MI (MIL.)	STAA TON-MI (MIL.)	DIVERTED TON-MI (MIL.)	PERCENT DIVERTED
NEW ENGLAND	8,348	8,200	(148)	-1.77%
MID ATLANTIC	48,550	47,993	(556)	-1.15%
SOUTH ATLANTIC	80,790	80,411	(379)	-0.47%
SOUTHEAST	63,644	63,303	(341)	-0.54%
EAST NO CENT	148,127	136,501	(11,626)	-7.85%
EAST SO CENT	112,579	111,879	(700)	-0.62%
WEST NO CENT	166,547	164,545	(2,001)	-1.20%
WEST SO CENT	124,348	123,305	(1,043)	-0.84%
ROCKY MOUNT	254,616	254,520	(96)	-0.04%
PACIFIC	99,535	95,111	(4,423)	-4.44%
TOTAL	1,107,085	1,085,769	(21,316)	-1.93%

DISTRIBUTION OF STATES WITHIN REGIONS:

NEW ENGLAND
- MAINE
- NEW HAMPSHIRE
- VERMONT
- MASSACHUSETTS
- RHODE ISLAND
- CONNECTICUT

MIDDLE ATLANTIC
- NEW YORK
- NEW JERSEY
- PENNSYLVANIA

SOUTH ATLANTIC
- DELAWARE
- MARYLAND
- DIST. OF COLUMBIA
- VIRGINIA
- WEST VIRGINIA

SOUTHEAST
- NORTH CAROLINA
- SOUTH CAROLINA
- GEORGIA
- FLORIDA

EAST NORTH CENTRAL
- MICHIGAN
- WISCONSIN
- OHIO
- INDIANA
- ILLINOIS

EAST SOUTH CENTRAL
- KENTUCKY
- TENNESSEE
- ALABAMA
- MISSISSIPPI

WEST NORTH CENTRAL
- MINNESOTA
- NORTH DAKOTA
- SOUTH DAKOTA
- IOWA
- NEBRASKA
- MISSOURI
- KANSAS

WEST SOUTH CENTRAL
- ARKANSAS
- OKLAHOMA
- LOUISIANA
- TEXAS

ROCKY MOUNTAINS
- MONTANA
- WYOMING
- COLORADO
- UTAH
- NEW MEXICO
- ARIZONA
- IDAHO
- NEVADA

PACIFIC COAST
- WASHINGTON
- OREGON
- CALIFORNIA

TABLE 4.4 REGIONAL MIXED SHIPMENTS AND TOTAL TON MILES IN BASE CASE, 1990.

	MIXED SHIPMENTS (MIL.)	MIXED/ TOT MIXED (PER.)	TOTAL TON-MI (MIL.)	MIXED/ TOT T-M (PER.)
NEW ENGLAND	1,203	1.9%	8,348	14.4%
MID ATLANTIC	3,846	6.1%	48,550	7.9%
SOUTH ATLANTIC	2,280	3.6%	80,790	2.8%
SOUTHEAST	3,959	6.3%	63,644	6.2%
EAST NO CENT	21,083	33.6%	148,127	14.2%
EAST SO CENT	3,798	6.0%	112,579	3.4%
WEST NO CENT	3,777	6.0%	166,547	2.3%
WEST SO CENT	4,939	7.9%	124,348	4.0%
ROCKY MOUNT	494	0.8%	254,616	0.2%
PACIFIC	17,402	27.7%	99,535	17.5%
TOTAL	62,781	100.0%	1,107,085	5.7%

ranging from about 3 to 30 percent of the post STAA'82 traffic (see Table 4.5). These uneven regional impacts indicate that a railroad whose traffic base is concentrated among the commodities and regions with the largest diversions to truck can have significant traffic losses. The 30% loss in rail originations from the Pacific region is especially noteworthy. The 17% loss in New England is also sufficiently large that the scale of railroad activity may be significantly reduced if railroads are unable to counter the truck productivity increases.

4.3 Revenue Impacts

The percentage losses in revenue are estimated to be 60% larger than the percentage losses in ton-miles when both the STAA and LCV effects are considered. There are several reasons why rail revenues can change more than rail ton-miles. The freight that is diverted to trucks may have above average freight rates within its commodity group, and the commodity groups with the larger diversions may have average freight rates that are higher than those groups with little or no diversion.[19/] An inspection of the data[20/] indicates that the latter of these two factors is certainly part of the explanation.

The assumption that railroads would respond to lower truck prices by lowering their own rates was a third factor causing revenue losses to exceed ton-mile losses (on a percentage basis). The effect of this assumption is that in addition to the revenue lost because of the decline in freight traffic, there is a further loss in revenue because of rate reductions on the freight that railroads continue to haul. As will be seen below, approximately one quarter of the projected drop

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19/ Obviously, these commodities may also cost the railroads more to handle.

20/ Specifically, by comparing revenue per ton-mile for the various commodities.

TABLE 4.5 EXPECTED REGIONAL TRAFFIC IMPACTS FROM LCV NETWORK.

	STAA TON-MI (MIL.)	LCV TON-MI (MIL.)	DIVERTED TON-MI (MIL.)	PERCENT DIVERTED	DIVERS./ TOT DIV (PER.)
NEW ENGLAND	8,200	6,752	(1,448)	-17.66%	1.57%
MID ATLANTIC	47,993	42,627	(5,366)	-11.18%	5.81%
SOUTH ATLANTIC	80,411	77,784	(2,627)	-3.27%	2.84%
SOUTHEAST	63,303	54,754	(8,549)	-13.50%	9.26%
EAST NO CENT	136,501	124,543	(11,959)	-8.76%	12.95%
EAST SO CENT	111,879	105,231	(6,648)	-5.94%	7.20%
WEST NO CENT	164,545	158,631	(5,914)	-3.59%	6.40%
WEST SO CENT	123,305	110,670	(12,635)	-10.25%	13.68%
ROCKY MOUNT	254,520	246,174	(8,346)	-3.28%	9.04%
PACIFIC	95,111	66,238	(28,873)	-30.36%	31.26%
TOTAL	1,085,769	993,405	(92,364)	-8.51%	100.00%

in rail revenue due to the creation of an LCV network is caused by the reduction in average rail freight rates (either because shipments with higher rates were diverted or because of the reduction in rail rates on retained traffic), while the other three quarters is directly traceable to the loss in rail freight.

The change in trucking costs expected as the provisions of the 1982 STAA are implemented will, under the models and assumptions used for this study, lead to an overall rail revenue drop of 2.7 % (see Table 4.6). The distribution of the revenue changes among commodity groups is uneven in ways that are similar to the differences observed in traffic changes reported in Table 4.1. Revenue increases occur for six commodity groups, but these are offset by the larger losses among the other commodity groups. The Mixed Shipments commodity group dominates the overall result; without the Mixed Shipments decline of $1.2 billion, revenue would have increased overall by $269 million. With two exceptions (produce and chemicals), the percent change in revenues, either positive or negative, is always greater than the percent change in ton-miles.[21/]

If a national network for LCV's is established, the reduction in truck costs are expected to lead to a 14.0% decline in 1990 rail revenues, considerably larger than the 2.7% loss estimated for the STAA'82 case. As seen in Table 4.7, these revenue losses are spread among all of the commodity groups (except for the three groups -- Field Crops, Mining Products, and Scrap -- that are assumed to have no losses). Three groups account for 54 percent of the total revenue decline (Column 5); these are Building Materials, Chemicals, and Mixed Shipments. The estimated revenue changes shown in Table 4.7 evidence

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21/ It might seem that with a railroad price response, the industry's revenue losses (gains) should always be greater (in percentage terms) than the industry's ton-mile losses (gains). However when a commodity group contains some sub-markets where truck rates are higher after STAA'82 and other sub-markets where rates are lower, results such as those observed for produce and chemicals are not illogical.

TABLE 4.6 EXPECTED RAIL REVENUE IMPACTS FROM STAA'82.

	BASE REVENUE (MILLIONS)	STAA REVENUE (MILLIONS)	REVENUE CHANGE (MILLIONS)	PERCENT REVENUE CHANGE	CHANGE/ TOTAL REV CHANGE (PERCENT)
CROPS	7,168	7,168	0	0.00%	0.00%
PRODUCE	345	244	(101)	-29.28%	5.24%
MINING	19,723	19,723	0	0.00%	0.00%
FOREST	1,178	1,214	35	3.01%	-1.84%
FOOD	6,289	6,257	(31)	-0.50%	1.63%
TEXTILES	95	68	(28)	-28.99%	1.43%
CONSTRUCT MAT	4,615	5,203	588	12.75%	-30.57%
FURNITURE	217	180	(37)	-17.09%	1.93%
PAPER	4,312	4,546	234	5.43%	-12.16%
CHEMICALS	8,362	8,316	(47)	-0.56%	2.42%
PETROLEUM	1,824	1,652	(172)	-9.42%	8.93%
PRIM MET	3,945	4,474	529	13.42%	-27.50%
FABR MET	246	284	38	15.59%	-1.99%
MACHINERY	395	484	88	22.29%	-4.58%
ELEC MACH	449	329	(120)	-26.73%	6.23%
TRANSP	4,069	3,793	(276)	-6.78%	14.34%
SCRAP	1,456	1,456	0	0.00%	0.00%
MIXED	5,028	2,566	(2,462)	-48.96%	127.88%
OTHER	561	395	(166)	-29.51%	8.60%
TOTAL	70,276	68,352	(1,925)	-2.74%	100.00%

TABLE 4.7 EXPECTED RAIL REVENUE IMPACTS FROM LCV NETWORK.

	STAA REVENUE (MILLIONS)	LCV REVENUE (MILLIONS)	REVENUE CHANGE (MILLIONS)	PERCENT REVENUE CHANGE	CHANGE/ TOTAL REV CHANGE (PERCENT)
CROPS	7,168	7,168	0	0.00%	0.00%
PRODUCE	244	83	(161)	-66.13%	1.68%
MINING	19,723	19,723	0	0.00%	0.00%
FOREST	1,214	1,159	(55)	-4.50%	0.57%
FOOD	6,257	5,526	(731)	-11.69%	7.65%
TEXTILES	68	29	(39)	-57.31%	0.40%
CONSTRUCT MAT	5,203	3,299	(1,904)	-36.59%	19.90%
FURNITURE	180	136	(44)	-24.59%	0.46%
PAPER	4,546	3,837	(709)	-15.59%	7.41%
CHEMICALS	8,316	6,996	(1,320)	-15.87%	13.79%
PETROLEUM	1,652	1,067	(585)	-35.42%	6.12%
PRIM MET	4,474	3,563	(911)	-20.36%	9.52%
FABR MET	284	223	(61)	-21.48%	0.64%
MACHINERY	484	330	(153)	-31.74%	1.60%
ELEC MACH	329	88	(241)	-73.18%	2.51%
TRANSP	3,793	3,277	(516)	-13.61%	5.39%
SCRAP	1,456	1,456	0	0.00%	0.00%
MIXED	2,566	624	(1,942)	-75.67%	20.30%
OTHER	395	200	(195)	-49.40%	2.04%
TOTAL	68,352	58,785	(9,567)	-14.00%	100.00%

a need for the railroad industry to undergo a basic evolution to accommodate the LCV impacts. Since the impact is large for many important commodity groups, many parts of the industry would be affected. To the extent these revenue losses are associated with traffic declines, the effect on profits will be moderated by lowered costs unless the moves involve high margin traffic. To the extent, however, these revenue losses stem from rate reductions on traffic that the railroads continue to carry, they represent direct reductions in the contribution to operating profits and a concern to the companies most seriously affected.

Table 4.8 apportions the revenue changes between those resulting from diverted traffic and those resulting from price changes for the STAA'82 case, and Table 4.9 presents the analogous information for the LCV case. The first three columns give the aggregate revenue changes and the next two columns report the shares (adding to 100%) due to the two effects. The estimates given in these two tables were developed using aggregate data, i.e., total ton-miles and average rates for each commodity group.[22/] The total STAA'82 effect is roughly a 65-35 split favoring the quantity induced effect, but some key commodity groups have changes substantially different from the industry average. For example, for the Mixed Shipments group, 77% of its revenue loss is due to the loss in traffic (quantity), reflecting a number of factors including the model assumption that large rail rate reductions are unlikely for this commodity group because of its relatively low margins. The dominant influence of price on revenue change for the Construction Materials group indicates that relatively large rate reductions resulted in a relatively small traffic loss.

22/ The revenue loss (gain) due to traffic losses (gains) was estimated as the change in ton-miles times the (pre-change) revenue per ton-mile. The price effect revenue losses (gains) were the differences between the total change in revenue and the change attributed to quantity.

TABLE 4.8 SOURCE OF RAIL REVENUE CHANGE FOR STAA'82 CASE.

	TOTAL REVENUE CHANGE (MILLIONS)	REVENUE CHANGE DUE TO Q (MILLIONS)	REVENUE CHANGE DUE TO P (MILLIONS)	PERCENT OF REVENUE CHANGE DUE TO: QUANTITY CHANGE	PRICE CHANGE
CROPS	0	0	0	NA	NA
PRODUCE	(101)	(108)	7	107.13%	-7.13%
MINING	0	0	0	NA	NA
FOREST	35	22	14	60.62%	39.38%
FOOD	(31)	(23)	(8)	73.07%	26.93%
TEXTILES	(28)	(22)	(5)	81.04%	18.96%
CONSTRUCT MAT	589	217	372	36.82%	63.18%
FURNITURE	(37)	(25)	(12)	68.11%	31.89%
PAPER	234	109	125	46.55%	53.45%
CHEMICALS	(47)	(52)	6	112.25%	-12.25%
PETROLEUM	(172)	(97)	(75)	56.42%	43.58%
PRIM MET	530	261	269	49.19%	50.81%
FABR MET	38	22	17	56.87%	43.13%
MACHINERY	88	66	22	74.51%	25.49%
ELEC MACH	(120)	(87)	(33)	72.31%	27.69%
TRANSP	(276)	(175)	(102)	63.20%	36.80%
SCRAP	0	0	0	NA	NA
MIXED	(2,465)	(1,897)	(568)	76.96%	23.04%
OTHER	(166)	(139)	(27)	83.62%	16.38%
TOTAL	(1,928)	(1,930)	2	66.63%	33.37%

NOTE: PERCENT TOTALS BASED ON ABS. VAL. OF CHANGES IN REVENUE.

TABLE 4.9 SOURCE OF RAIL REVENUE CHANGE FOR LCV CASE.

	TOTAL REVENUE CHANGE (MILLIONS)	REVENUE CHANGE DUE TO Q (MILLIONS)	REVENUE CHANGE DUE TO P (MILLIONS)	PERCENT OF REVENUE CHANGE DUE TO: QUANTITY CHANGE	PRICE CHANGE
CROPS	0	0	0	NA	NA
PRODUCE	(161)	(177)	16	109.66%	-9.66%
MINING	0	0	0	NA	NA
FOREST	(55)	(39)	(16)	71.15%	28.85%
FOOD	(731)	(423)	(309)	57.76%	42.24%
TEXTILES	(39)	(36)	(3)	92.26%	7.74%
CONSTRUCT MAT	(1,904)	(1,804)	(99)	94.78%	5.22%
FURNITURE	(44)	(24)	(20)	54.19%	45.81%
PAPER	(709)	(391)	(318)	55.14%	44.86%
CHEMICALS	(1,320)	(705)	(615)	53.39%	46.61%
PETROLEUM	(585)	(383)	(202)	65.40%	34.60%
PRIM MET	(911)	(555)	(355)	60.97%	39.03%
FABR MET	(61)	(44)	(17)	72.26%	27.74%
MACHINERY	(153)	(138)	(16)	89.76%	10.24%
ELEC MACH	(241)	(194)	(46)	80.82%	19.18%
TRANSP	(516)	(390)	(126)	75.53%	24.47%
SCRAP	0	0	0	NA	NA
MIXED	(1,942)	(1,543)	(399)	79.46%	20.54%
OTHER	(195)	(157)	(38)	80.33%	19.67%
TOTAL	(9,567)	(7,001)	(2,565)	73.19%	26.81%

Of the revenue losses under the LCV case, approximately 73% are due to rail quantity reductions. The commodity groups whose revenue losses are both large and more highly influenced by price reductions are of special interest since their profit margins or "contribution" may have declined significantly. Thus the data in Tables 4.7 and 4.9 can be used to help identify the commodity groups for which LCV competition will most severely impact rail profitability. While these data are reported by commodity group they also can be used to help identify the range of impacts among rail carriers since railroads that carry a relatively high proportion of commodities with large price effects will, other things equal, have the largest reductions in earnings.

Rail revenue changes by origin region are reported in Table 4.10 for the STAA'82 case and in Table 4.11 for the LCV case. These data provide information about the geographical distribution of revenue impacts and thus give an insight to the potential impact on specific rail carriers. The data for the LCV case are especially enlightening in this regard since the New England and Pacific regions are seen to have revenue reductions considerably greater than the national average, a result that is consistent with the ton-mile losses projected for these two regions in Table 4.5. Carriers with large traffic bases in these two regions can be expected to experience the largest revenue losses due to LCV competition, and the absolute scale of these losses, 25 and 34 percent, is an indication of the magnitude of the consequences for the railroads originating traffic in these regions.

4.4 Results for Mixed Shipments

As pointed out previously, since the HTFS and WB90 models do not incorporate all changes in the competitive environment that will occur, the models' results will not forecast and were not intended to forecast actual changes in rail traffic

TABLE 4.10 EXPECTED REGIONAL REVENUE IMPACTS FROM STAA'82.

	BASE REVENUE (MIL.)	STAA REVENUE (MIL.)	REV CHANGE (MIL.)	PERCENT REV CHANGE	CHANGE/ TOT CHANGE (PER.)
NEW ENGLAND	722	704	(18)	-2.49%	0.93%
MID ATLANTIC	4,462	4,404	(58)	-1.29%	2.99%
SOUTH ATLANTIC	5,543	5,498	(46)	-0.82%	2.37%
SOUTHEAST	4,440	4,406	(35)	-0.79%	1.81%
EAST NO CENT	12,878	11,551	(1,327)	-10.31%	68.97%
EAST SO CENT	7,129	7,062	(67)	-0.95%	3.51%
WEST NO CENT	9,750	9,594	(156)	-1.60%	8.09%
WEST SO CENT	8,175	8,134	(41)	-0.51%	2.15%
ROCKY MOUNT	10,332	10,383	51	0.50%	-2.66%
PACIFIC	6,843	6,615	(228)	-3.33%	11.84%
TOTAL	70,276	68,351	(1,924)	-2.74%	100.00%

TABLE 4.11. EXPECTED REGIONAL REVENUE IMPACTS FROM LCV NETWORK.

	STAA REVENUE (MIL.)	LCV REVENUE (MIL.)	REV CHANGE (MIL.)	PERCENT REV CHANGE	CHANGE/ TOT CHANGE (PER.)
NEW ENGLAND	704	527	(178)	-25.25%	1.86%
MID ATLANTIC	4,404	3,694	(710)	-16.13%	7.43%
SOUTH ATLANTIC	5,498	5,194	(304)	-5.53%	3.18%
SOUTHEAST	4,406	3,621	(784)	-17.80%	8.20%
EAST NO CENT	11,551	9,799	(1,752)	-15.17%	18.31%
EAST SO CENT	7,062	6,300	(762)	-10.79%	7.96%
WEST NO CENT	9,594	8,894	(701)	-7.30%	7.32%
WEST SO CENT	8,134	6,813	(1,321)	-16.24%	13.81%
ROCKY MOUNT	10,383	9,554	(830)	-7.99%	8.67%
PACIFIC	6,615	4,390	(2,226)	-33.65%	23.27%
TOTAL	68,351	58,784	(9,567)	-14.00%	100.00%

patterns. Nonetheless, for Mixed Shipments there are differences between the predicted changes as a consequence of STAA'82 and the actual changes between 1981 and 1984 that should be noted. The model predicts that as a result of STAA'82, Mixed Shipments rail traffic in 1990 will be 38% lower than the 1990 base case forecast. However, in the model's base case, there is substantial growth in Mixed Shipments between 1981 and 1990. If the effects of STAA'82 are experienced gradually over time, an interpolation of the model's results for the intervening years projects a slower rate of growth for Mixed Shipments, peaking in 1985, before receding toward the 1990 level. (The base case and STAA'82 profiles are displayed in Figure 4.1) The interpolation yields a ton-mile estimate of Mixed Shipments in 1984 which is <u>9%</u> higher than the 1981 level of traffic. Data for the rail industry show that between 1981 and 1984 (which included two years after passage of the 1982 Surface Transportation Assistance Act) Mixed Shipments ton-miles actually increased from 41.3 billion to 60.9, a jump of <u>47%</u>.[23/]

The primary factor in the extraordinary growth of Mixed Shipments traffic was the ICC's decision to deregulate all TOFC/COFC movements. Railroads could for the first time, enter into contracts with shippers and tailor both rates and service to the shippers' individual needs. As a result, railroads have become much more aggressive in their marketing approach. Unfortunately for the railroad industry, an important source for new TOFC/COFC has been rail traffic previously moving in other types of rail equipment. This was recognized as early as 1982:

> "Where is this surge in TOFC/COFC traffic coming from? Some of it has been from highway trucks; some of it

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23/ All data on rail ton-miles in the section are taken from Federal Railroad Administration, <u>SS1 Reports - Carload Waybill Sample</u>.

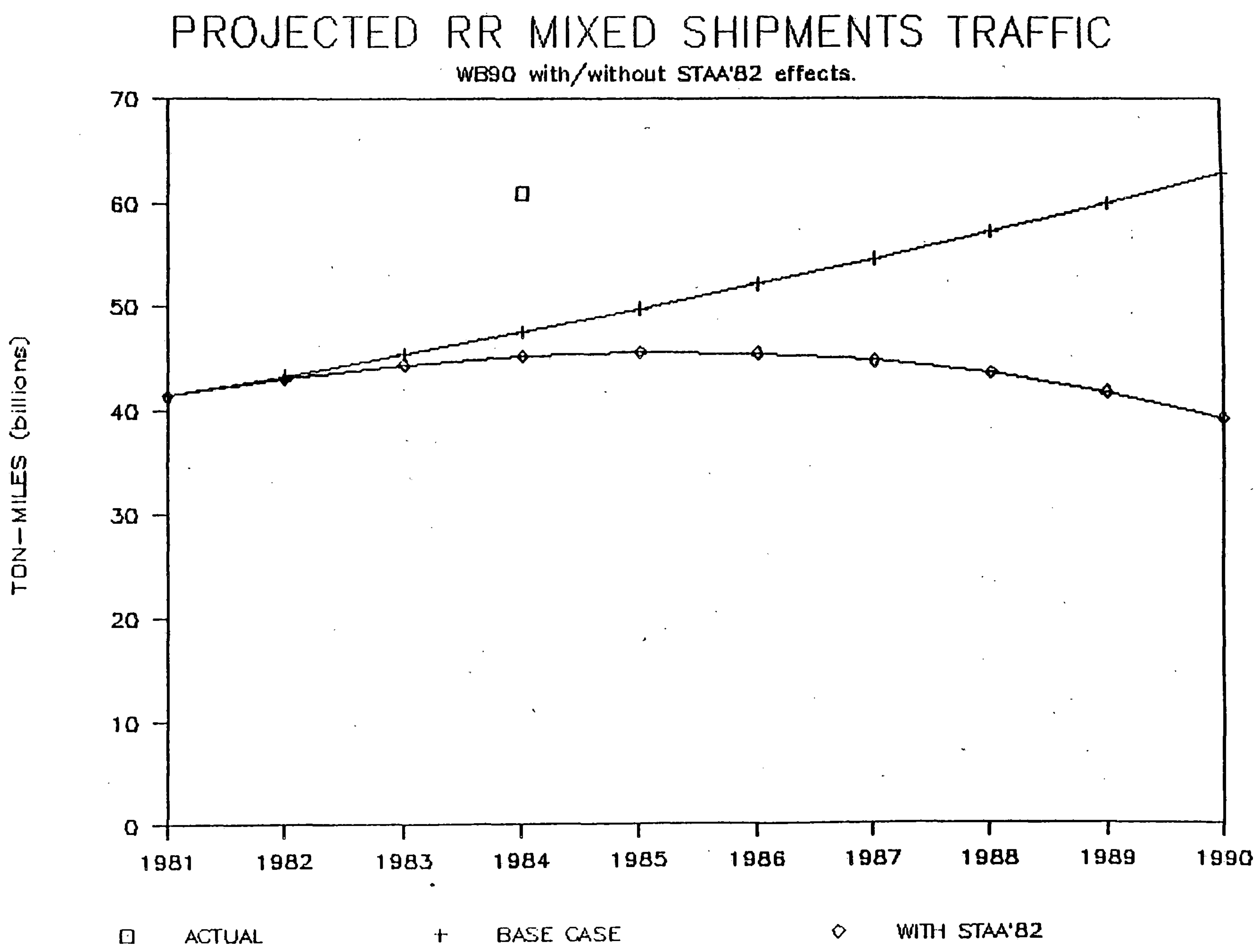
PROJECTED RR MIXED SHIPMENTS TRAFFIC
WB90 with/without STAA'82 effects.
TON-MILES (billions)
0
10
20
30
40
50
60
70
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
ACTUAL
BASE CASE
WITH STAA'82

FIGURE 4.1

is traffic that formerly moved in boxcars. Just how much of the latter is not certain; but clearly the total deregulation of piggyback has hurt the boxcar business.... (G)ood piggyback service does seem to meet many shippers' needs for fast, consistent service with the ability, especially important during the economic depression, to ship in smaller quantities than is possible in boxcars."24/

The data on rail ton-miles confirms that a significant shift in the mix of rail traffic has occurred. In 1981, Mixed Shipments represented 5.9% of all non-coal ton-miles. By 1984 the share had grown to 9.4%. Between 1981 and 1984, revenue per ton-mile on Mixed Shipments decreased from 4.40 to 4.21 cents (a 4.3% reduction and revenue per ton-mile for all other non-coal traffic increased from 3.30 to 3.46 cents (5.0% higher).25/ These changes in rates also reflect changing competitive conditions that would result in an increase of the Mixed Shipments share of non-coal traffic.

A second important factor in the growth of Mixed Shipments has been the surge in container imports through the Pacific Coast ports. Using revenue tonnage as the unit of measurement, these imports grew by 55% between 1981 and 1984.26/ This was paralleled by an increase in ton-miles on Mixed Shipments rail traffic originating in the Pacific Coast states from 11.5 to 22.9 billion (a 99% increase - as compared to the 47% national total). The Pacific region's share in Mixed Shipments ton-mile originations rose from 28% to 37%.

24/ Modern Railroads Dec. 1982, p. 40. This article was written before the effects of STAA'82 could have been felt.

25/ Data for gross freight revenues, all commodities and coal, were obtained from Association of American Railroads, Analysis of Class I Railroads. Revenues for Mixed Shipments (STCC's 44, 45, 46, and 47) were obtained from Federal Railroad Administration, SS1 Reports - Carload Waybill Sample.

26/ Pacific Maritime Association, Annual Report, 1985, p. 38.

The rapid growth in Mixed Shipments is not expected to continue, since at least some of the growth factors will not be present in the future (obviously Mixed Shipments cannot be deregulated again). In fact, the number of trailers and containers loaded in 1985 was 1.1% lower than in 1984.[27/] However, given that the changes have occurred, an important conclusion that can be drawn from the 1981-84 experience is that the railroad industry might be more vulnerable to the introduction of an LCV network than is suggested by the WB90 analysis. The results reported in Section 6 are consistent with this observation.[28/]

27/ Traffic World, Jan. 20, 1986, p.22.

28/ Table 6.2 projects a total rail revenue loss of 19% from an LCV network, as compared to the 14% of Table 4.7.

5.0 Railroad Profitability, Seven Selected Railroads

Information on rail revenue and ton-mile changes can give only a limited indication of the STAA and LCV impacts on rail profitability. A more complete picture requires knowledge of a carrier's cost structure and how this will be affected by traffic diversions and price cuts. There is however, no singularly acceptable procedure for identifying costs that would vary directly with changes in railroad traffic, especially if the goal is to measure the long run profitability consequences due to changes in a railroad's traffic base.

In this study, the STAA'82 and LCV effects on rail profitability have been analyzed for seven Class I railroads. For each carrier, contribution was estimated for each shipment handled by the carrier in the projected 1990 Waybill Sample.[29/] The costing methodology employed was the ICC's Uniform Rail Costing System (URCS).

The contribution measure used here, was also considered a proxy for a carrier's (pre-tax) profits on a move. Given the problems of applying any costing technique over a broad range of movements, and the difficulties of identifying the (short or long run) costs attributable to a move, it should be understood that actual profit conditions may be different from the measures of this study.[30/] For example, the URCS costing techniques indicate that even in the base case, two commodities, Produce and Mixed Shipments, are handled on average, at a loss (i.e., the estimated contribution is negative). By applying more specific information on the directly variable costs of individual moves, railroads may nonetheless believe this traffic or at least a major portion of it to be profitable

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29/ For more details on the assignment of costs and revenues to a particular carrier in the WB90 analysis, see Section 2.

30/ See footnote 14.

despite the apparent loss indicated by the application of URCS techniques. Shipments in these categories are generally considered by the industry to be low margin, but nonetheless profitable.

The seven railroads have been chosen to reflect a wide diversity of carriers in the Class I category. Not all of the carriers selected are among the largest, and the data show striking differences in commodity mix and base case profitability. To maintain confidentiality, the railroad specific results of this section are reported in indexed form.

5.1 Aggregate Results

Tables 5.1 and 5.2 contain, for the seven selected railroads, the ton-mile data equivalent to the industry wide figures reported in Tables 4.1 and 4.2. The seven railroads' ton-miles represent 29% of the industry's ton-miles in the base case. The commodity diversion percentages are roughly the same as those for the industry as a whole, not surprising since the seven railroad data are a subset of the data used in Section 4. The percentage of total ton-miles diverted is slightly higher for the seven carriers because they carry a relatively high share of traffic that is truck competitive.

According to Table 5.3, the seven railroads lose only 3.6% of revenue and 1.2% of contribution because of STAA'82. A large loss in contribution for Mixed Shipments is almost entirely offset by gains for other commodity groups, especially Building Materials, Paper, and Primary Metal Products. For these commodities higher STAA'82 user fees push truck costs up (as discussed in Section 2). Railroads are assumed to respond to truck rate increases in the same way they respond to reductions, that is by changing their own rates, but not to the same extent as truck rates. Higher rates and the diversion of traffic from truck to rail (due to the greater price differential

TABLE 5.1 EXPECTED TRAFFIC IMPACTS FROM STAA'82 FOR SEVEN SELECTED RAILROADS.

COMMODITY	TON MILES IN BASE CASE (MILLIONS)	TON MILES IN STAA'82 (MILLIONS)	LOSS/GAIN DUE TO STAA'82 (MILLIONS)	PERCENT LOS/GAIN
CROPS	35,505	35,505	0	0.00%
PRODUCE	2,092	1,613	(479)	-22.89%
MINING	93,432	93,432	0	0.00%
FOREST	4,210	4,285	74	1.76%
FOOD	29,881	29,777	(104)	-0.35%
TEXTILES	335	257	(78)	-23.19%
CONSTRUCT MAT	22,235	23,229	994	4.47%
FURNTURE	480	433	(47)	-9.86%
PAPER	20,162	20,621	459	2.28%
CHEMICALS	40,654	40,429	(225)	-0.55%
PETROLEUM	8,041	7,669	(373)	-4.64%
PRIMARYMET	20,977	22,380	1,403	6.69%
FABMET	532	577	46	8.56%
MACHINERY	1,034	1,201	166	16.09%
ELECTRICAL	875	703	(172)	-19.68%
TRANSPORT	8,109	7,766	(343)	-4.23%
SCRAP	5,764	5,764	0	0.00%
MIXED	26,096	16,470	(9,626)	-36.89%
OTHER	1,834	1,394	(440)	-23.99%
TOTAL	322,249	313,505	(8,745)	-2.71%

TABLE 5.2 EXPECTED TRAFFIC IMPACTS FROM AN LCV NETWORK FOR SEVEN SELECTED RAILROADS.

COMMODITY	TON MILES IN STAA'82 (MILLIONS)	TON MILES IN LCV (MILLIONS)	LOSS DUE TO LCV (MILLIONS)	PERCENT LOSS
CROPS	35,505	35,505	0	0.00%
PRODUCE	1,613	638	(976)	-60.47%
MINING	93,432	93,432	0	0.00%
FOREST	4,285	4,164	(121)	-2.82%
FOOD	29,777	27,776	(2,001)	-6.72%
TEXTILES	257	117	(140)	-54.47%
CONSTRUCT MAT	23,229	15,503	(7,726)	-33.26%
FURNTURE	433	374	(59)	-13.58%
PAPER	20,621	18,933	(1,688)	-8.19%
CHEMICALS	40,429	36,838	(3,591)	-8.88%
PETROLEUM	7,669	5,974	(1,695)	-22.10%
PRIMARYMET	22,380	19,572	(2,808)	-12.55%
FABMET	577	471	(106)	-18.43%
MACHINERY	1,201	858	(343)	-28.58%
ELECTRICAL	703	276	(426)	-60.67%
TRANSPORT	7,766	6,940	(826)	-10.64%
SCRAP	5,764	5,764	0	0.00%
MIXED	16,470	6,391	(10,079)	-61.20%
OTHER	1,394	838	(557)	-39.92%
TOTAL	313,505	280,362	(33,142)	-10.57%

TABLE 5.3 RAIL CONTRIBUTION LOSES BY COMMODITY TYPE FOR SEVEN SELECTED RAILROADS, BASE CASE VS. STAA'82.

COMMODITY	BASE CASE REVENUE (MILLIONS)	BASE CASE COSTS (MILLIONS)	BASE CASE CONTRIB. (MILLIONS)	STAA'82 REVENUE (MILLIONS)	STAA'82 COSTS (MILLIONS)	STAA'82 CONTRIB. (MILLIONS)	LOSS IN REV-STAA (MILLIONS)	LOSS IN COST-STAA (MILLIONS)	LOSS IN CON-STAA (MILLIONS)
CROPS	1,579	1,397	182	1,579	1,397	182	0	0	0
PRODUCE	114	155	(40)	92	124	(32)	(22)	(31)	9
MINING	5,414	3,920	1,494	5,414	3,920	1,494	0	0	0
FOREST	337	297	40	347	302	44	9	5	4
FOOD	2,217	1,770	447	2,206	1,765	441	(12)	(6)	(6)
TEXTILES	46	39	7	34	31	3	(12)	(8)	(4)
CONSTRUCT MAT	1,476	1,203	273	1,655	1,256	399	179	53	127
FURNITURE	96	81	16	81	72	9	(15)	(8)	(7)
PAPER	1,451	1,229	222	1,524	1,257	267	73	27	45
CHEMICALS	2,868	1,885	983	2,852	1,875	977	(16)	(10)	(6)
PETROLEUM	658	482	176	601	461	140	(57)	(21)	(36)
PRIMARYMET	1,538	1,162	376	1,745	1,233	513	207	70	137
FABMET	68	60	9	79	64	14	10	5	5
MACHINERY	130	89	41	158	103	55	28	14	14
ELECTRICAL	153	96	57	112	77	35	(40)	(19)	(22)
TRANSPORT	1,571	1,393	178	1,464	1,335	129	(108)	(58)	(49)
SCRAP	531	454	77	531	454	77	0	0	0
MIXED	2,065	2,139	(74)	1,085	1,400	(315)	(980)	(739)	(240)
OTHER	242	190	51	173	145	27	(69)	(45)	(24)
TOTAL	22,555	18,042	4,513	21,731	17,271	4,460	(824)	(771)	(53)

PERCENT LOSS IN REVENUE DUE TO STAA = 3.65%

PERCENT LOSS IN COSTS DUE TO STAA = 4.27%

PERCENT LOSS IN CONTRIBUTION DUE TO STAA = 1.18%

after STAA) both contribute to larger contribution levels for these commodities.

The LCV results reported in Table 5.4 are much more devastating to the railroads. In this case, there is a 28% reduction in contribution. This result is even more significant considering that Crops, Mining Products, and Scrap, three commodities assumed to be unaffected by the STAA and LCV changes account for 39% of the STAA contributions. The changes in contribution from STAA to LCV are almost all negative, and four commodities, Textiles, Furniture, Electrical Machinery, and Other Traffic, have marginally negative total contribution in the post-LCV environment. Over 2/3 of post-LCV railroad contribution is derived from Mining Products and Chemicals.

The data on Mixed Shipments in Tables 5.3 and 5.4 raise some important questions for the analysis. As previously pointed out, even in the base case, URCS variable costs exceed revenues,[31/] with an implied rate to variable cost ratio of 0.97. The substantially larger negative contribution in the STAA'82 and LCV cases increases the likelihood that this traffic might be carried at a loss. Certainly, in terms of the analysis of this section, it would appear to be more profitable if the railroads were to lose all of this traffic. In fact the model results reported in Table 5.4 show that the traffic diversions in the LCV scenario keep the Mixed Shipment contribution losses at the STAA'82 level, despite an assumed rail price response.

Because of the net negative contribution for Mixed Shipments, alternative estimates of revenue and contribution losses were made with the assumption that for Mixed Shipments, carriers did not lower their prices, choosing instead to absorb

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31/ The same is true for Produce, which accounted for a much smaller percentage of total rail shipments. The analysis assumed that railroads did not make any price concession for Produce (see Section 3).

TABLE 5.4 RAIL CONTRIBUTION LOSES BY COMMODITY TYPE FOR SEVEN SELECTED RAILROADS, STAA'82 VS. LCV.

COMMODITY	STAA'82 REVENUE (MILLIONS)	STAA'82 COSTS (MILLIONS)	STAA'82 CONTRIB. (MILLIONS)	LCV REVENUE (MILLIONS)	LCV COSTS (MILLIONS)	LCV CONTRIB. (MILLIONS)	LOSS IN REV- LCV (MILLIONS)	LOSS IN COST- LCV (MILLIONS)	LOSS IN CON- LCV (MILLIONS)
CROPS	1,579	1,397	182	1,579	1,397	182	0	0	0
PRODUCE	92	124	(32)	43	56	(13)	(49)	(68)	19
MINING	5,414	3,920	1,494	5,414	3,920	1,494	0	0	0
FOREST	347	302	44	333	295	38	(13)	(7)	(6)
FOOD	2,206	1,765	441	1,954	1,655	298	(252)	(109)	(143)
TEXTILES	34	31	3	15	16	(1)	(19)	(15)	(4)
CONSTRUCT MAT	1,655	1,256	399	1,057	847	210	(598)	(409)	(189)
FURNTURE	81	72	9	61	62	(1)	(20)	(10)	(9)
PAPER	1,524	1,257	267	1,289	1,156	133	(235)	(101)	(134)
CHEMICALS	2,852	1,875	977	2,388	1,713	675	(464)	(162)	(302)
PETROLEUM	601	461	140	394	369	25	(207)	(92)	(115)
PRIMARYMET	1,745	1,233	513	1,395	1,092	303	(350)	(141)	(209)
FABMET	79	64	14	58	53	5	(20)	(11)	(9)
MACHINERY	158	103	55	108	75	33	(50)	(28)	(22)
ELECTRICAL	112	77	35	30	33	(3)	(82)	(44)	(38)
TRANSPORT	1,464	1,335	129	1,258	1,195	63	(205)	(139)	(66)
SCRAP	531	454	77	531	454	77	0	0	0
MIXED	1,085	1,400	(315)	265	577	(312)	(819)	(823)	3
OTHER	173	145	27	88	89	(1)	(85)	(56)	(28)
TOTAL	21,731	17,271	4,460	18,262	15,055	3,207	(3,469)	(2,216)	(1,253)

PERCENT LOSS IN REVENUE DUE TO LCV = 15.96%

PERCENT LOSS IN COSTS DUE TO LCV = 12.83%

PERCENT LOSS IN CONTRIBUTION DUE TO LCV = 28.09%

a greater amount of traffic diversion. Table 5.5 contains the results based on this assumption. It is apparent from this table that eliminating the assumed price response for Mixed Shipments has very little effect on the aggregate revenue and ton-mile results for all commodities.[32] LCV ton-mile losses are 10.9% instead of 10.6%. The LCV revenue loss is 15.8% compared to 16.0%. The aggregate contribution loss is affected somewhat more. The STAA'82 loss of 1.2% becomes a gain of 3.4%, while the LCV loss of 28.1% is reduced to 24.7%. The ton-mile and revenue results for Mixed Shipments show a greater change. Under LCV, there is a larger reduction in ton-miles (74.2% vs. 63.4%), while the revenue drop is lower (68.0% vs. 75.6%). Not surprisingly, in view of the data presented in Tables 5.1 - 5.4, the contribution effects of a no price response assumption are substantial. In fact, the $311 million deficit for Mixed Shipments in the LCV case, completely disappears.

Since the no price response assumption for Mixed Shipments did not have a significant effect on the aggregate results, and since the calculation of negative contribution using URCS cost formulas does not necessarily imply that the traffic is moving at a loss, the remainder of this section and Section 6, report results using the price response assumptions. In some cases, when the data are disaggregated so that Mixed Shipments assume a greater share of the traffic in question, this procedure may lead to an overestimate of the full effects of the STAA'82 and LCV.

5.3 Results for the Seven Railroads

As Table 5.6 shows, the impacts of the STAA'82 and LCV can be substantially different among railroads. The STAA'82 results show that four of the seven carriers are actually

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[32] The results were so close, that no attempt was made to consider the effect of no price response for Mixed Shipments for all railroads in the analysis of Section 4.

TABLE 5.5 TON-MILE, REVENUE AND CONTRIBUTION EFFECTS, ASSUMING NO PRICE RESPONSE FOR MIXED SHIPMENTS, SEVEN SELECTED RAILROADS.

	ALL COMMODITIES:			MIXED SHIPMENTS ONLY:		
	WITH PRICE RESPONSE FOR MIXED SHIP. (MILLIONS)	W/OUT PRICE RESPONSE FOR MIXED SHIP. (MILLIONS)	RATIO, WITH P RESP. TO W/O P RES.	WITH PRICE RESPONSE FOR MIXED SHIP. (MILLIONS)	W/OUT PRICE RESPONSE FOR MIXED SHIP. (MILLIONS)	RATIO, WITH P RESP. TO W/O P RES.
TON-MILES B.CASE	322,249	322,249	1.00	26,096	26,096	1.00
TON-MILES, STAA'82	313,505	311,812	1.01	17,470	14,777	1.18
TON-MILES, LCV	280,362	277,784	1.01	6,391	3,813	1.68
% T-M LOSS, BC/STAA	-2.71%	-3.24%		-33.05%	-43.37%	
% T-M LOSS, STAA/LCV	-10.57%	-10.91%		-63.42%	-74.20%	
REVENUE, B.CASE	22,555	22,555	1.00	2,065	2,065	1.00
REVENUE, STAA'82	21,732	21,811	1.00	1,084	1,164	0.93
REVENUE, LCV	18,262	18,367	0.99	265	373	0.71
% REV LOSS BC/STAA	-3.65%	-3.30%		-47.49%	-43.63%	
% REV LOSS STAA/LCV	-15.97%	-15.79%		-75.55%	-67.98%	
CONTRIB. B. CASE	4,514	4,514	1.00	(74)	(74)	1.00
CONTRIB. STAA'82	4,460	4,670	0.96	(315)	(104)	3.04
CONTRIB. LCV	3,207	3,518	0.91	(311)	0	N/A
% CON. LOSS BC/STAA	-1.19%	3.44%		327.03%	40.54%	
% CON. LOSS STAA/LCV	-28.11%	-24.67%		-1.27%	-100.00%	

TABLE 5.6 TON-MILE REVENUE AND CONTRIBUTION EFFECTS OF STAA'82 AND LCV FOR SEVEN SELECTED RAILROADS.

	RAILROAD I	RAILROAD II	RAILROAD III	RAILROAD IV	RAILROAD V	RAILROAD VI	RAILROAD VII
TON MILES, BASE	100.0	100.0	100.0	100.0	100.0	100.0	100.0
REVENUE, BASE	100.0	100.0	100.0	100.0	100.0	100.0	100.0
VAR. COST, BASE	90.7	68.3	87.5	73.0	59.2	87.5	83.2
CONTRIB., BASE	9.3	31.7	12.5	27.0	40.8	12.5	16.8
CON AS % REV	9.27%	31.74%	12.46%	26.97%	40.78%	12.53%	16.80%
TON MILES, STAA'	98.3	99.6	97.1	98.8	99.5	99.9	91.5
REVENUE, STAA'82	97.6	99.3	97.3	98.9	98.8	99.8	87.3
VAR. COST, STAA'	88.4	67.4	83.3	70.7	58.2	86.9	73.4
CONTRIB., STAA'8	9.2	31.9	14.0	28.2	40.5	12.9	13.8
CON AS % REV	9.38%	32.17%	14.35%	28.48%	41.03%	12.91%	15.87%
STAA'82 EFFECTS:							
CONTRIB. LOSS	-0.1	0.2	1.5	1.2	-0.3	0.4	-3.0
% CHANGE, TM	-1.69%	-0.38%	-2.95%	-1.17%	-0.46%	-0.10%	-8.50%
% CHANGE, REV	-2.40%	-0.70%	-2.70%	-1.12%	-1.24%	-0.17%	-12.74%
% CHANGE, VC	-2.52%	-1.32%	-4.80%	-3.17%	-1.65%	-0.60%	-11.76%
% CHANGE, CON	-1.23%	0.63%	12.10%	4.42%	-0.66%	2.82%	-17.58%
TON MILES, LCV	89.0	90.6	79.6	84.5	96.4	94.1	78.5
REVENUE, LCV	82.7	85.1	74.6	76.9	92.8	87.7	68.8
VAR. COST, LCV	78.9	60.7	67.0	58.5	55.3	80.5	60.0
CONTRIB., LCV	3.8	24.5	7.6	18.4	37.6	7.1	8.8
CON AS % REV	4.61%	28.74%	10.14%	23.90%	40.46%	8.12%	12.75%
LCV EFFECTS:							
CONTRIB. LOSS	-5.3	-7.5	-6.4	-9.8	-2.9	-5.8	-5.1
% CHANGE, TM	-9.44%	-9.01%	-17.95%	-14.50%	-3.17%	-5.80%	-14.22%
% CHANGE, REV	-15.29%	-14.29%	-23.36%	-22.26%	-5.98%	-12.20%	-21.16%
% CHANGE, VC	-10.84%	-9.96%	-19.59%	-17.28%	-5.08%	-7.38%	-18.23%
% CHANGE, CON	-58.35%	-23.43%	-45.85%	-34.76%	-7.27%	-44.73%	-36.67%

NOTE: ALL DOLLAR FIGURES ARE INDEXED FOR EACH RAILROAD, WITH BASE REVENUE = 100. ALL TON MILES ARE INDEXED FOR EACH RAILROAD WITH BASE TON MILES = 100.

able to gain contribution moving from the base case. Again, this result stems from the fact that higher user taxes force truck costs up for high density commodities in some traffic lanes. Railroad III actually experiences a contribution gain of over 12% (although its base case contribution as a percent of revenue is among the lowest of the seven railroads). Railroad VII is especially hard hit by STAA'82 (a 17.6% loss in contributions). Its total traffic base includes a high percentage of Mixed Shipments.

Focusing on the LCV case, the railroads' ton-mile losses vary from 3.2% to 18.0%, while revenue losses range from 6.0% to 23.4%. In general, the more profitable carriers[33/] lose the smallest percentage of their contribution when Longer Combination Vehicles are introduced. The rankings are the same except that the fifth and sixth ranked carriers in terms of STAA'82 contribution as a percent of revenues, are reversed when ranked by LCV percentage loss of contribution. There is less of a correlation between ton-miles lost and contribution lost (both in percentage terms). For example, Railroad VI ranks second in lowest ton-miles lost (5.8%), but fifth in lowest contribution lost (44.7%).

33/ Measured by contribution as a percent of revenue.

6.0 Analysis of All Class I Railroads, 1984 Data

The final analytical procedure was designed to measure and present the differential impact of a Longer Combination Vehicle network on all Class I railroads existing in 1984.[34/] Several measures of "harm" were defined and the carriers were ranked from "most harmed" to "least harmed." The results show not only the extent of the differences of the impacts across railroads, but also the types of traffic or commodity mixes that make carriers susceptible to the changes in truck productivity attributable to Longer Combination Vehicles.

Instead of projecting revenues, etc. to 1990, the measures of impacts were derived in this section using the actual operating and financial results for 1984 available in the AAR's "Analysis of Class I Railroads, 1984" and in the 1984 Freight Commodity Statistics. Each railroad's gross revenues were divided into the commodity groups used throughout this study and the expected contribution losses were derived using the techniques described in Section 6.1. The effects were measured from the changes that are assumed to occur as a result of a Longer Combination Vehicle network only. By 1984, the 1982 Surface Transportation Assistance Act had been in effect two years.

The impact measures were based on estimates of losses in railroad earnings on traffic that railroads keep by reducing rates (prices) in response to the introduction of a Longer Combination Vehicles network as well as on losses associated with diversions of traffic (quantity). The price effect revenue losses would result in a dollar for dollar reduction in contribution, that is, the difference between revenues and variable costs, as described in Section 5. In more formal railroad accounting

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34/ The Class I carriers used in this analysis were all the reporting Railroads contained in the AAR's "Analysis of Class I Railroads, 1984." This included some railroads from the same corporate family. All information on net return on investment, operating ratios, margins of safety, etc., came for this source.

terms, when rates change on existing traffic, there is also a dollar for dollar loss in Railway Operating Revenues and, because Railway Operating Expenses would not change, in Net Revenue from Operations. Finally, lower rates would cause a reduction in Net Railway Operating Income (NROI) which is the amount available after taxes for distribution to stock and bond holders. The amount of NROI lost would depend on how the revenue loss would change tax liabilities for the carrier.

Obviously, the introduction of an LCV network would also cause railroads to lose traffic (quantity effect) and therefore to lose additional amounts of earnings, and Railway Operating Revenues. The magnitude of the quantity effect changes in Net Revenue from Operations and NROI is less clear however. If carriers lose traffic, they will adjust their levels of operations and eventually their physical plant to an appropriate size for the remaining customers. Railway Operating Expenses, as well as Revenues, will be lower. The following section suggests one way to measure the contribution losses despite these difficulties. This value, when added to the price effect contribution loss, can be assumed equal to the railroad's loss in Net Operating Revenues, Net Revenues from Operations and, with the appropriate tax adjustment, NROI.

6.1 Calculating the Contribution Loss

Since a 1984 Costed Waybill tape was unavailable, it was necessary to develop a method that calculated indirectly, contribution losses for each railroad likely to result from the introduction of Longer Combination Vehicles. The method, explained in this section, was based on the average rate to (URCS variable) cost ratios for each commodity, developed in Section 5 and data on industry-wide quantity and revenue losses from Section 4. Before applying this method to 1984 data, it was tested using the seven railroad information of Section 5.

The initial steps in the procedure estimate changes in revenue separately attributable to the price and quantity effects described in Section 6. The first step is to calculate the total change in one carrier's revenue from a particular commodity i.

$$(1) \qquad \Delta rev_i/rev_i = \Delta rev'_i/rev'_i$$

where $\Delta rev'_i$ and rev'_i refer to industry wide estimates and the unprimed variables refer to a single railroad. It was also assumed that all carriers would experience the same percentage quantity losses:

$$(2) \qquad \Delta Q_i/Q_i = \Delta Q'_i/Q'_i$$

(again, the primed letters refer to industry-wide totals). To estimate the percentage loss in revenue due to traffic losses (the "quantity effect"), assume that the change in revenue due to a change in growth is proportional to the change in quantity. This yields:

$$(3) \qquad \Delta\, rev_i(Q)/rev_i = \Delta Q_i/Q_i = \Delta Q'_i/Q'_i.$$

The change in revenue due to a change in price can now be estimated simply as the difference between the total change in revenue and that portion of the change due to the quantity shift:

$$(4) \qquad \Delta rev_i(P) = \Delta rev_i - \Delta rev_i(Q).$$

The "price effect" change in contribution was assumed equal to the "price effect" change in revenue:

$$(5) \qquad \Delta Con_i(P) = \Delta rev_i(P).$$

The "quantity effect" change in contribution was measured as the difference between the change in revenue and the change in variable costs (VC) attributable to lost traffic:

$$(6) \qquad \Delta Con_i(Q) = \Delta rev_i(Q) - \Delta VC_i(Q).$$

The change in a railroad's variable costs was estimated by the formula:

$$(7) \qquad \Delta rev_i(Q) / \Delta VC_i(Q) = (R/CR)'$$

where (R/CR)' is an industry wide estimate of the rate to cost ratio for commodity i.

Before applying this method to all railroads, tests of these formulas were applied to the seven carriers analyzed in Section 5 for which railroad specific results were available. These tests yielded the data presented in column two of Table 6.1. These results could be compared to the contribution losses in Section 5 that were obtained by costing every shipment for the carrier (column three). All numbers in Table 6.1 are indexed to the contribution losses obtained when shipments were costed individually. The use of industry-wide data appears to underestimate the contribution loss. In only one case (Railroad III), the use of industry-wide data yields an estimate of the total contribution loss which is greater than the WB90 estimates.

Since costing individual moves in a 1984 shipment sample was beyond the scope of this study, it was necessary to apply industry-wide data to the railroads' gross (commodity specific) revenues. Table 6.1 shows that this should provide a reasonable estimate of the full contribution loss.

TABLE 6.1 COMPARISON OF CONTRIBUTION LOSS USING INDUSTRY DATA, COMPARED TO ACTUAL CONTRIBUTION LOSS, WB90 ANALYSIS, SEVEN SELECTED RAILROADS (STAA'82 VS. LCV).

RAILROAD:	ESTIMATES OF CONTRIBUTION LOSS USING INDUSTRY AVERAGES (SECT. 6.1 OF THIS REPORT)	TOTAL CONTRIBUTION LOSS FROM WAYBILL ANALYSIS (SECT. 5 OF THIS REPORT)
I	99.9	100.00
II	81.9	100.00
III	104.4	100.00
IV	77.2	100.00
V	84.0	100.00
VI	98.4	100.00
VII	88.8	100.00

NOTE ALL VALUES INDEXED TO 100.0 FOR ACTUAL CONTRIBUTION LOSS FROM WB90 ANALYSIS.

6.2 Impacts for the Twenty-Eight Railroads

The "impact" of LCV's was measured several ways. To be consistent with ICC decisions on revenue adequacy (Ex Parte 393) the analysis focused on each carrier's return on net investment defined as the ratio of net railway operating income (NROI) to the net asset base. It was assumed for the purposes of this analysis that the corporate marginal tax rate of 46 percent was the appropriate adjustment factor for converting contribution loss to loss in NROI, i.e.:

$$\Delta \text{NROI} = .54 * \Delta \text{Contribution}.$$

The loss of traffic will change the net asset base as railroads adjust to lower traffic levels. Since the net asset base is the denominator in the ICC's revenue adequacy determination, estimates of changes in return on investment that do not account for changes in the asset base will be overstatements. Rather than guess at the extent of changes in the base, the results reported here include changes to the numerator only.

Even if two railroads lose the same return on net investment, the impact may not be judged to be the same for both carriers. If, for example, Railroad A's return was 7% before LCV, while Railroad B's return was 2% and each lost an amount equivalent to a 2% return, the consequences would be quite different. Railroad B has lost all of its NROI as a result of LCV's and B may be judged to have been harmed more than Railroad A.[35/] In order to account for both the changes in return on net

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35/ On the other hand it could also be argued that an LCV network increased the difficulty of attaining revenue adequacy by the same degree for the two carriers, since the effect of LCV's is the same on the two railroads' return on net investment. Other market forces caused Railroad B's return to be only 2 percent in the pre-LCV environment and this fact should not alter the assessment of the LCV impacts. In addition, a company's return on investment in a single year may not be a good measure of its long run viability.

investment and the existing pre-LCV return, both the loss in return on net investment and the percentage of total return lost (equivalent to the percentage of NROI lost) have been estimated.

Impacts on the 28 Class I railroads were also made by calculating changes in the operating ratios and the margins of safety. The operating ratio equals:

O.R. = Railway Operating Expenses / Railway Operating Revenue

Lower operating ratios indicate a better earnings performance. The best operating ratios among Class I carriers in 1984 (top five) were in the range of 0.74 to 0.81. Four carriers had ratios above 1.0 and several others approached this figure. The industry average (Total Railway Operating Expenses divided by Total Operating Revenues) was 0.88.

The margin of safety is defined as:

M = (Net Revenue from Operations - Fixed Charges)/(Operating Revenue)

This ratio reflects the percentage decline in total revenue that could be sustained before jeopardizing coverage of Fixed Charges. The industry average of 9.04% includes a wide variation among railroads -- the top four having a margin of safety of 17% or higher, the bottom four being below zero.

The numerator and denominator of both the operating ratio and the margin of safety are affected by the projected changes in expenses and revenues generated by the estimating procedures. The results reported here reflect all of these changes.

The calculated revenue loss for all Class I carriers was $5.6 billion, 18.9% of total Class I gross freight revenues.

The predicted aggregate revenue losses exceed the losses forecast in Section 4, primarily because of a relative increase in Mixed Shipments in the traffic base over the 1981-1984 period (see Section 4.4). More importantly, the loss resulted in a reduction of 33.3% in net revenue from operations and, when adjusted by the marginal tax rate, translated into 28.6% drop in the industry's total 1984 NROI. The aggregate return on net investment (sum of all NROI's divided by sum of all net asset bases) was 5.17%. The loss in rate of return due to LCV's was -1.48%, making the industry's post-LCV return 3.69%.

In order to preserve confidentiality, the railroads were ranked from "least harmed" to "most harmed" as measured by the loss of return on net investment and listed in Table 6.2 by number according to that rank. The four carriers with a negative return in 1984 are shown as "NA" when measuring the loss in return as a percent of the pre-LCV return. Four railroads actually lost more NROI than they had in the pre-LCV environment. They are listed in the table with a 100% loss of pre-LCV return. The individual carriers' projected losses in rate of return on net investment, with two exceptions, range from 0 to 3.0%. While this may appear to be a fairly narrow range, it must be understood within the context of the 1984 range of reported rates (for carriers reporting a positive return in 1984, the range was from 0.4 to 9.3). The percentage losses in NROI show greater variation. In addition to the four carriers who would lose all of their existing NROI, four others lose over 50%. Five carriers (all included among the seven "least harmed" in Table 6.2) lose less than 20% of their NROI.

The rankings of the railroads do not change substantially if changes in the operating ratio or margin of safety are used as the ranking variables. As Figures 6.1 and 6.2 confirm, the correlation among the three impact variables is high. Excluding the two extremely low values of return on investment

TABLE 6.2 RANKING OF CLASS I RAILROADS BY ESTIMATED LOSS IN RETURN ON NET INVESTMENT DUE TO LCV NETWORK.

RAILROAD	PERCENT OF GROSS REVENUE LOST	LOSS IN RETURN ON INVESTMENT (PERCENT)	PERCENT OF 1984 RETURN LOST#	INCREASE IN OPER-ATING RATIO	LOSS IN MARGIN OF SAFETY (PERCENT)
U.S. TOTAL	-18.91%	-1.48	-28.58%	0.0221	-2.99
1	-0.35%	-0.04	NA *	0.0012 *	-0.12 *
2	-2.88%	-0.37	-6.77%	0.0091	-1.05
3	-32.01%	-0.59	-13.07%	-0.0901	8.84
4	-7.41%	-0.83	NA *	0.0496 *	-7.06 *
5	-6.12%	-0.85	-18.84%	0.0162	-1.83
6	-10.08%	-0.97	-17.78%	0.0102	-1.15
7	-13.81%	-0.99	-11.18%	-0.0067	0.27
8	-31.90%	-1.05	-29.19%	-0.0032	-0.88
9	-25.20%	-1.25	-35.38%	0.0171	-2.56
10	-7.54%	-1.30	-100.00%**	0.0357	-3.76
11	-15.60%	-1.30	-38.88%	0.0272	-3.09
12	-17.74%	-1.31	-34.46%	0.0400	-4.64 **
13	-19.05%	-1.36	-22.43%	0.0143	-2.36
14	-15.10%	-1.59	-54.40%	0.0552	-6.49 **
15	-17.63%	-1.71	-36.98%	0.0310	-4.65 *
16	-16.61%	-1.73	-28.11%	0.0266	-3.40
17	-18.95%	-1.75	-100.00%**	0.0594 **	-8.09 *
18	-19.90%	-1.83	-21.01%	0.0281	-3.48
19	-17.34%	-1.92	-45.00%	0.0469	-5.68
20	-29.30%	-1.93	-69.51%	0.0488	-5.90
21	-19.07%	-1.96	-92.49%	0.0485	-5.45 **
22	-28.30%	-2.09	-100.00%**	0.0733 **	-8.67 *
23	-16.43%	-2.10	-35.99%	0.0417	-5.25 **
24	-25.53%	-2.14	NA *	0.1062 *	-15.64 *
25	-15.62%	-2.25	-32.61%	0.0391	-4.71
26	-19.76%	-2.94	-100.00%**	0.0618 **	-6.84 **
27	-18.47%	-6.60	NA *	0.0913 *	-9.60 *
28	-19.42%	-6.70	-72.37%	0.0734 **	-7.49 **

#- MAXIMUM LOSS ALLOWED = 100%. RAILROADS WITH NEGATIVE PRE-LCV RETURN ON NET INVESTMENT APPEAR WITH "NA" IN PERCENT OF NET INVESTMENT LOST.

*- INDICATES RR WITH RATE OF RETURN OR MARGIN OF SAFETY LESS THAN ZERO, OR OPERATING RATIO GREATER THAN ONE IN 1984.

**- INDICATES RR WOULD HAVE RATE OF RETURN OR MARGIN OR SAFETY FALL BELOW ZERO, OR OPERATING RATIO RISE ABOVE ONE, AS RESULT OF LCV NETWORK.

FIGURE 6.1

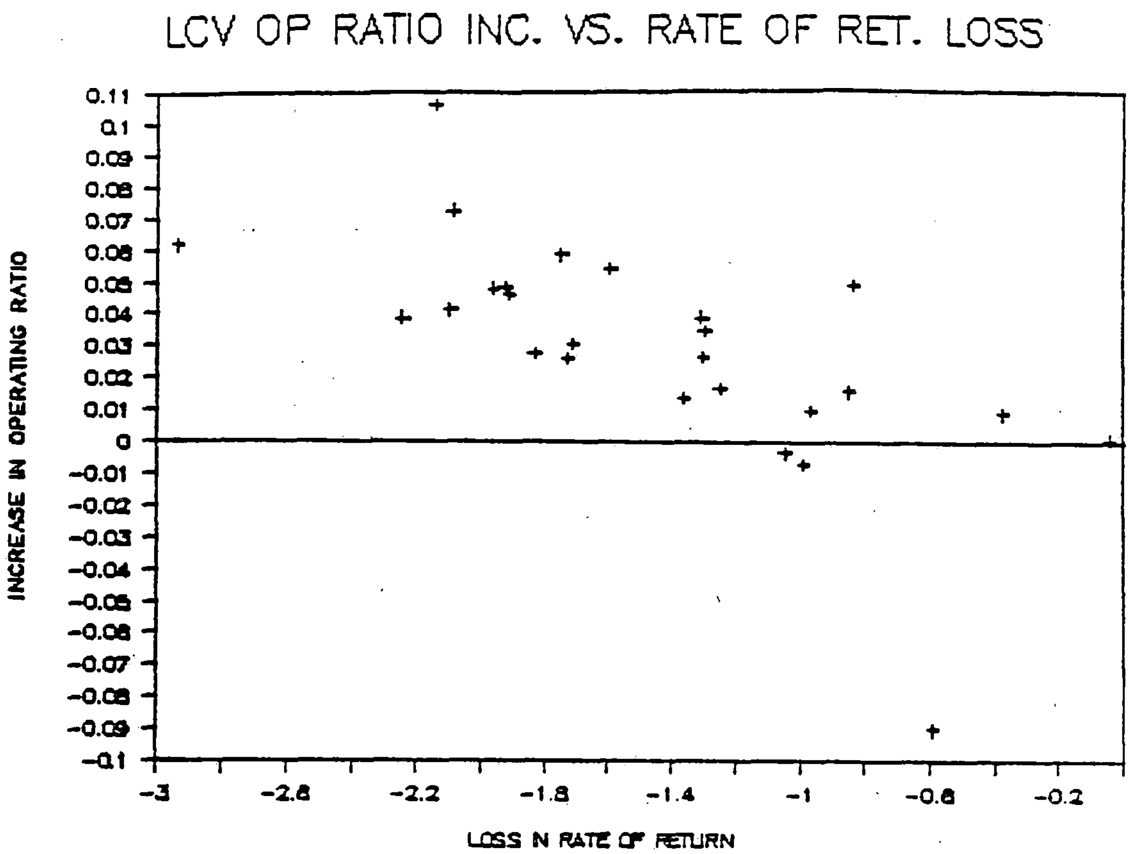
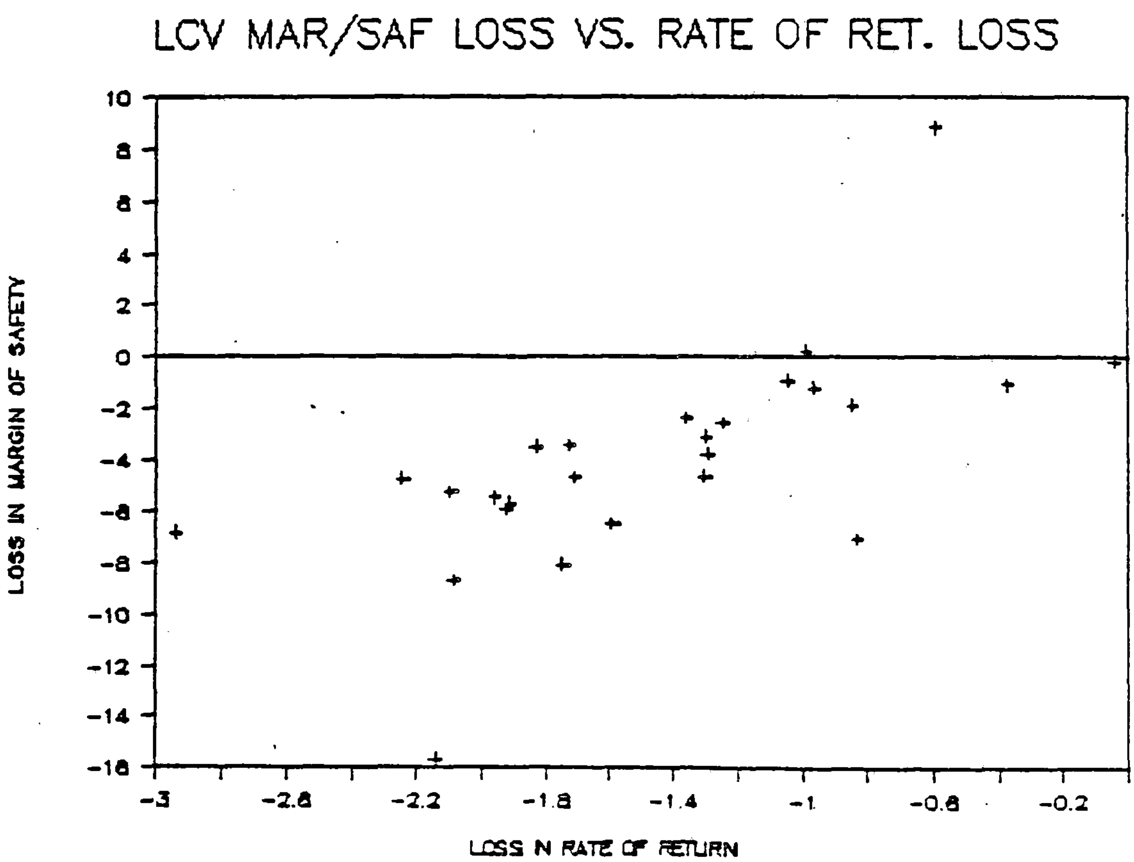


FIGURE 6.2



changes, the correlation coefficient is .67 between the loss in return on investment and the increase in the operating ratio, .65 between the loss in return on investment and the loss in margin of safety. Despite the negative results for all railroads, as reflected in lower NROI's, three carriers are estimated to have an improvement in their operating ratios (i.e. the O.R.'s are lower after LCV's), while two have an improvement in their margin of safety (i.e. the M's are higher after LCV's).[36/] The table shows that four carriers have their operating ratios move from less than one to greater than one, and six carriers have their margin of safety fall below zero. The aggregate industry O.R. increases from 0.88 to 0.90. For ten carriers, the increase in their O.R. is at least twice the industry average. Railroad 24, one of the four railroads reporting negative NROI in 1984, would absorb the greatest increase in its ratio, followed by Railroad 27, also with a negative NROI in 1984. The industry's Margin of Safety falls from 9.0% to 6.0%. Eight carriers face a decline equal to at least two times the industry average.[37/] As in the case of the O.R., Railroads 24 and 27 are the biggest losers. Although Railroad 1 appears to be unaffected by LCV's using any of the three impact measures, its NROI in 1984 was actually negative.

36/ The operating ratio can improve (i.e. be lower) even if the change in return on net investment is negative, provided that the pre-LCV ratio is low. When the operating ratio is less than one, if Operating Expenses and Operating Revenues fall by the same dollar amount (no change in NROI and therefore in net income), the operating ratio must necessarily fall. If the reduction in revenues exceeds only slightly the reduction in expenses (reducing net income) the operating rato may still be lower. For example, assume a railroad currently has operating expenses of $750,000 and revenues of $1,000,000 (an O.R. of 75%). If expenses fall by 75,000 to $675,000, while revenues fall by 80,000 to $920,000, there is a net loss in NROI of 5,000. In this case, the Operating Ratio drops from 75% to 73%. Similarly a relatively high margin of safety (M) permits M and the return on net investment to move in opposite directions.

37/ All eight are among the ten whose O.R. increases by at least twice the industry increase.

6.3 Differential Impacts by Railroad Type

What kinds of railroads would be harmed more than others? The extent of the impact would depend on commodity mixes. Railroads carrying commodities where diversions due to the introduction of an LCV network are not likely to occur, would be relatively less harmed than the carriers who move tonnage more susceptible to truck competition. In Figures 6.3 to 6.7, commodity profiles are presented of carriers, called Max-1 through Max-5,[38] where the revenue impact would be relatively high, while Figures 6.8 to 6.12 show the commodity mixes for railroads, called Min-1 through Min-5, that would be relatively less harmed. The commodities in the figures are arrayed left to right, from least susceptible (Coal) to most susceptible (Mixed Traffic). Table 6.3 lists the commodity groups used in the figures.

The railroads that would be relatively most harmed carry disproportionately high amounts of Mixed Traffic, which includes TOFC/COFC (Max-2, Max-3, and Max-4) and Nondurables, which include Food Products, Textiles, and Paper (all "Max" carriers are above the industry average). In one case (Max-1), the shipment of Nondurable Commodities dominates total shipments, so that there are only two other groups where Max-1's revenues exceed the industry average (and then by only a small amount). Max-4's revenues from coal are so small, that the bar figure barely appears. Max-5 receives a very high percentage of revenues from Durables (Metal Products, Machinery, Transportation Equipment).

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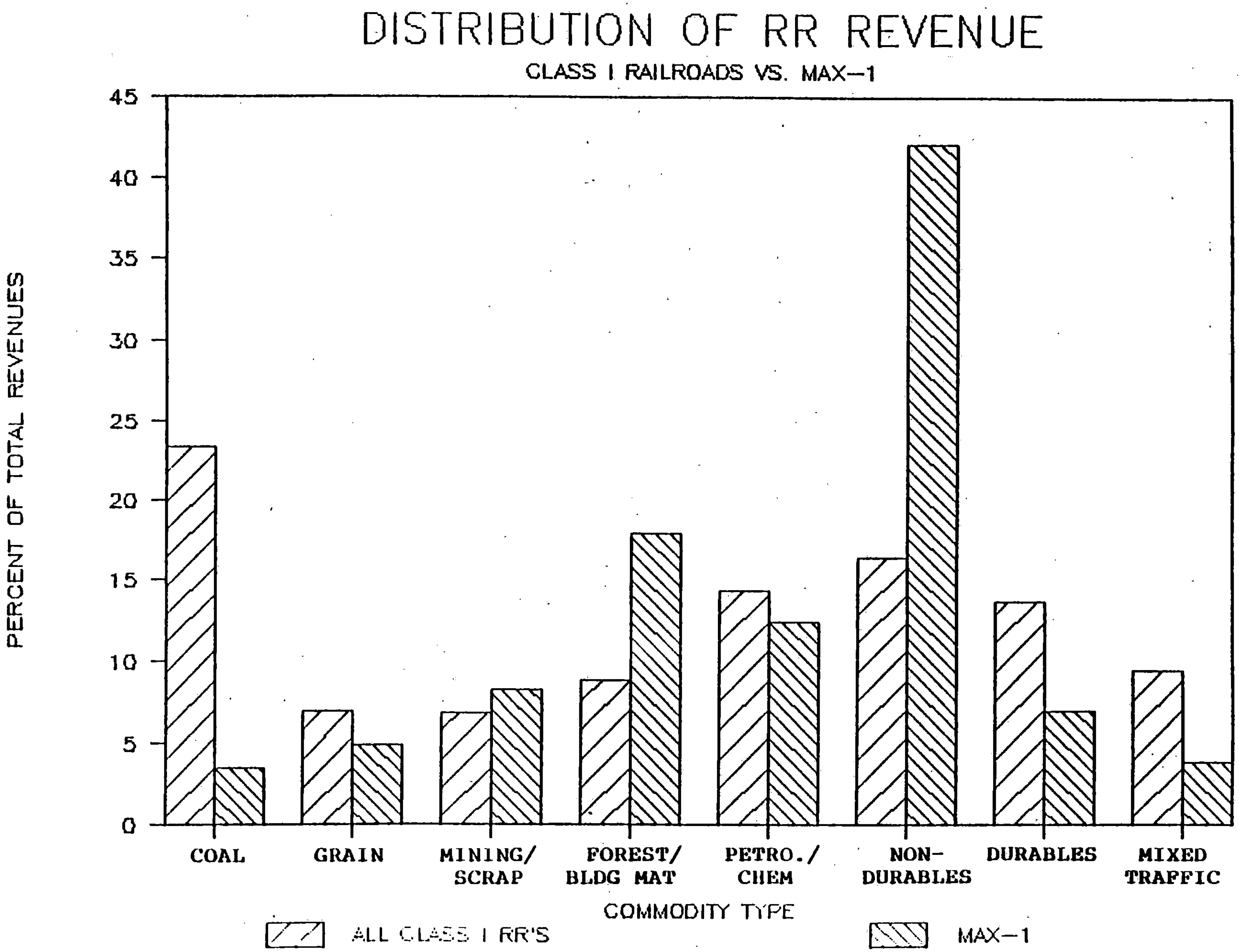
[38] The railroads were selected from the information given in Table 6.1 and were randomly assigned numbers. Both the "Min" group and the "Max" group contain small as well as large railroads. In order to increase diversity in the selected railroads, selection was not restricted to the "top five" and "bottom five" of Table 6.1. All of the "Min" railroads lost less than 1% of return on investment; all of the "Max" railroads lost more than 1.9%.

TABLE 6.3 COMMODITY GROUPS USED IN FIGURES 6.3 TO 6.12.

COMMODITY NAME IN FIGURES 6.3-6.12	COMMODITY NAMES IN HTFS MODEL	STCC
COAL	N/A	11
GRAIN	FIELD CROPS	011
MINING/SCRAP	MINING PRODUCTS (LESS COAL)	10,14
	SCRAP,REFUSE,GARBAGE	40
FOREST PROD/ BLDG MATERIAL	FOREST PRODUCTS	08,241
	BLDG MATERIALS (WOOD,CLAY,GLASS STONE,CONCRETE)	240,242-249,32
CHEMICALS/ PETROLEUM	CHEMICALS	28
	PETROLEUM AND COAL PRODUCTS	13,29
NON-DURABLES	PRODUCE	012-013
	FOOD	20
	TEXTILES	22-23
	FURNITURE	25
	PAPER	26-27
	OTHER	
	ORDINANCE	19
	TOBACCO	21
	RUBBER OR PLASTIC	30
	LEATHER	31
	INSTRUMENTS	38
	MISCELL. MANUFACTURING PROD.	39,41
DURABLES	PRIM. METAL PROD.	33
	FABRIC. METAL PROD.	34
	MACHINERY (EX ELEC.)	35
	ELEC. MACHINERY	36
	TRANSPORT. EQUIP.	37
MIXED TRAFFIC	MIXED TRAFFIC	44-47
	FREIGHT FORWARD.	
	SHIP. ASSOC.	
	MISCELL. MIXED	
	SMALL PACKAGES	

FIGURE 6.3

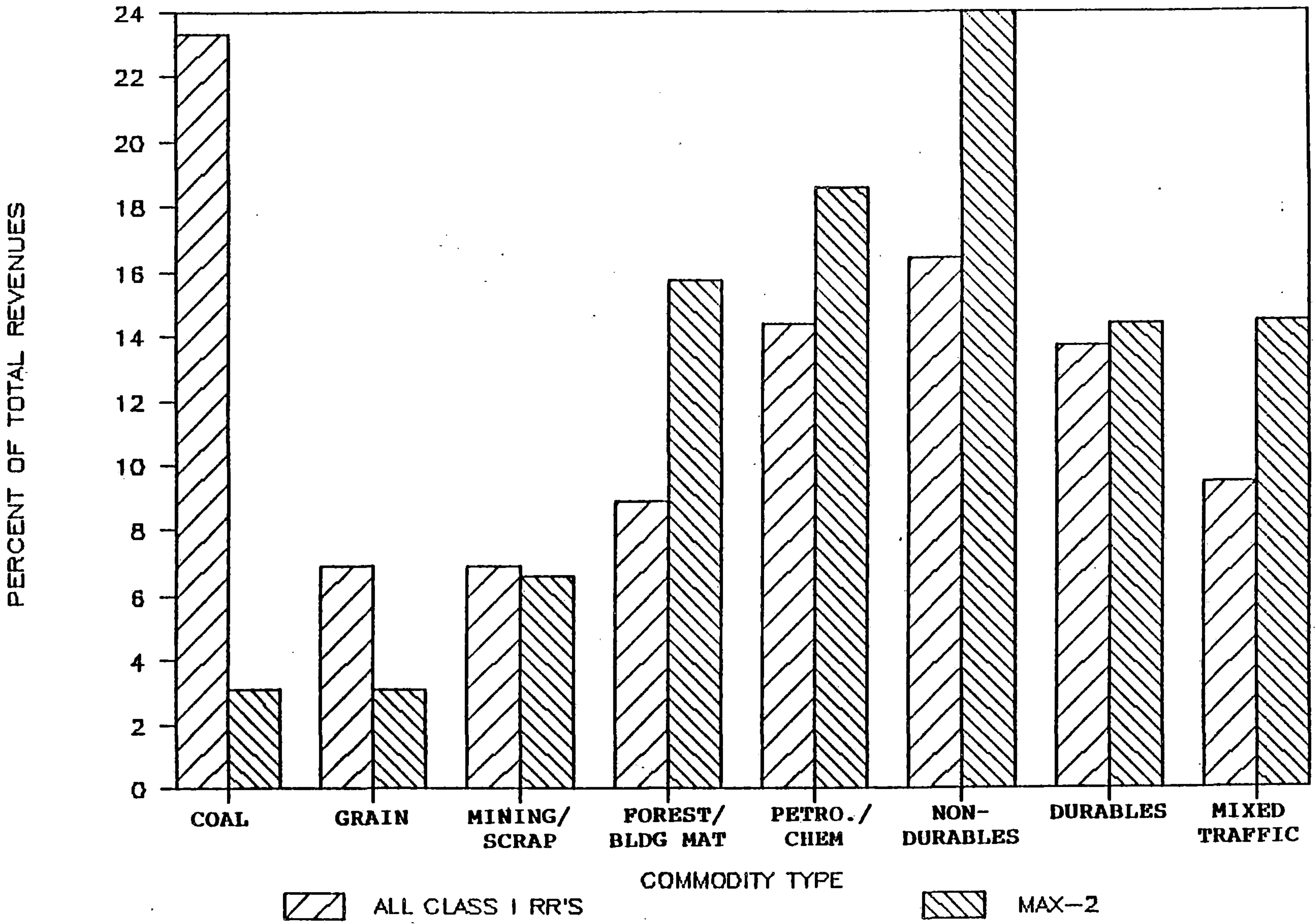


See Table 6.3 for explanation of commodity groups.

FIGURE 6.4

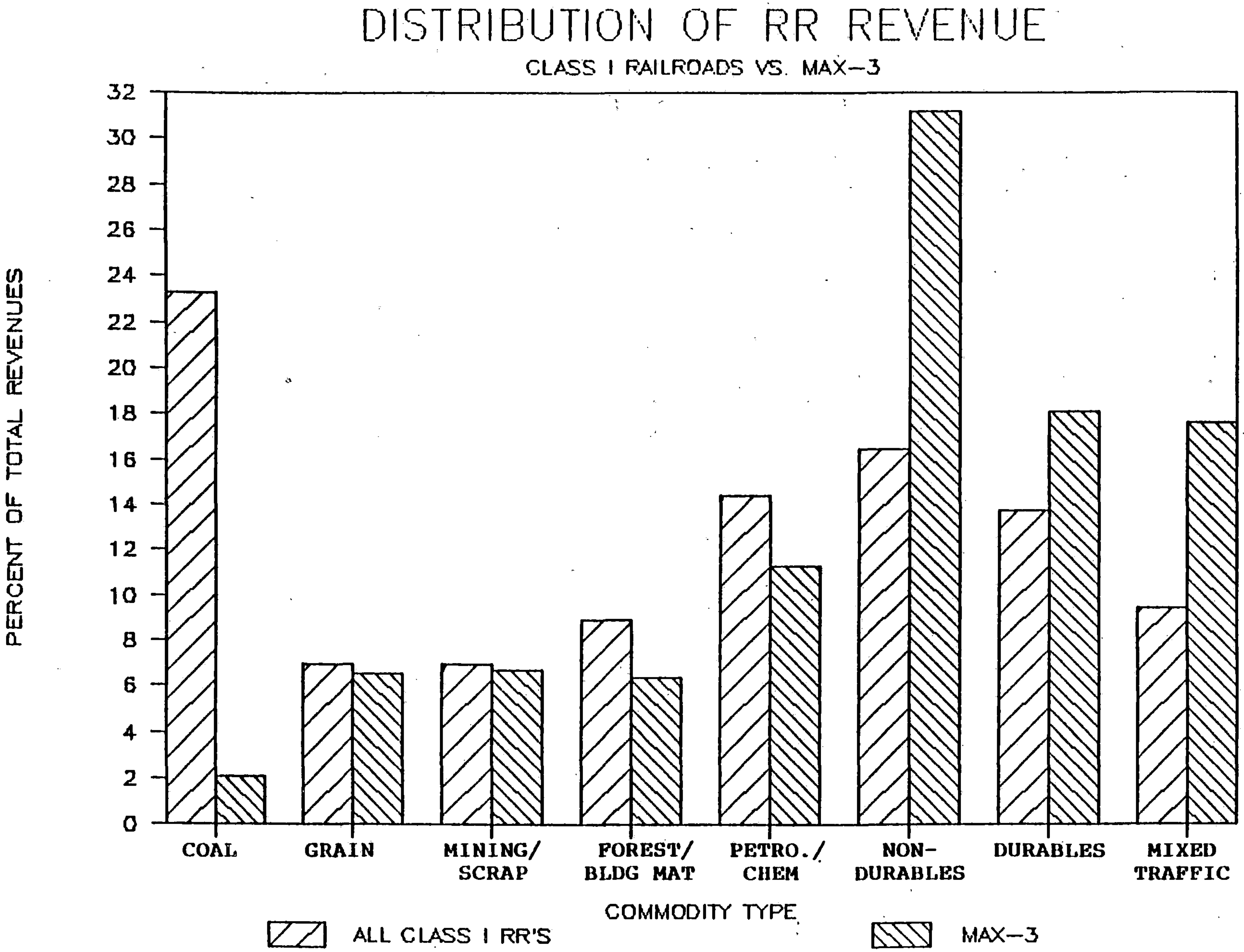
DISTRIBUTION OF RR REVENUE

CLASS I RAILROADS VS MAX-2



See Table 6.3 for explanation of commodity groups.

FIGURE 6.5

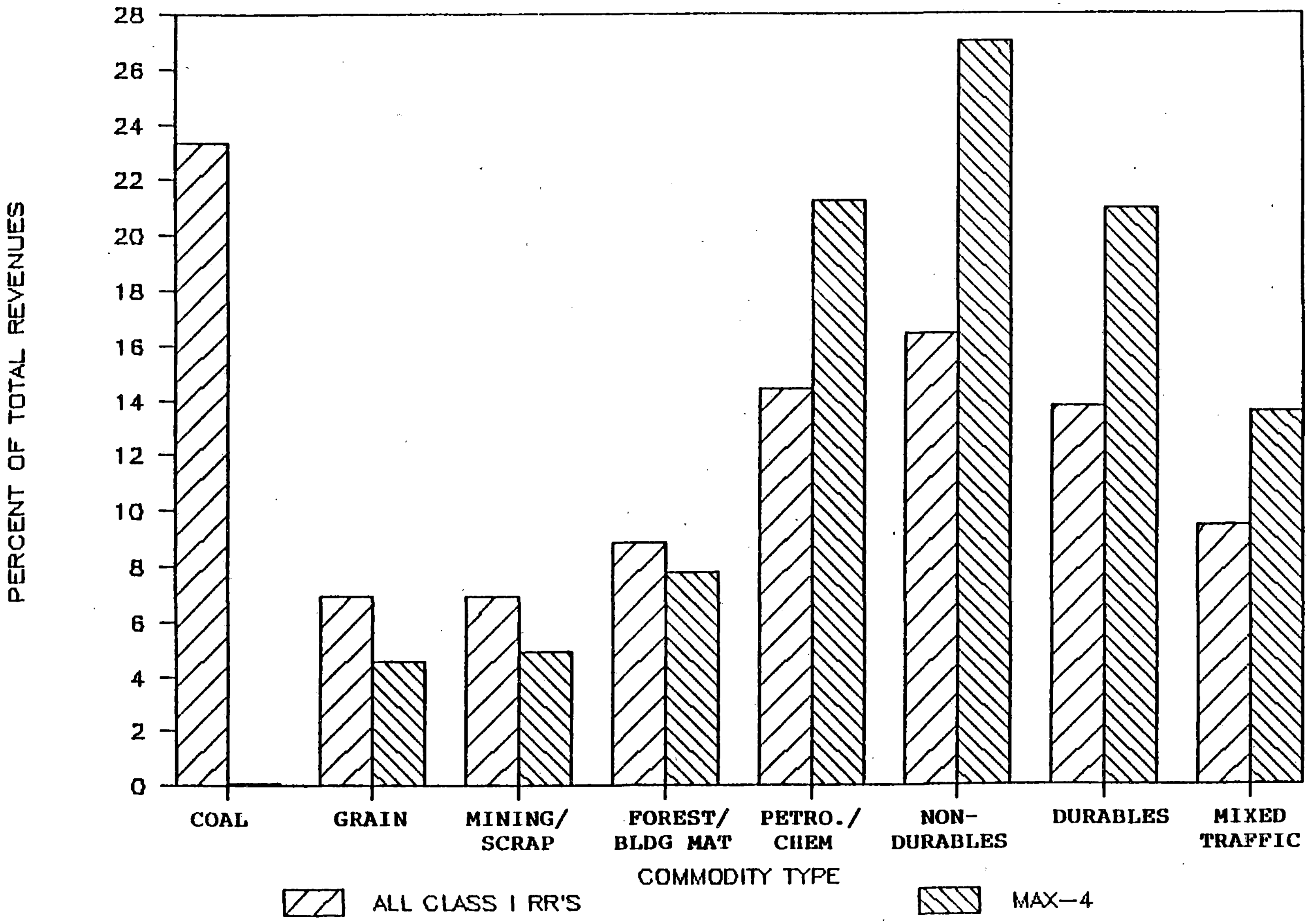


See Table 6.3 for explanation of commodity groups.

FIGURE 6.6

DISTRIBUTION OF RR REVENUE

CLASS I RAILROADS VS. MAX-4

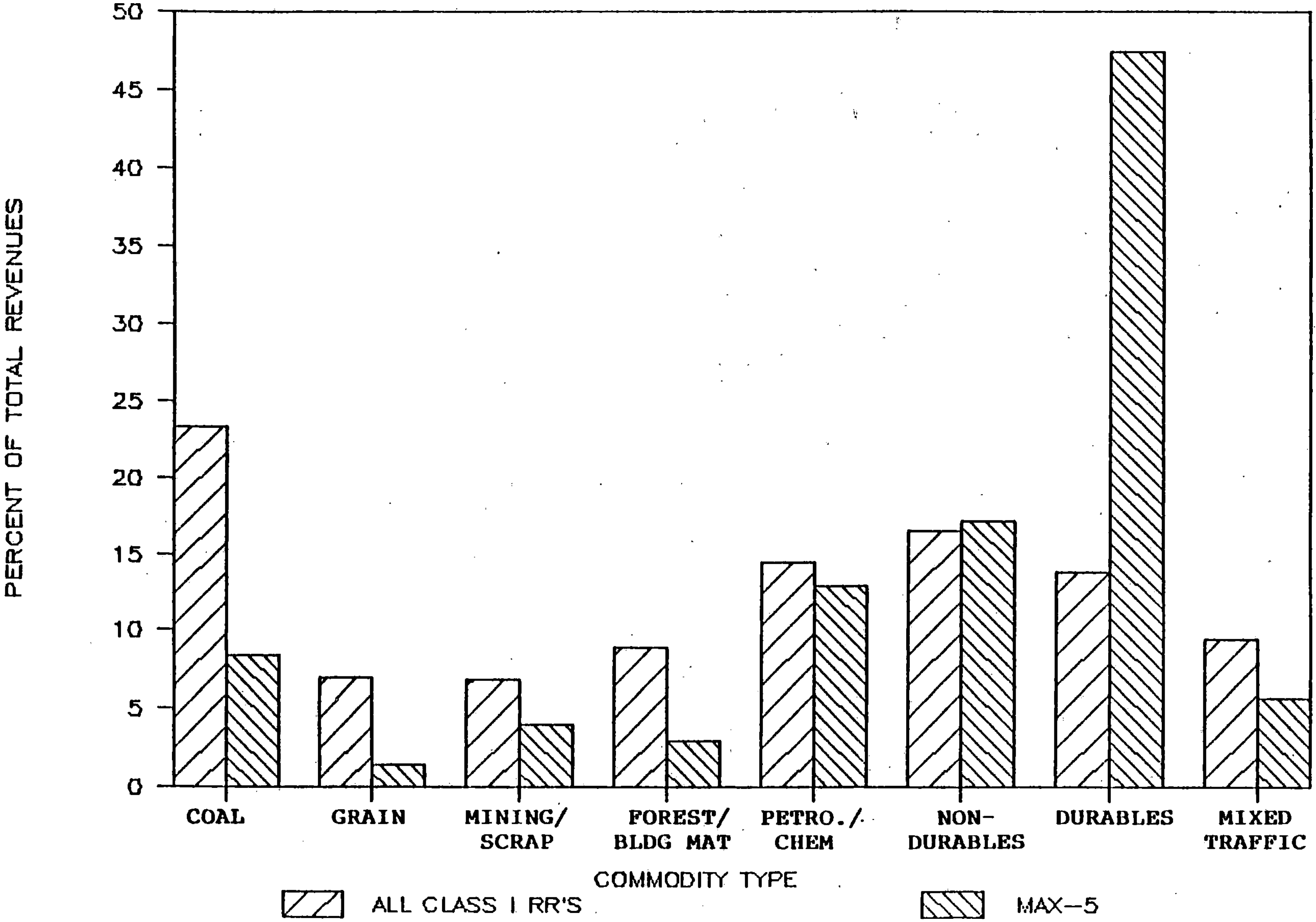


See Table 6.3 for explanation of commodity groups.

FIGURE 6.7

DISTRIBUTION OF RR REVENUE

CLASS I RAILROADS VS. MAX-5

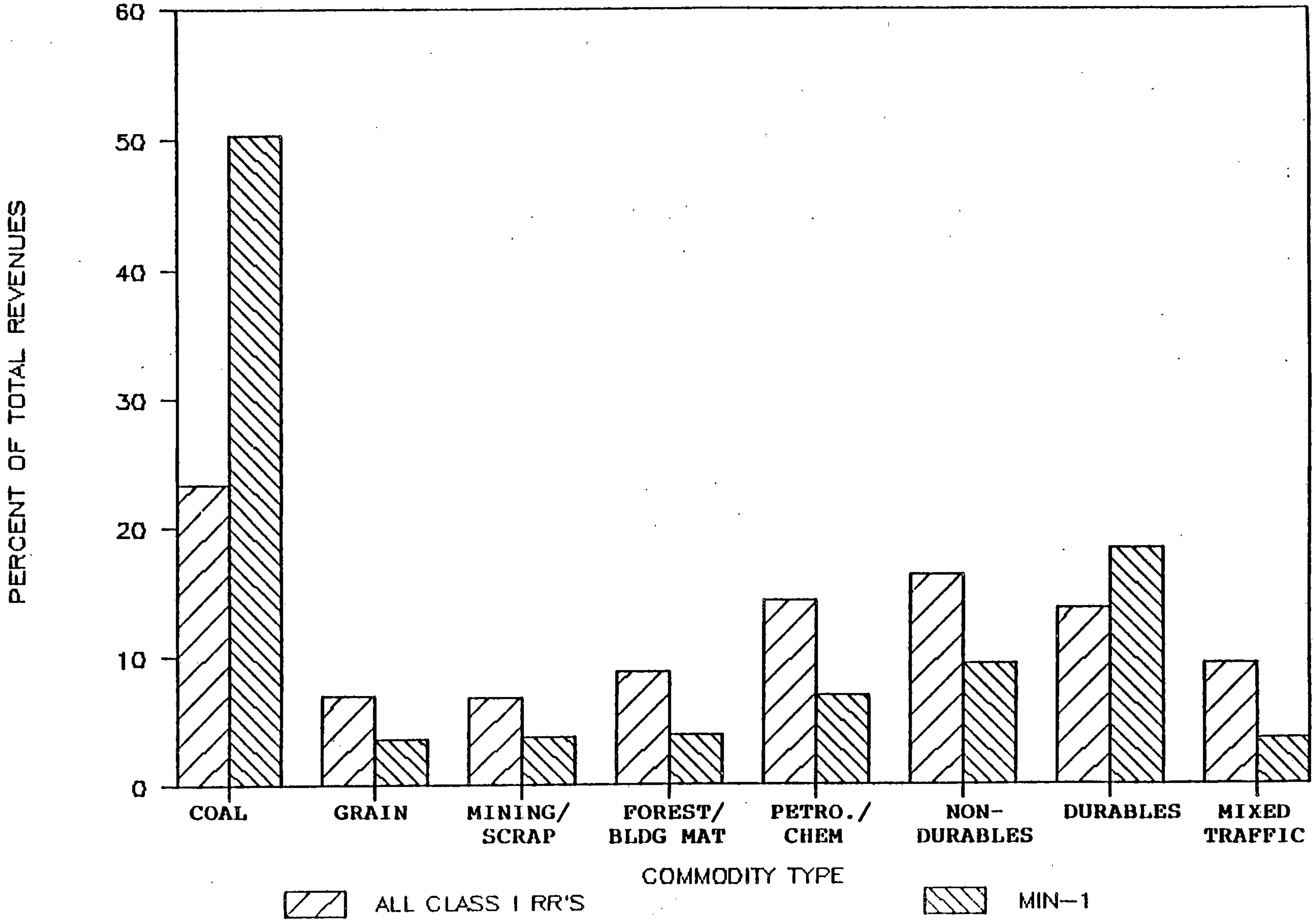


See Table 6.3 for explanation of commodity groups.

FIGURE 6.8

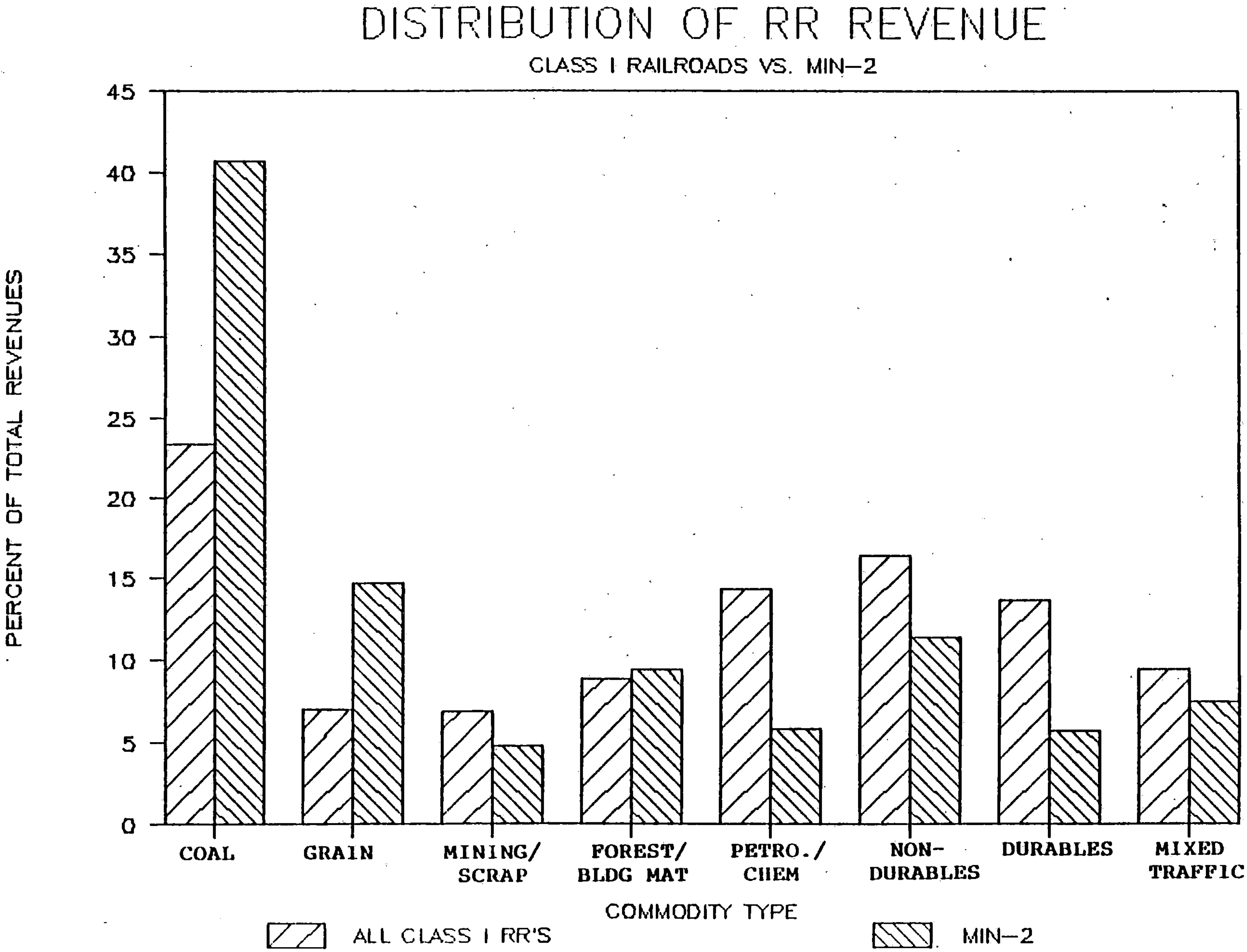
DISTRIBUTION OF RR REVENUE

CLASS I RAILROADS VS. MIN-1



See Table 6.3 for explanation of commodity groups.

FIGURE 6.9

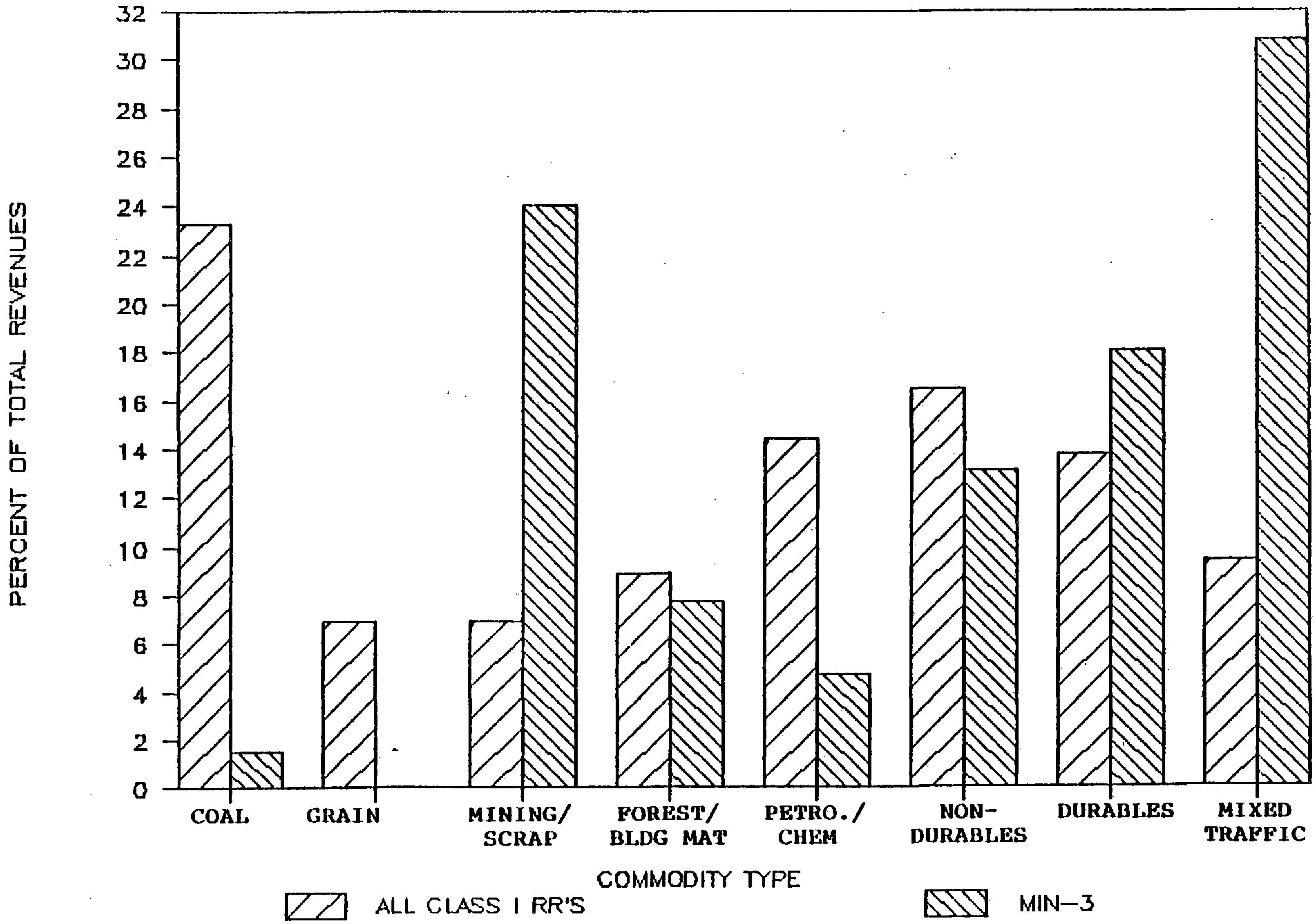


See Table 6.3 for explanation of commodity groups.

FIGURE 6.10

DISTRIBUTION OF RR REVENUE

CLASS I RAILROADS VS. MIN-3

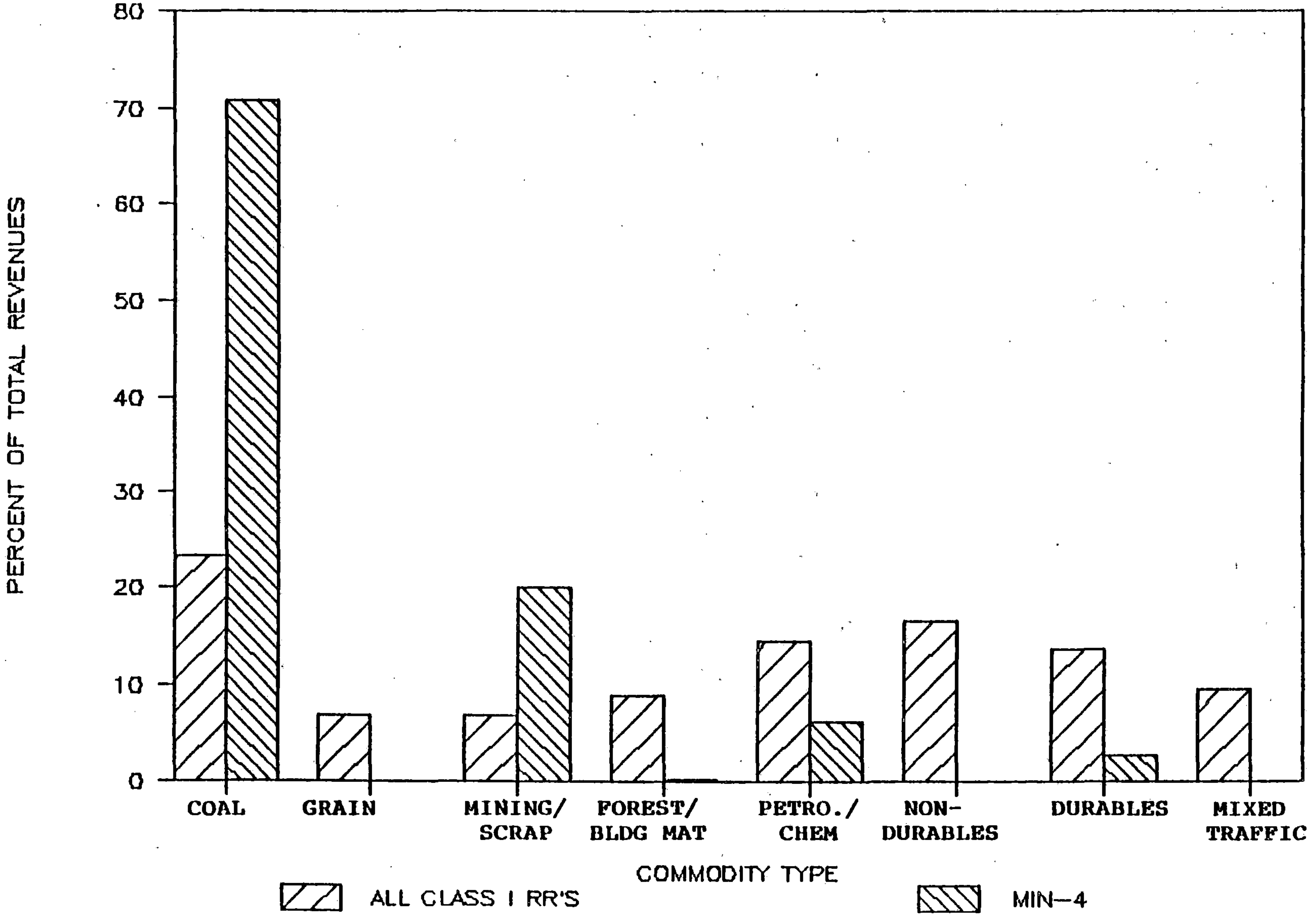


See Table 6.3 for explanation of commodity groups.

FIGURE 6.11

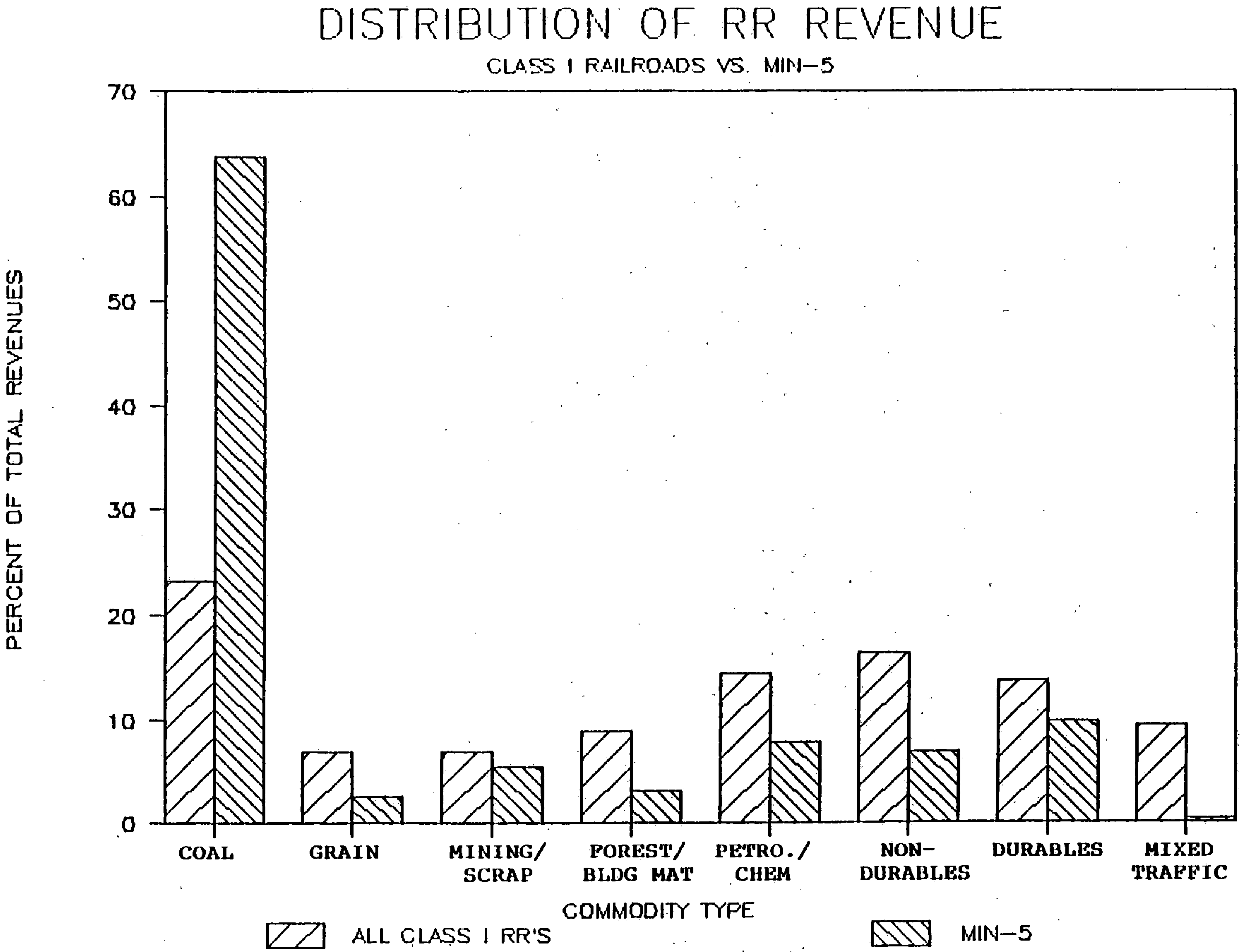
DISTRIBUTION OF RR REVENUE

CLASS I RAILROADS VS. MIN-4



See Table 6.3 for explanation of commodity groups.

FIGURE 6.12



See Table 6.3 for explanation of commodity groups.

Four of the five railroads where the impact would be relatively small, receive a high percentage of their revenues from coal (Min-1, Min-2, Min-4, Min-5). Railroad Min-2 also handles a relatively high percentage of grain. Based on its revenue profile, Railroad Min-3 would not appear to be a likely candidate for inclusion among the relatively less harmed carriers. It does, however, carry a large amount of (non-coal) mining products.

7.0 Summary and Conclusions

This study has considered the impacts on the railroad industry resulting from the changes in the Surface Transportation Assistance Act of 1982 (STAA'82) as well as the proposal to introduce a Longer Combination Vehicle (LCV) network. The STAA'82 changes in truck dimensions, accompanied by an increase in user fees, have only a small impact, compared to the introduction of Longer Combination Vehicles and their inherent productivity advantages over the more traditional truck configurations.

There are three sources of potential savings to shippers as a result of truck productivity improvements. Shippers currently using the truck mode would benefit from rate reductions when trucking firms pass on cost savings. Shippers using the rail mode would, in some markets, experience a rail rate reduction due to the competitive pressures of the market place brought on by lower truck costs. Finally, some shippers would switch from rail to truck, since the lower truck rates would enable shippers to reduce their total logistics costs if they shift. The latter two of these events would hurt the railroad industry, and indirectly other rail shippers who might face higher rates in a regulatory environment that encourages differential pricing but limits a railroad's overall revenue level.

The findings of this study show that railroads could lose roughly 8.5% of their traffic and 14.0% of their revenue if an LCV network were introduced. The revenue loss is attributable to both a drop in traffic (75% of the loss) and lower railroad rates (25% of the loss). Based on 1984 data, the industry could lose as much as one third of <u>net</u> revenue from operations (operating revenues less expenses) and approximately one quarter of Net Railway Operating Income (NROI).

The impacts will not be felt evenly throughout the industry. Railroads originating traffic in the Pacific States (California, Oregon, and Washington) and in New England will be hardest hit. Railroad specific data show that the non-coal carrying carriers are most susceptible to harm if an LCV network is introduced. The greatest traffic losses are expected to occur in Mixed Traffic (including TOFC/COFC), Construction Materials (Lumber, Stone, Clay and Glass), and Chemicals and Allied Products. Eight of the 28 Class I railroads in 1984 would lose at least half (and in four of these cases all) of their reported return on net investment for 1984.

Throughout this study, one commodity group, Mixed Shipments, has presented analytical problems. The costing techniques described in Section 2 and used in Sections 3 and 5 confirm the industry view that this is at best marginal traffic. Yet railroads reported a willingness to cut prices in this area in order to maintain traffic levels. In many of the tables of this report showing aggregate losses of tonnage and revenue, the Mixed Shipments category dominates the results. Between 1981 and 1984, there was an explosive growth in this category of shipments, spurred in part by the Interstate Commerce Commission's decision to deregulate this component of the railroad's traffic base. Some of this growth has come at the expense of railroad traffic moving in other rail equipment. No matter what the source of this growth however, the change in the traffic mix may make railroads increasingly sensitive to changes in the cost structure of the trucking industry.

The modelling processes used in this analysis are based on a vast array of empirical data describing the truck and railroad industries. The results must nonetheless be understood as establishing orders of magnitude rather than precise estimates that can be tested against the actual outcomes of future events. Using this perspective, we have found that the likely effects on the railroad industry of a Longer Combination Vehicle network are not trivial. Railroads haul large amounts of traffic that are truck competitive and therefore "at risk" when overall truck dimension restrictions are relaxed. Some rail carriers with a truck competitive traffic base may need to consider making major adjustments in the services they will provide. At the same time, the results cannot be interpreted as so catastrophic as to seriously threaten the long run viability of most railroads.