KNEAFSEY, James Thomas, 1940-
AN ECONOMIC EVALUATION OF MERGERS IN THE
RAILROAD INDUSTRY -- THE C. & O./B. & O.
CONSOLIDATION: A CASE STUDY.

The Ohio State University, Ph.D., 1971
Economics, theory

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AN ECONOMIC EVALUATION OF MERGERS IN
THE RAILROAD INDUSTRY—

THE C. & O./B. & O. CONSOLIDATION: A CASE STUDY

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

James Thomas Kneafsey, B.S., M.A.

* * * * *

The Ohio State University
1971

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Some pages have very light type. Filmed as received.

University Microfilms.
ACKNOWLEDGMENTS

I am deeply indebted to the members of my doctoral dissertation committee for their gracious assistance and guidance. In particular, I wish to thank my adviser, Professor Richard A. Tybout and my minor committee members, Assistant Professor J. Hayden Boyd and Professor Jon Cunyngham, all of the Department of Economics of The Ohio State University.
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CHAPTER I

INTRODUCTION

A. Purpose and Objectives:

The history of merger waves in American industry and the fact that merger frequencies have fluctuated sharply over time, is a thoroughly documented topic.\(^1\) Far less has been noted of the fact that merger frequencies tend to vary sharply among industries and that a temporal distribution of merging firms would be highly concentrated in certain types of industries. One of these types would be the railroad industry, which has experienced significant structural reorganizations stemming from its most recent wave of merger activity, beginning around 1957 and continuing until the present time. Although some of the benefits from the organizational changes in the railroad industry could have occurred in the absence of merger, the extent to which mergers have induced structural changes and allocative impacts warrants serious investigation and serves as a foundation for this study.

At present, railroads which desire to merge must submit formal applications and voluminous, supportive bits of evidence to the Interstate Commerce Commission (I.C.C.) for processing, evaluation, and

adjudication. One of the public policy dilemmas is that the I.C.C. has been prone to adjudicate each merger on a case-by-case approach without developing any overall transportation criteria. The results of this approach are two undesirable features: first, some of the mergers proposed and approved may not have been the best of possible alternatives; and second, the merger proceedings in many cases have created additional intra-industry litigation. On the other hand, in several cases the primary goal of merger proceedings (the improvement in internal efficiency, both with respect to the cost minimization of railroad operations and to public considerations) has been achieved.

Some of the historical criteria on which mergers have been allowed will be analyzed in this study, but the main purpose will be to examine the optimal criteria on which mergers should be allowed. The analysis will be conducted, first in a theoretical framework, and second, in the application of an important case: the Chesapeake and Ohio Railway Company (C. & O.) - Baltimore and Ohio Railroad Company (B. & O.) consolidation of 1963 (which, incidentally, is a prelude to the contemplated incorporation of the two companies into the Norfolk and Western Railway Company (N. & W.) system).

From the theoretical standpoint, the study will: (1) analyze the criteria that have been developed for the public evaluation of mergers in the railroad industry (minimizing the effects of abandonments and service discontinuances); and (2) estimate the impacts of mergers in the industry on the rate of technical progress of the companies and on the degree of returns to scale in the industry.

Specifically, the study will empirically investigate, appraise, and generalize about the impacts of the C. & O./B. & O. case with res-
pect to: internal operations and economies, managerial goals, financial aspects, and selected external consequences. An evaluation will be made of the alleged benefits and cost savings of consolidation in this case and conclusions will be drawn, verified by statistical evidence, on the predictions of increased efficiency, better service, and other qualitative advantages. In particular the focus in the case study will be on the areas of: equipment utilization, physical plant economies, service improvement for shippers, managerial economies, planning and research efforts, administration, and maintenance procedures.

B. Preliminary Statement of Summary and Conclusion:

In general, this study should provide a more comprehensive and integrated view of the factors bearing on merger aspects in the railroad industry than has heretofore been available. Moreover, the study relates merger criteria to individual cases in order to demonstrate the extent of the consideration given to the pertinent and usable public interest factors. In addition, there is an attempt to indicate the timeliness of a review of three principal merger problems: 1) the determination of a precise concept of what is meant by the public interest in railroad merger proceedings; 2) the need for an appraisal of the criteria utilized by the I.C.C. in the proceedings; and 3) the importance of an expediting of the adjudication process. The brief review of the merger history in Chapter II traces major motivating factors in both past rail mergers and current proposals and outlines the present trends in this area.

In Chapter III, the evaluation depends on two types of criteria that are applied in the cases by the I.C.C.: 1) the statutory ones
which the I.C.C. is required to consider; and 2) the "ad hoc" ones which the Commission has adopted over time to be applied as the case may merit. Guidelines enunciated in landmark court decisions are identified and the fundamental standard of consistency with the public interest is noted. The study then proceeds to describe the use of these criteria in a series of selected consolidation proceedings, where the objective is to explore the basic criteria used, the components of such criteria, and how and why the criteria were applied to resolve various questions. A lengthy evaluation of mergers then is presented which examines the conditions under which mergers induce both cost reductions and improved service activities.

Chapter IV is the case study designed to exemplify the internal effects of a merger. The methods and techniques employed in calculating the impacts by the participants in the case study are claimed to be representative of others in the industry. A series of proposed projects by the companies are examined in detail and the costs of alternate operations are analyzed. In addition, a comparison is made between some cost-savings four years after the merger and what the companies originally proposed in their official testimony. At present, this is the only publicly known verification of post-merger effects in the industry.

Since the basic tone of the first three chapters is generally one of merger affirmations, with an underlying plea for less time-delays in the regulatory process, Chapter V is intended to verify some of these tendencies by statistically testing several hypotheses for the industry. Among the more important hypotheses are the following: 1) that rail-
roads which have merged develop a higher rate of technological progress than those which remain essentially unmerged; 2) that among those railroads that merge, higher rates of technological progress are experienced after merger than before, and 3) that economies of scale in the industry do exist, which could be exploited by increases in the size of railroads through the merger process. As separate peripheral ventures stemming from these investigations, a unique way of measuring scale effects is developed and a contribution to the area of aggregation theory is presented.

Finally, in Chapter VI, an attempt is made to examine some of the public policy implications stemming from the above criteria and from the implementation of the I.C.C.'s decisions based upon its criteria. The main thrust of the chapter is to draw together the elements of the particular case and the general analysis in the preceding chapters in order to estimate the relative merits of mergers in light of important historic influences and expected future requirements in the industry.

The remainder of this chapter is devoted to providing a rationale and foundation for the study in terms of the methodology, significance, and necessity of mergers in the industry. There will be no attempt to enumerate all the hypotheses about the causes of mergers that are currently in fashion, but rather the focus will be on those which appear to be significant for railroads.

**C. The Nature of the Problem:**

The effects of large scale mergers are significant to the efficiency of any industry. In the case of the railroad industry, the impacts
are observable in many areas: in the intramodal competitive structure, in relative operating costs, in service, in the managerial and organizational structure, and so on. Since mergers induce important consequences for the allocative efficiency aspects of the total national transportation network, they have become a topic of serious public interest and a legitimate concern of domestic public policy. Problems arise essentially on account of possible divergencies between private and public interests. It is in this context that the I.C.C. merger criteria both promote public objectives and be addressed to the internal organizational structure of the railroad industry.

1. The Need for Mergers:

In recent years, only a few railroad companies have shown a consistent record of earnings and growth. The direction and degree of internal expansion plans by the railroads are unclear and diversification efforts are sporadic and seem to be pursued without strong objectives. Antiquated work-rules inhibit the implementation of certain technological advances, and in many cases the needs of shippers and passengers, in terms of equipment and service, are not being fulfilled. Consequently, serious issues regarding the public interest arise such that a choice must be made that will determine the extent to which the railroad industry is to survive as a vital component of the free enterprise system.

In the future, it is anticipated that the railroad industry will face the requirements of: increased speeds, improved signaling systems, superior yard facilities, better communications, transformed inter-
changes, and a number of other property and operational advances. In order to meet these needs, the mechanism of merger might provide the desired impetus in the following ways: first, by allowing the combined railroads to realize the benefits of economies of scale attributable to larger size; second, by inducing cost savings through consolidation of duplicate or excess facilities; third, by insuring that the post-merger environment will contribute to the public interest provided that the merged company displays improved service to rail users and induces technological improvements; and fourth, by demanding that new procedures, different standards, aggressive marketing, and fresh philosophies of conducting business be established by the companies involved.

The basis for merger has two facets: one, short term, and the other, long term. In the short run, the impacts of merger are realized in terms of a railroad company's operating efficiency in the small where cost minimization is the pursued operating policy. Over the longer term, the impacts are visible in terms of its operating efficiency in a larger context (or what is called allocative efficiency). This suggests that a certain level of competition might imply a different industrial organization than efficiency in the small, and efficiency in the small might imply a different organization than efficiency in the large. The essential point is that different merger policies might yield different consequences.\(^2\) If larger size railroads are required for viability reasons, then the process of how the increased size is brought about is crucial in terms of public policy considerations.

\(^2\)As an example, consider an end-to-end merger versus a parallel one.
The allocative efficiency consequences of any merger that increases both efficiency and market power can be evaluated only by net effects, insofar as all the relevant effects can be determined. The consideration of both immediate and eventual effects will ordinarily require the consideration of industry as well as local impacts. The implementation of a merged system thus would involve the expected monopoly power consequences of a merger being allowed in comparison with those that would result if the economies instead were realized by internal expansion. A decision with respect to the timing tends to be affected by the rate of growth of market demand for rail services, that is, ceteris paribus, the greater the rate of growth of market demand, the easier it is to achieve the requisite expansion by internal means and the less compelling is the case for merger. If the expected rate of growth of rail services for the companies tended to be low, particularly for the smaller railroads, the stronger would be the conditions for merger.

2. The Process of Adjudicating Mergers:

The process of merger can be treated as an innovation, or the implementation over time of a new idea or structure. If the managerial goal of railroad companies were to maximize profits, mergers would occur only when they produce some increase in market power, when they produce a technological or managerial economy of scale, or when the managers of the acquiring railroad possess some special insight into the opportuni-

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4This assumes that changes in market structure, once introduced, tend to persist.
ties for profit in the acquired railroad which neither its managers nor stockholders possess. It has been the *modus operandi* of competitive economies which suggests that firms tend to select the most efficient of the available means of production. The absence from view over time of less efficient processes creates the illusion that either no alternatives exist or any alternative is massively difficult to implement. This illusion is heightened by the feeling that mergers contain an optimal set of institutional arrangements, appurtenances, structure, and personnel. Furthermore, the industry adjusts to any given merger which allows it to become more ingrained such that the merging railroads' survival depends upon the speed and effectiveness with which they adopt these supplementary arrangements and adjust to the new conditions. Thus the accessories of the process of merger become the conditions under which the mechanism or merger operates and through which it imparts its contribution and significance to the growth of the merged railroad and the industry.

In studying the effects of rail mergers on the public, one must be prepared to involve more than merely qualitative statements. If it is true that qualitative analyses always contain implicit quantifications, then the measurement of railroad impacts by quantitative methods must be attempted. Robert Fogel, in his unique study relating the impact of railroads and rate of economic growth, contends:

To eschew the application of quantitative techniques because the data are too poor, while at the same time asserting that
railroads had an enormous qualitative impact on the economy, involves a gross inconsistency.\(^5\)

If the result is that the quantitative impacts are unmeasurable, then one must conclude that the significance of a series of qualitative assertions is indeterminate. Consequently, an important requisite for measuring merger effects depends on (1) the ability to ascertain relevant costs and benefits, and on (2) the utilization of the appropriate analysis and criteria to satisfy the goals of public policy in seeking a solution to the merger problem.

The process of merger must be evaluated within the framework of assessing the overall potential of railroads. Problems relating the exact impacts of different kinds of mergers, or no mergers at all, to the industry's performance eventually must be analyzed. Some of the responsibility for these analyses will belong to individuals in the regulatory commissions, but some will accrue to railroad management in the industry so that the regulators can be presented with the important questions and the significant data. The study herein represents only a beginning in attempting to assess the aggregate impacts of railroad mergers.

D. Significance of Mergers in the Railroad Industry

In economic policy some words possess an emotive impact that far exceeds their dictionary definitions. Words are appropriated and used for ideas and proposals that bear little resemblance to their etymological form. One such word is "merger", which has multiple interpretations,

including: stock control, consolidation, conglomeration, augmentation, integration, total absorption, or merely co-ordination. Irrespective of its interpretation, it has come to be one of the main desiderata of corporate activity in the last decade.

The basic problem of regulation in the railroad industry is that of establishing or maintaining the necessary conditions for the economic utilization of resources under a system of private enterprise. In some cases, this might imply that a single firm provides the total service in a particular environment. For example, it was not normally efficient for several railroads to serve a given town since a substantial fraction of total rail costs were indivisible and invariant with traffic. As a result, it was frequently true that one railroad could handle the traffic at a total cost considerably less than several railroad companies with their separate facilities.

Exactly the same argument has been applied to public utilities: on account of economies of scale of the system, one network is cheapest. But the application of the "natural monopoly" argument to railroads is rather strained, for railroads generally do not have a monopoly or even a "substantial" portion of the total traffic of all modes, and even if they did, it would not necessarily follow that regulation was the best method of amending the effects of monopolistic behavior. In fact, many people have contended that, historically, government regulation has contributed to the demise of railroad rates of profitability. If this

6 Perhaps one of the most recent views on this thesis deserves mention. See A.A. Walters, *Integration in Freight Transport* (London: The Institute of Economic Affairs, 1968), especially pp. 13-18.
hypothesis is true, then an important issue can be raised concerning the efficiency of the continuance of the regulatory agency in performing its activities.

An important observation is that railroad mergers are adjudicated according to different standards and by a different regulatory agency than mergers in other industries are decided. In fact, the actual affirmation of a merger by the I.C.C. tends to refurbish the status quo aspects of its continued regulation in the post-merger situation. However, a sufficient discussion of this topic is beyond the scope of the present study; so it will be assumed herein that existing levels of regulatory involvement (namely, the I.C.C.) will prevail.

On the basis of this assumption, the mechanism of "merger" in the railroad industry becomes partially a responsibility of government and is not left entirely to the market system. What matters are the impacts of mergers, both short and long run. And for the impacts to be evaluated effectively, the study must be approached along the following two lines: first, it must be focused on some of the loose ends that have served as criteria in the past for adjudicating mergers, and second, it must demonstrate that mergers induce efficiencies and benefits which in the absence of merger, would not occur. This is not to say that all mergers must have been good ones, but it does require that a significantly large number must have yielded efficient impacts.

A major reason for the dilemmas in merger cases is the diversity of the interests involved: the railroad companies, the users, the governmental agency, and the general public. To satisfy all parties is ideal but unlikely; thus, the aim will be to develop criteria which are consistent with the welfare of the four interest groups with the anticipa-
tion that a near-optimal solution be attained.

E. Analytic Framework:

The analysis of the study will be conducted in three stages:

1. an evaluation of various merger criteria;
2. an in-depth observation of a particular merger case; and
3. a more comprehensive observation of the industry as a whole.

The criteria will be examined from the standpoints of the I.C.C., of the railroad companies, and of allocative efficiency, respectively. A historic discussion is designed to supplement the interpretations of these criteria, such that an eventual integration of the different concepts of criteria will be developed in terms of an evaluation of recent merger activity.

Some of the elements from the C. & O./B. & O. case will be identical to those analyzed in the more comprehensive, statistical chapter, but many items in the case study are endemic to the two railroads, for example, the sections on cost savings and on the maintenance of equipment policies. Inferences will be drawn from both areas of interest in the context of the above criteria, on which interpretations of selected impacts will be performed. If the case study is considered to be a representative one in gauging merger effects, then one would expect the observed impacts to be fairly consistent for the industry and for the C. & O./B. & O. case.

Some of the ways in which mergers are anticipated to result in efficiencies are the following: technological development, displacement of ineffective management, requirement changes, and mixtures thereof. Technical developments may provide opportunities for a significant re-organization of railroad resources into more efficient configurations,
for example, the utilization of large-system electronic digital computers for train control, yard surveillance, car identification, and so on. A significant, persistent decline in demand might cause a condition of excess capacity in which mergers would permit economies, despite a likely increase in market power consequences. The amount of tradeoff between increases in market power and better utilization of capacity becomes the basis for a criterion by which a merger can be evaluated.

As an example of requirement changes, consider two railroads that have entered a particular market segment at an efficient scale of operation but have incorrectly estimated the volume necessary to support an efficient distribution system. Here a merger might induce efficiencies but might also induce some monopoly power effects. The comparison of the desirable vis-a-vis the undesirable effects in the context of existing merger criteria will determine the final outcome of any particular case.

Finally, displacing an inefficient management by a more efficient one might be more expeditiously accomplished by merger. These managerial benefits may be short-run only, because a manifestly inefficient management most likely would be displaced by other means eventually, if the merger path was not feasible. This assumes that no frictional barriers in the industry would exist which would perpetuate an inefficient manage-

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If the two railroads are small in size, competition between them of course is reduced, but competition with respect to other railroads might be enhanced, and intermodal competition might be stronger.
ment. However, in practically every case in the railroad industry, mergers result in managerial shake-ups. It is hypothesized herein that (in general) the resulting management in a merger tends to be more competent on the whole than the average level of the two pre-merger managements. Without a merger, the less competent management might have been displaced or replaced eventually (for example, by attrition or by stockholder dissent). But the process of merger allows this displacement activity to be accelerated such that competence levels are increased more quickly. Therefore, assuming the preceding premises are valid, mergers in the railroad industry do provide for an organizational benefit such that both companies in their new, merged structure are better off than before.

It is expected that some of the benefits and cost savings of mergers would result from the following items: centralization and modification of joint classification yards, concentration of through traffic on more direct and efficient routes, the reduction of interchanges, the utilization of best access tracks and terminal facilities, and the consolidation of schedules. On the other hand, some of the anticipated disadvantages might involve the ordinary, transitory implementation costs associated with a change in structure; labor objections; time delays associated with "ironing out the kinks"; and on a larger scale, a possible lessening of competition. Each of these features will be explored in detail.

The focus of the analysis will be on an evaluation of merger activities in this industry. The pivotal point will be the case study which is designed to be an exemplary merger and one on which other com-
binations might be modelled. In order to generalize and to extend the analysis to a broader range of situations, observations of merger effects over time over a large number of cases are necessary. These observations are intended to support and confirm the \textit{a priori} expectations of merger benefits. Historical elements from selected merger cases are intended to provide the links between the conclusions of the case study and those of the more general industry-wide analysis. Finally, the integration of these conclusions into the regulatory decision-making framework based on various criteria will be sufficient for an approximation to a general theory of mergers in the railroad industry.
CHAPTER II

A REVIEW OF RECENT RAILROAD MERGER HISTORY

The most recent upward trend in rail mergers dates from 1957 when the Interstate Commerce Commission approved the consolidation of the Louisville and Nashville Railroad with the Nashville, Chattanooga, and St. Louis Railway. From that time, the trend of rail mergers as a whole has accelerated until, at present, a large proportion of the major carriers are either actively considering consolidation or have submitted formal merger proposals for I.C.C. approval. Recent cases vary in complexity, from relatively simple proceedings involving acquisition of stock control in order to simplify corporate structures, to highly complex cases involving several large competing railroads. In the case of certain Eastern railroads, the trend toward consolidation signifies resort to a means of preserving the profitability of rail lines under private operation. On the other hand, the issues in the applications of some Western railroads, which have been generally more profitable than those in the East, are concerned more directly with the question of competition versus regulated monopoly, first in railroad services over certain routes, and second, between railroads and their alternative transport modes. It will be argued that most proceedings tend to be handled uniquely without much attention being devoted to the ways in which each merger affects the overall operational and geographical structure of the industry. In the following brief review of selected, recent cases, evidence intended to confirm or disconfirm the hypothesis is presented.
The railroads are confronted with both the intensification of external competition from other modes of transport and increased operational costs from within the industry itself—problems to which only soundly conceived mergers might offer solution. Yet, typically, the process of adjudicating mergers has been unduly slow. Seemingly endless rounds of legal maneuvering and regulatory deliberations create an impression of wheel-spinning, the costs of which some feel are barely offset by the post-merger savings. For example, one of the simplest combinations to effectuate—the consolidation of the Chicago Great Western into the Chicago and North Western—was proposed in early 1964, approved by the I.C.C. in 1967, but sent back to the I.C.C. because of Federal Court litigation in January, 1968. Similarly, the Northern Lines merger scheme was conceived in 1957, reviewed by the I.C.C. for several years, rejected in 1966, reconsidered and approved in 1967, contested in 1968 and finally implemented in 1969. If these cases are representative of all mergers in the industry, it is important to assess later the impacts of mergers on the performance characteristics and resource allocation decisions of the railroad companies.

A. Complications in Merger Cases:

Several of the railroads in the midwestern region of the United States are marginally strong and favorable decisions in the Northern Lines case could make the mergers of the other carriers inevitable due to competitive effects. The two leading proposals at this time involve the Chicago and North Western and the Chicago, Milwaukee, St. Paul and Pacific (Milwaukee Road) and a unique case: the battle for the Chicago, Rock Island and Pacific. The latter case is the more interesting one since
it involves competing bids for the Rock Island by the Chicago and North Western and a combine of the Union Pacific and Southern Pacific. Legal outlays by late 1967 have been estimated at more than $40 million with the end nowhere in view. The Union Pacific and the Southern Pacific plan to split the Rock Island between them, arguing that this would be the best means of serving the "public interest." The opponents to this joint application offer substantial evidence that the U.P. and the S.P. are primarily concerned with protecting their own interests since neither would want the other to gain exclusive control of the Rock Island. On the other hand, the alternative outcome to this case is that the Chicago and North Western could win eventual control of the Rock Island.

In 1967, the Atchison, Topeka and Santa Fe, which for a long time has coveted an entry into St. Louis, bartered with the C. & N.W. by agreeing to relinquish opposition to the C. & N.W. bid for control of the Rock Island. The A.T. & S.F. also bargained to purchase for $100 million, subject to I.C.C. approval, part of the southern lines of the Rock Island and to acquire trackage rights into St. Louis. At the same time, a considerably smaller railroad, the Denver and Rio Grande Western, declared that if the Union Pacific won control of the Rock Island, it wanted the Rock Island's lines from Denver to Kansas City and from Kansas City to Omaha. At the same time, the Missouri Pacific demanded trackage

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1. Wall Street Journal, April 12, 1968, p. 1
2. Finance Docket, No. 35561, Sec 3
3. Ibid, Sec 5
rights from Kansas City to Denver as well as rights over the Southern Pacific to the west coast. This case tends to be unique when one considers the complications created by the various interests.

In terms of United States corporate history, the I.C.C. has the distinction of setting an unusual precedent: it is believed that for the first time a corporate merger was ordered by a federal agency. This occurred when the I.C.C. insisted that the Norfolk and Western Railway (N. & W.), contrary to its desires, absorb the smaller Erie Lackawanna Railroad (E.L.), which sought the union. The Norfolk and Western had fought the acquisition with the I.C.C. and in the courts for several years. Instead, it had preferred to merge first with the Chesapeake and Ohio Railway (C. & O.) and then to acquire the E.L. along with four other smaller roads via a subsidiary labeled Dereco, Inc. Many of the features of the E.L. that the N. & W. found unpalatable in the past were rectified in the April 1, 1968 mandate. For example, the N. & W. will not have to assume or guarantee E.L.'s $341 million in long-term debt, since it will continue to be a burden of the new Erie Lackawanna Railway, subsidiary of Dereco which in turn, is the new subsidiary of the N. & W. Nor will the N. & W. be required to assume the burden of E.L.'s commuter services and the N. & W. can apply any future deficits of the E.L.'s $81 million in tax loss carryovers from prior-year deficits. The transaction continues to pose the following question: to what extent can an agency of the Federal government require a private company to

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4Wall Street Journal, April 6, 1968, p. 6

5Finance Docket, No. 32724, Sec. 1-3
take over another one which the company does not prefer to have at a price it is unwilling to pay? Under existing antitrust statutes, from which railroads generally have been immune, there have been many cases involving an ordered divestiture of companies, but this is the first case where the emphasis is in the reverse direction.

The merger of the Pennsylvania Railroad Company (P.R.R.) and the New York Central Railroad Company (N.Y.C.) originally was proposed and studies were authorized in January, 1957. The studies were completed in substance by January, 1959, when merger plans were discontinued by the N.Y.C. on the grounds that its officials believed that, as long as the P.R.R. controlled the Norfolk and Western Railway Company (N. & W.), a merger would create an "unbalanced competitive situation" in the East and perhaps ultimately result in the nationalization of independent railroads. At that time consideration was given to the fact that the N. & W. was in the process of purchasing the Virginian Railroad Company. After its merger discussions with the P.R.R. were terminated, the N.Y.C. began purchasing capital stock in the Baltimore and Ohio (B. & O.). Shortly after February, 1959, the N.Y.C. entered into negotiations with the Chesapeake and Ohio Railway Company (C. & O.) and the B. & O., looking toward the possibility of a so-called two party railroad system in the east composed of the N.Y.C., C. & O. and B. & O., on the one hand, and, on the other, the P.R.R. and its satellites including the N. & W. The N.Y.C.'s action in pursuing the C. & O. and B. & O. arrangement was largely founded upon consummation of the N. & W.--Virginian Merger,\(^6\) which it had not opposed other than seeking limited conditions.

\(^6\)Finance Docket, No. 20599
On June 14, 1960, the C. & O. filed an application with the Commission under Section 5 of the Interstate Commerce Act for authority to control the B. & O. Even though the C. & O. was opposed to inclusion of the N.Y.C. in this proposed transaction, negotiations continued between the N.Y.C. and the B. & O. The discussions were halted abruptly when the C. & O., through ownership and stock exchange assents, acquired over 50 percent of the B. & O.'s outstanding capital stock. The reaction of the N.Y.C. was to file an application under Section 5 for authority to control the B. & O. jointly with the C. & O. and these matters were heard on a consolidated record. During the pendancy of these transactions, the I.C.C. approved the merger of the Delaware, Lackawanna and Western Railroad Co. into the Erie Railroad Company. The N.Y.C. did not oppose this merger despite the fact its officials felt that it would lose substantial traffic as a result thereof, and the P.R.R. also supported the E.L. merger despite its estimates of loss of traffic.

On March 17, 1961, the N. & W. filed applications under Section 5 of the Act to merge, purchase, control and/or lease the properties of the New York, Chicago and St. Louis Railroad Company (Nickel Plate), Wabash Railroad Company (Wabash) and the so-called Sandusky line of the Connecting Railway Company, a P.R.R. subsidiary. The N.Y.C. intervened in these proceedings prior to hearing and filed a petition seeking inclusion under Sections 5(2)(d) of the Act. In October, 1961, after the C. & O. had contracted to purchase approximately 61 percent of B. & O. stock and after the N.Y.C. determined that it had little, if any, chance of obtaining with the C. & O. joint control of the C. & O. or effectuating

7Finance Docket, No. 20797
a N.Y.C.--C. & O.--B. & O. merger, the N.Y.C. advised the P.R.R. that it was ready to resume negotiations leading to merger. It was the belief of the President of the N.Y.C. that if the transactions embracing the N. & W., Nickel Plate, and Wabash and the control of the B. & O. by the C. & O. were consummated, that the N.Y.C. could not compete with these two systems independently. While in large measure the action of the N.Y.C. in seeking merger with the P.R.R. was defensive, the former believed that a P.R.R./N.Y.C. System divorced from the N. & W. and competing with an expanded N. & W. System and a C. & O./B. & O. System would offer the Eastern section of the United States a competitively balanced railroad system. As a result of negotiations with the P.R.R., the N.Y.C. withdrew its application in the C. & O./B. & O. proceedings and its petition for inclusion in the N. & W. proceeding.

Negotiations were carried on between the P.R.R. and the N.Y.C. during the latter part of 1961 and the merger agreement was signed on January 12, 1962, with the approval of their respective Boards of Directors and with the subsequent approval of the shareholders. Although the outcome was not apparent for several years, the merger application finally was effectuated in April, 1968. The Penn-Central case was a merger that was completely different from any previous one because it involved the combination of two large size companies into what is presently the largest railroad system.

The net effect of the complications resulting from current merger proceedings is to raise pertinent, more aggregative questions of public policy. For example, the President of the Chicago and Eastern Illinois states that:
Any merger proposal involving two or more railroads has advantages and disadvantages irrespective of whether the railroads are operating in the "black" or in the "red." The affect of the merger on the railroads involved, on their employees, competing railroads, individual shippers and others must be subordinated to what is considered to be in the best interest of the public. The Interstate Commerce Act attempts to safeguard the rights of those who may have conflicting interests in a merger proceeding by providing for participation of interested parties in public hearings, for the issuance of reports, and for the filing of petitions for rehearing, reconsideration, etc. Finally, after administrative remedies are exhausted, provision is made in the Interstate Commerce Act for review of the Commission's order in the courts. Carriers operating in the "black" who can successfully meet the requirements of the statute relating to railroad mergers are more likely to strengthen the overall U.S. transportation system than those operating in the "red" who are permitted to merge in the hope that the merged company can achieve results one or more of the railroads parties to the merger could not achieve while operating as a separate entity. We cannot have a strong transportation system without strong, healthy railroads.

Despite the piecemeal efforts to achieve mergers in the West, the I.C.C. might not give its approval to any of them unless some type of overall plan is developed which will meet national transportation policy requirements and the nebulous public interest criterion. Even without an overall plan, though, an important empirical issue is to examine the impacts of mergers on which public policy considerations can be developed at a later point.

B. Problems in the Institutional Aspects of the Regulatory Structure

One of the items which has contributed to misunderstandings concerning regulatory practices is the belief that the railroads whose mergers had been affirmed would be immune from Department of Justice prosecution as violation of the Sherman or Clayton Acts. The establishment

of statutory precedence for this immunity is well documented. The Justice department may appeal to the courts on the grounds that the I.C.C. did not give proper weight to anti-competitive effects or that its conduct of a merger proceeding was unfair. In some cases regarding appeals by the Justice Department, the Supreme Court has remanded the cases for further consideration on specific points, but the evidence indicates that in the end, the Supreme Court consistently has upheld all I.C.C. merger approvals. In its more recent decisions on mergers, the Supreme Court position has become more clearly manifest, implying that substantial savings in money and time could result solely from an upgrading of the proceedings.

The approval in 1967 of the merger of the Atlantic Coast Line (A.C.L.) and Seaboard Air Line (S.A.L.) railroads into the Seaboard Coast Line (S.C.L.) was significant because both were relatively large companies. While neither had a history of financial difficulties which worked in favor of some earlier rail mergers, the clinching issue involved that of intermodal competition, especially waterways. However, it is important to note that the specification of criteria in the S.C.L. case was rather ambiguous, and that this was one of the few cases to date where the time lag between application and approval dates was fairly short.

In early 1967, William H. Tucker, then chairman of the I.C.C., levied harsh words at those railroads involved in the complicated merger situation in the West when he charged that "the majority of railroads are attempting to maximize their own special position ... without any real regard for the public interest or the interests of other railroads
and the vital services which such roads perform.\(^9\) He urged that each carrier review its own proposal with the view toward "amending or modifying" it such that a realistic provision would be insured for a vigorous assessment of the over-all public considerations.\(^10\) Tucker's assailment was aimed especially at the Rock Island case,\(^11\) although in the Northern Lines case the Burlington, Northern Pacific, and Great Northern were doing what he suggested. After an initial reflection by a 6 to 5 vote before the I.C.C.,\(^12\) there was some "amending and modifying" to satisfy the demands of other lines, presumably in the public interest. The I.C.C. was satisfied and approved the merger by a 7 to 4 vote,\(^13\) and although some opposition prevailed, this received neither judicial nor stockholder support.\(^14\) The Department of Justice then intervened and claimed that the Northern Lines Companies may have resorted to collusion in order to sway the important opponents to withdraw their protests. Eventually, these problems were straightened out to the satisfaction of all parties.

On the one hand, railroads are urged to amend and modify; on the other hand, suspicions of collusion prevail. Admittedly, legalistic

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\(^10\)Ibid

\(^11\)See Chapter II, pp. 18-19

\(^12\)Finance Docket No. 21478, March, 1966

\(^13\)Finance Docket No. 21478, November, 1967

maneuvering of this kind should not be taken at face value, although it does tend to cloud the issues and delay the decision-making process. Also, it is not surprising to discover that railroads do attempt to maximize their individual positions. What Tucker should have been suggesting in the above quotation was merely that each railroad’s objective function be maximized subject to an additional constraint of the public interest criterion.

In the remaining chapters, the hypothesis that mergers in general induce increased efficiencies will be subjected to testing. The statistical tests will be performed in light of the legal proceedings which have prevailed during the period of investigation. An important question to pose at this juncture is: To what extent have the legal proceedings contributed to or whittled away merger benefits to the participants? If it can be shown that the social costs of the proceedings are high, relative to the benefits of mergers, then testimony delays produce negative benefits as well as positive costs. A remedy in the form of a reduction in delays would induce positive returns, unless there are circumstances in which mergers may not be desirable.\(^{15}\)

The question in the final analysis of mergers is whether each merger is in the public interest. Vacillation over this issue beyond a reasonable time tends to obscure the facts and the cases become more cumbersome. This is precisely the reason why the avoidance of delays is

\(^{15}\)If these undesirable circumstances are present, the problem becomes more complicated and delays may yield an increase in marginal social product. But even here, if a reduction in delays could permit the regulatory resources to perform more frequent structural adjustments instead of being involved with extended testimony, the net effect would be positive returns.
necessary. If the I.C.C. would utilize its administrative experience gained in recent cases, merger decisions could be made on a much faster schedule. Without impinging on the rights of due process, the I.C.C. would re-assess its own procedures to meet an expedited timetable, similar to what has been done in passenger train discontinuance and freight rate cases.

Each merger case contains voluminous testimony which is heard by different examiners, practitioners, and commissioners. Numerous time-saving measures which are consistent with procedural due process of law can be adopted: submission if evidence by the applicants with the original application for merger approval, a limitation of redundant cross-examination in multi-party proceedings, dismissal for lack of diligent prosecution and so on.\(^{16}\)

The largest amount of legal funds expended by the public and private parties on cases over which the I.C.C. regulates have been on (1) mergers, (2) service and maintenance violations, and (3) tariff (rate) case. The legal amounts expended on merger cases (M in Figure 1) were approximately $85 million in 1956 and increased to $285 million in 1969.\(^{17}\) These sums follow from all the merger cases listed in Appendix E

\(^{16}\) America's Sound Transportation Review Organization (ASTRO) was created by the Association of American Railroads (A.A.R.) in September, 1969 to make an in-depth study of national transportation policies and to recommend measures needed to assure a balanced system. The reactions to the report, labelled the ASTRO report, have been mixed, but its recommendations on merger proceedings in the railroad industry are comparable. See American Association of Railroads, The ASTRO Report (Washington, D.C., June 30, 1970), especially pp. 37-39.

\(^{17}\)The figures are only approximations derived from the Annual Form A Document which railroads must submit to the I.C.C. Inasmuch as some railroads record their legal fees by class (including merger) and others do not, the data for the former which were in the process of merger were
over the period 1957-1969. More than 70 percent of these totals arise from the private legal sector. In comparison, rough approximations for legal fees in service and maintenance violations and on tariffs were substantially less in absolute terms and grew over time at a substantially lower rate. Since the focus is on the costs of merger proceedings, these other legal expenditures can be dismissed without further discussion. Some legal costs are not treated differently by railroads, an implication of the following analysis is that the railroads act irrationally in expending funds for legal services without evaluating the merits of the cost savings which are to be generated from the adjudication process.

The curve labelled CS in Figure 1 depicts the discounted cost savings which had been promised in merger cases by the applicants on an annual basis. These cost savings represent the discounted present values of all future cost savings in each case. Again, the sources of all the data are the cases listed in Appendix E. It is assumed that the participating railroads in each case were best suited to estimate the relevant cost savings for its unique circumstances. Besides, these are the data on which the Commissioners must base their decision to approve or reject the applications. In the sense that these cost savings accrue as benefits, the important consideration in this section is the comparison of the cost savings with the costs of adjudicating the proceedings.

used and estimates for these railroads which did not breakdown their legal fees by class but which also were merging were added on. For the latter, a rule-of-thumb of 33 1/3% of the total legal fees (or roughly a ratio similar to the railroads which recorded legal fees) was applied. Finally, the governmental legal fees were added on and the sum of all these items is shown on annual basis in Figure 1 as the curve M.
If the costs of conducting merger cases exceed the discounted present value of the cost savings resulting from the mergers, then some serious questions concerning the methods of hearing testimony and delaying proceedings could be raised.

The procedure for determining the cost savings (CS) in all the merger cases over the 1957-1969 period is the following: If a merger case was filed in 1957, the estimated cost savings were extracted from the testimony in the finance docket, the time horizons were stated for future cost savings (if any), the future cost savings were discounted to the present year, using a rate of discount of eight percent, and the sum of all the present values for all the cost savings yielded the total cost saving for that merger, beginning with the year of the filing date. If other mergers were filed in 1957, the same procedure as described above would apply, and the CS variable in Figure 1 would be the sum of all the discounted cost savings.

The approach has several limitations; first, the longest time horizon considered was five years (this is consistent with the testimony)—in practice, many benefits certainly are significant after five years; second, the eight percent discount rate was selected to reflect more recent rates of interest than were evident in the earlier years of the period under investigation. A lower rate of discount, ceteris paribus, would have increased the total cost savings, but, as is suggested by Figure 1, a sharply lower discount rate would be required to make the net present value (the difference between M and CS) zero; and third, the estimates clearly ignore social benefits and social costs, which conceivably are significant in many cases. Also, the estimates for the discounted cost savings are applied to the year of filing, and no account
was taken for subsequent revisions.

The approach is designed only to be suggestive to the extent that some light may be shed on the worthiness of delays in adjudicating mergers. The vertical distance in Figure 1 between CS and M suggests (in a crude sense) that the benefits may not even cover the costs of the litigation. Over time, notice the increasing gap between M and CS\textsuperscript{18} which suggests that it is costing proportionately more than the savings warrant. Since the slope of the CS curve is positive (except for 1961-1962, when economic conditions in the industry were unfavorable), which indicates that the total cost savings are increasing over time, substantial reductions in the gap would likely occur if delays associated with the legal interests were reduced. Even if the costs savings were undiscounted, there would be a gap between the legal expenditures curve and the cost savings curve for the years since 1959.

The magnitude and implications of this approach to regulatory proceedings are so large as to preclude any further efforts in this study. One then should regard the results as only preliminary indications of the comparison between the costs of mergers and the benefits derived from them. Insofar as this approach is meaningful, it is hoped that the basis for an independent study on this issue has been provided.

\textsuperscript{18}The absolute height of the gap is not a true welfare index since the CS curve only contains private cost savings (no estimates were attempted for social benefits). What is important, however, is the sharp widening of the gap over time.
where M-legal expenditures on merger cases (private and public)
CS-cost savings (discounted)

Sources: Selected Finance Dockets; Annual Form A Documents,
Interstate Commerce Commission; and Appendix E

Figure 1: Estimated Annual Legal Expenditures
and Cost Savings on Railroad Merger
Cases before the Interstate Commerce
Commission
C. The Penn Central Case

In June, 1970, the Penn Central Railroad subsidiary of the overall Penn Central conglomerate filed bankruptcy proceedings and reorganizational needs under Chapter 77 of the Federal Bankruptcy Statue. It is in this domain that the following questions should be asked:

1. To what extent did the merger of the Pennsylvania and New York Central create the unstable environment which preceded recent events?
2. What would have happened had the two railroads not merged?
3. What will be the impact on the N.W./C. & O. case?

Since most of the empirical analysis of this study suggests positive benefits accruing from mergers, the first question above needs to be analyzed in detail. The current question seems to revolve around whether or not the collapse of the Penn Central is due to an industrial phenomenon per se vis-a-vis the decadent status of the railroad industry, to an inefficient management which resulted principally from the merger, to the overbearing onus of passenger operations, or a general diseconomy of scale related to non-railroad activities. The information necessary to provide answers to these questions is not yet available and, actually, not yet known. Since several years may be required before the definite causes can be determined, the best choice in this study is to discuss the case with a minimum of comment.

At first glance, the current plight of the Penn Central merger case appears to be spectacularly at odds with the general conclusions of this study. But time may bear out the fact that the implications of the Penn Central case are consistent with the conclusions of the industry analysis in this study for the following reasons: first, the focus of this study is on freight operations (which account for approximately 96 percent of
all freight revenues), and there has been little evidence so far that the Penn Central freight operations are inefficient; second, there has been no strong evidence that the managerial effect has induced the bankruptcy; third, the passenger operations may be a more significant deterrent than most analysts realize; and fourth, as a matter of conjecture, the most significant cause may be the conglomeration effect, wherein the demise of the railroad operations was the result of disproportionate attention given to non-railroad activities.

Profit conditions in the railroad industry are a result of the rate of growth of the firms, which in turn is dependent upon technical conditions prevalent in the industry. Growth can occur as a result of technical conditions which can be segmented into four categories: first, an absolute growth in inputs, for example, more workers, more locomotives, ceteris paribus; second, capital embodied technical change; third, labor embodied technical change; and fourth, disembodied technical change, or, growth which occurs solely from reorganizational changes, such as a merger. It is asserted that this last category, the disembodied technical change factor, is the key to the Penn Central case. Generally, the merging process is characterized by several sequential events. First, the announcement effect, which results in some people leaving the respective firms on the grounds that they might lose their jobs when the merger occurs; second, the shakeout effect, which results in some management being removed between the time of the announcement and the time of the actual implementation of the merger; and third, the operations effect, bringing additional managerial consolidation as a result of the post merger operations. The net effect should be substantial reduction in the
work force accompanied by improved efficiency. However, in the Penn Central situation, there was some reduction in manpower—a consequence of the announcement and shakeout effects—but the operations picture was a different story. Apparently, many of the expected gains from the consolidation of the two companies failed to materialize in the operations areas.

In the post-merger scenario, it was discovered that some computer systems operations of the Pennsylvania were incompatible with those of the New York Central and vice versa, the result being substantially increased inefficiency and an eventual need for additional cash flow. Then the debts began to pyramid and finally a saturation point was reached. But the relevant question (to which an answer cannot yet be supplied) is: How are the inefficiencies that occurred, to be reconciled with the degree of technical change the Penn Central has experienced, its internal managerial problems, and the state of the industry itself? This latter condition, of course, is contingent upon the health of the national economy and the securities markets which simultaneously had been suffering significant declines.

If the Penn Central merger could have been approved several years earlier, then the timing of the initial operations activity might have led to a different outcome. In other words, it is possible that the Penn Central was in the waiting stages for so long, that when the time came to formally merge, it actually was not prepared.

D. Some Implications of Mergers in the Railroad Industry

1. Optimum Size:

The conditions under which monopoly gains or gains from economies
of scale may follow from merger in the railroad industry will be discussed. One intention is to relate the frequency of mergers in the railroad industry to the types of other industries in which high merger rates are found. At this point, it is imperative to clarify assumptions which must be made to limit the scope of this discussion. Demand considerations obviously play an important role in determining the optimum size of the firm in any industry. However, demand conditions facing the railway will be considered given and constant throughout. This assumption of constant demand allows attention to be focused on the railroad's production function.

Under competitive conditions, the optimum size of the railroad is limited by the absence of cost incentives which would encourage the railroad to grow and the presence of cost forces which would discourage growth. If increasing returns to scale exist the railroad will expand its scale of plant to take advantage of the lower cost. In order to transfer this analysis to the production function, from which the cost functions are derived, one assumes that for the small scale of plant the production function exhibits increasing returns and for the larger than optimum scale of plant it exhibits decreasing returns. One of the relevant questions to be asked in this study is: do merging railroads possess increasing returns to scale? The empirical evidence from the railroad industry over a fourteen year period will be used to either confirm or refute this issue.

2. Merger Rates:

In the industries other than railroads where markets are fairly evenly divided among many small sellers, the increase in monopoly power
through a few acquisitions will be too small to increase prices and pro-
mits. This suggests that in order for merger rates to be high, a few
firms must account for a substantial share of industry output. In the
railroad industry, relatively few firms do account for a substantial
share of the industry output. Also, the larger the barriers to new entry,
the longer is a gain in earnings from reduced competition likely to
continue and, thus, the greater the incentive for merger. This is clear-
ly the case in the railroad industry, where substantial entry barriers
do exist.

On the economies of scale hypothesis, one would predict that in
the sectors in which mergers are an adaptation to changes in the rela-
tive efficiencies of various sizes of railroads, there will be a con-
current change in the average size of the railroad, that is, if changes
in the shape of the long run average cost curve are sufficient to in-
duce numerous mergers, one can expect that a sufficient number of old
firms will grow and that any new firms entering the industry will be
required to do so on a larger scale than previously, such that the average
size of the firms in the industry will increase. If economies of scale
are significant, merger activity should be inversely related to industry
growth.19 The reason for this is that with rapidly growing demand, it
is easier to achieve the requisite size for the minimum cost firm
through construction of new capacities. If the scale of output that
corresponds to minimum cost is larger, it probably will be difficult to
provide quickly the requisite market for an efficient level of output in

19See Michael Gort, "Economic Disturbance Theory of Mergers,"
the absence of rapid growth and demand. Thus, the smaller the rate of
growth of an industry, the greater is the likelihood that mergers will
be the more attractive to growth in firm size. In other words, for a given
level of economies of scale, the ratio of growth by mergers to growth
by other means should be inversely related to industry growth.

3. **Managerial Effects**

One might expect to find that a reason for mergers is the dif­
ference between two firms in the quality of skills, where a superior
management team could utilize opportunities from resources of another
firm whose management might not recognize them. Often these differences
are independent of the size of the firm. In the subsequent statisti­
cal analysis, these differentials are expected to show up in the
technical change variable, since a shift in the production function re­
sulting from reorganizational gains is imputed to the general classifi­
cation of technical change. It is assumed that a necessary condition
for a merger is that the average ability (or skill) of the resulting
post-merger management exceeds the average of two pre-merger managements.
What this also amounts to is a "shake-out" effect of inefficient manage­
ment attributed to the merger process.

4. **Merger Impacts:**

It is relevant to note that the policy implications of an adjudi­
cation case in a merger proceeding depend upon which merger impacts the
I.C.C. considers significant, which criteria are used, and how the bene­
fits are discounted to present for evaluation purposes. Only the first
of these considerations will be treated in this section.

Generally, the impacts of any merger are many and intricate. The
scope of this study is limited to the direct, observable impacts by choice. It is assumed that the secondary (or indirect) impacts are sufficiently complex to render them unobservable and hopefully insignificant, relative to the direct impacts. The impacts under consideration will be the following:

1. the effects of mergers on the size of railroads;
2. the effects of mergers on internal operations (efficiency) of railroads; and
3. the effects of mergers in the railroad industry within the regulatory framework.

These impacts will be evaluated in terms of a specific case, in terms of all the recent merger cases in the industry, and in terms of a comparison between railroads which choose to merge and those which do not. Subsequently, theoretical and statistical analyses will focus on these issues.

In a different realm of the merger issue, analysts occasionally fail to distinguish between economies of scale (meaning system-wide size of the railroad company) and economies of density on given segments of railroad routes. The general presumption that the technology of railroading should produce economies of density has been misread as a presumption that there should also be system-wide economies of scale in railroading. The important task for analysis and regulatory policy is to distinguish between mergers which will merely produce large size. Greater density may depend on: (1) the generation of new traffic, or (2) the consolidation of existing routes and the reduction of parallel trackage, or (3) the abandonment of branch lines. New traffic can be a result of various kinds of mergers, particularly end-to-end mergers which divert traffic from other modes and from other railroads. Consolidation of main line routes requires parallel mergers that simultaneously reduce
competition. Abandonment is an issue separate from merger, but it is possible that in a post-merger situation there would be pressure not to abandon trackage which otherwise would have been abandoned. This may be due to a public presumption that the merger system could more easily bear the financial burden of such trackage. As a result, the impacts of mergers upon economies of density, quite distinct from their impacts on economies or diseconomies of overall size, cannot be readily determined. Each merger is likely to have differential impacts. In the past, the problem has been to estimate these impacts correctly. In the future, the problem will not be different.

As one example of an approach to estimating the more significant impacts on the merging railroads, consider the following configuration, which displays a variety of possible combinations of merger candidates and their alternative routes.

Figure 2: Alternate Route Combinations for Merging Railroads
Each numbered point could represent a major terminal (node). Using the upper-Mid-West region as an example, the following nodes could be:
1--Chicago, 2--Cleveland, 3--Pittsburgh, and 4--Cincinnati.

The lettered symbols refer to railroads, with each terminal being connected by the tracks as indicated by the lines between the nodes. Assume that at any one point in time only two of the alternatives exist. The intermodal effects here are not considered, but they could be in an expanded analysis. Routes A and B are competing railroads, serving nodes 1, 2, and 3. A merger of these two and other combinations would result in the possible benefits and disadvantages as indicated in the following illustration:

<table>
<thead>
<tr>
<th>ROUTE COMBINATIONS</th>
<th>AB</th>
<th>AC*</th>
<th>AD</th>
<th>AE</th>
<th>AG</th>
<th>AF</th>
<th>AI</th>
<th>HC</th>
<th>HE</th>
<th>FC**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desirable Features</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consolidation of stations and terminals</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Elimination of duplicate lines</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Through freight service</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Effects of shorter joint routes</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Solicitation of freight for longer hauls</td>
<td>x</td>
<td></td>
<td></td>
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<tr>
<td>Pooling of l.c.l. freight</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pooling equipment</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Consolidation of repair facilities</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Reduction in material</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Locomotive utilization</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Possible higher frequency of service</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>Speed of delivery</td>
<td></td>
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<td></td>
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<tr>
<td>End-to-end benefits</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Undesirable Features</th>
<th>AB</th>
<th>AC*</th>
<th>AD</th>
<th>AE</th>
<th>AG</th>
<th>AF</th>
<th>AI</th>
<th>HC</th>
<th>HE</th>
<th>FC**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Possible decrease in employment</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trackage rights substitution</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased costs under labor contracts</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possibly adverse routing of freight by shippers</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possibly less frequent service</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possible abandoned line</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* identical to AH and GI
** identical to FH
For example, the merger of A and D, where D enters node 2 and competes with A for traffic between nodes 2 and 3, might result in the benefits of internal consolidation at node 2, and so on, and the general disadvantages, although some parties will gain, as indicated in the table. A merger between A and E might result in more traffic being diverted to E's line with the result that volume flows at node 2 would drop.

Regardless of the magnitude of the impacts, and how they are estimated, the I.C.C. will continue to be ultimately responsible for the adjudication decision. The evidence from this study suggests that in most instances the amount to be gained in overall efficiency terms from dragging out cases is small, while the amount to be gained from expediting the case proceedings, and by transferring regulatory resources toward increased control in situations like the Penn-Central, is frequently significant.
A. The Interstate Commerce Commission: The Regulatory Agency

The development of the Interstate Commerce Commission in 1887 was a general reflection of the trend toward more reliance upon administrative agencies in dealing with major social problems and a specific reflection of the unfolding railroad problem at that time. The complex and varied nature of the existing problems necessitated the creation of an agency with maneuverability and versatility and whose functions would not too greatly defy the traditional separation of powers principle. With the implementation of the Interstate Commerce Act, the railroads and rate-setting associations were required to adjust the rate determination process and rate structures to comply with the establishment of the Commission.

The Transportation Act of 1920 instructed the Interstate Commerce Commission to prepare and adopt a plan for the consolidation of the railway properties of the United States into a limited number of systems. Following the Transportation Act of 1920, the I.C.C. was converted from an agency devoted to facilitating private collusion to an "outright public cartel,"¹ which was vested with the power of minimum rate regulation, given control of entry into, exit from, and capital formation in the in-

dustry, and granted a variety of means for endeavoring to equalize the rate of return between the financially strong and weak railroads. The prohibition of pooling prescribed in the original Act of 1887 was changed to allow for discretionary approvals of pooling arrangements.

The famous Ripley consolidation plans for equalizing disparities among the various railroads were a result of the 1920 Act, but the stronger railroads were not interested in assisting the limping ones and had the right to refuse under the vague prescriptions of the statute.

1. **Criteria: Statutory and "Ad Hoc"**

The I.C.C. published the Complete Plan of Consolidation in 1929.

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2. The I.C.C. provided a return of 5 1/2 percent on a fair value of investment as a target for 1920 and 1921, after which the target was 6 percent. If a railroad's rate of return exceeded the maximum, it was required to retain half the excess in a contingency reserve and to deposit the other half in a fund administered by the I.C.C. for loan purposes to the weaker railroads. This provision proved unworkable, mainly because of the depression, and in 1933 the Emergency Transportation Act ended any effort at a target rate of return for the industry.

3. For an inquiry into the effects of cartel agreements on rates, tonnage shares, and profits of the major Eastern railroads in the last three decades of the nineteenth century, see Paul W. MacAvoy, *The Economic Effects of Regulation: The Trunk-Line Railroad Cartels and the Interstate Commerce Commission before 1900*. According to MacAvoy (p. 14), there were four major reorganizations of the cartel, each of which was occasioned by failures from "cheating" by some of the members. Each reorganization was an attempt to provide means for detecting deviations from the agreed rates and to provide penalties for such deviations. In general, if it was possible for an individual railroad to increase its profits by being loyal to a cartel agreement than being disloyal, the cartel would likely be stable. However, the evasion of regulation by individual railroads, and the reduction of the powers of the I.C.C. by the courts, induced the eventual collapse of cartel rates.

4. In fact, the Transportation Act of 1940 repealed the Ripley plan for consolidations and substituted other criteria.

5. In the *Matter of Consolidation of the Railways of the United States into a Limited Number of Systems*, 159 I.C.C. 522 (1929).
under which any consolidation had to conform to the configuration de-
signed in the plan and be in the public interest. None of the consoli-
dated systems proposed under the plan ever was effected, and very few
rail consolidations occurred during the period of the 1920 statute. How-
ever, the Transportation Act of 1940 repudiated the concept of a master
plan for rail unifications and instead insisted that all proposals to
purchase, lease, merge, consolidate, or otherwise acquire control of
railway properties was to be examined on its own merits in the light of
certain criteria as specified by Congress in Sec. 5(2)(c) of the Inter-
state Commerce Act of 1887. The 1940 Act redefined the criteria as:

(1) the effect of the proposed transaction upon adequate trans-
portation service to the public; (2) the effect upon the public
interest of the inclusion, or failure to include, other railroads
in the territory involved in the proposed transaction; (3) the
total fixed charges resulting from the proposed transactions;
and (4) the interest of the carrier employees affected.

In addition to the statutory requirements, the I.C.C. seems to
have adopted a set of "ad hoc" criteria, as a result of its being left
to adjudicate each case "on its own merits." These criteria appear at
various times in the cases discussed in the previous Chapter. The
criteria involve: (1) speed of delivery; (2) economy and frequency of
service; and (3) the appropriate provision and most efficient use of gen-
eral and specialized transport facilities. The "ad hoc" set actually

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6 The Transportation Act of 1940, Sec. 5(2). For a more complex
discussion of the statutory requirements, see Chapter 5, pp. 123-127.

7 Speed of Delivery indicates siding-to-siding elapsed time, apart
from frequency or dependability. It is a vital factor in the handling of
certain types of traffic, for example: perishable foods; livestock;
freight forwarder traffic, generally consisting of high-class and high-
value merchandise; export shipments, which must meet specified ship sailings;
auto parts traffic which must meet scheduled "release" dates; and piggy-
back traffic. Frequency of service facilitates the use of rail transpor-
has evolved as an attempt to clarify the ambiguities of their term "public interest," which is specified in the statutory criteria, and to maintain some degree of intramodal, competitive traffic flow. The "ad hoc"
criteria represents factors which are among the more important determinants influencing traffic or given routes and having a direct bearing on shippers' choice of routes. Since mergers can bring about structural changes, the protection of public and private interests with respect to routes and traffic volume are evaluated frequently in terms of the "ad hoc" criteria. In light of these criteria, a thorough discussion of the experience of the C. & O./B. & O. in terms of merger impacts appears in the following Chapter.

In an actual merger case, the applicants resort to demonstrating the beneficial impacts of what has been described above as the "ad hoc" set. The I.C.C. then attempts to evaluate this deluge of favorable data with the evidence which protestors and intervenors present. It is assumed that under the binds of testimony will the applicants carry out their promised and planned operating changes. Only occasionally does the I.C.C. subsequently "spot-check" a unified railroad for confirmation purposes. This is one area in which the regulatory agency needs to improve its efforts.

2. The Nature of Regulation

Regulation may be regarded as a measure designed to alleviate

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8 The deluge is overwhelming. A typical Volume of testimony contains approximately 400 pages, figures, and charts of information. An average Finance Docket consists of 300 Volumes. At an extreme, the Penn-Central Case contained 954 Volumes plus hundreds of separate exhibits. With all respect for due process, diminishing returns from additional testimony surely must occur early in the proceedings. In fact, the experience in collecting the data provides the impetus on which two hypotheses were developed in this study: the delay-cost hypothesis (in Chapter II) and the optimal control theory approach to merger regulation (in Chapter VI).

9 For example, in the C. & O./B. & O. case study, see Chapter IV.
any gaps between private and public interests which might arise. Traditionally the regulatory commissions have operated via a system of rules concerning items such as rates, depreciation methods, rates of return, and so on. Yet the problem remains that the rules really provide no inducements to superior performance on the part of the firms. Quite frequently the rules or methods do not tell how or with what instruments a company could induce superior dynamic performance, such as its managerial decisions involving increased risk-taking, cost-reduction, service innovation, and eliciting new markets. A consequence of the inherent limitations of regulation per se necessitates operating more as a restraining influence than as a positive impetus to good performance. These restraining influences exercised by the regulatory agencies can be interpreted in relation to the cartel stabilization features of regulation. In practice, the I.C.C. has devoted the major part of its efforts toward regulating selective competitive rate-cutting, but this fact is

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10 As mentioned earlier in this Chapter, cartels were elaborate organizations set up by agreements among the railroads for setting rates (principally on grains) in the 1870's and 1880's. A discussion of cartel theory, in terms of an analysis of the ways in which cartels tend to increase the profits of their members and an analysis of the conditions in which they tend to be unstable, is beyond the scope of this paper. One of the best discussions is referenced in footnote 3 (above): MacAvoy, op.cit., especially pp. 13-24, in which he states the conditions and requirements that a cartel arrangement must meet in order to operate successfully.

11 In a given year, say 1962, the Suspension Board of the I.C.C. considered 5,170 tariffs out of a total of more than 173,000 filed in that year. Of the ones considered, about 95 percent involved rate decreases. See Merton J. Peck, "Competitive Policy for Transportation?" in Almarin Phillips, ed., Perspectives on Anti-Trust Policy, p. 257.
not surprising, since this should be the primary duty of a cartel-stabilizing agency. Still, it remains to pose the following questions: if not regulation, what additional factors tend to explain why the performance of railroads has been as good as—or no worse than it has been? Principal influences which are offered as answers are: the profit incentive, managerial needs, long-run decreasing costs associated with continuously increasing demand, technological considerations, elasticity of demand, intermodal competition, and finally, the threat of government competition.

B. Regulatory Lag

A railroad prohibited from raising its rates or ordered to reduce them may react by reducing the quality of its service. In theory the I.C.C. can prevent a railroad from degrading the quality of its services but this would induce serious practical difficulties. To illustrate, if the waiting period for shipment arrivals lengthens, or the number of available boxcars decreases, or breakage is greater, or cars are less clean, the shipper may gain virtually nothing from a rate reduction. Yet these changes in the level of service, unless gross, are difficult to detect, prove or rectify.

The whole issue of whether incentives are provided for railroad management is hardly solved by the accident or regulatory lag. Rates are periodically, and not continuously, equated with costs. During the periods between regulatory determination the railroad has a profit incentive to become more efficient. However, this lag features probably does not provide much incentive to the railroads, because, first, it is an inadvertent method of injecting a profit incentive, and second,
it is not certain that the opportunity provided by regulatory lag to obtain supranormal profits is sufficient to avoid serious disincentive effects, although those effects might be even greater if there were no lag. If a railroad achieves a technical innovation which enables it to reduce its costs and increase its profits significantly, the I.C.C., if it is reasonably alert, will act accordingly as the railroad's rate of return begins to increase. The railroads will receive some profits in the interim, although the profits may be so much less than without regulation that the railroad's efforts in pursuing future innovations are dampened. An effectively regulated railroad, then may be denied the minimum reward for inventive activity which a competitive firm would obtain. This analysis can be applied to the case when the inventive activity is merger. The inference is that mergers may not be undertaken as effectively with regulation.

If the C. & O./B. & O. is an effectively regulated railroad, an empirical investigation into its merger properties could shed some light on the above issues. It is in this context that the investigation will be the subject matter of the following Chapter.
CHAPTER IV

AN INTERNAL EVALUATION: THE C. & O./B. & O.

CONSOLIDATION CASE

A. Historical Background

The Chesapeake and Ohio (C. & O.)/Baltimore and Ohio (B. & O.) consolidation case (1962-1969) conceivably could serve as a model on which controlling arrangements of strong railroads with weaker ones are facilitated. While special episodes do not normally justify generalization to other situations, this particular case illustrates an approach which could be used for future merger evaluations. Since transportation markets are characterized by substantial diversity, there are in fact few general principles that can be generated from particular circumstances. But in this case, the participants and the I.C.C. acted in a rational way so as to meet the exigencies of the particular time and place.

In 1962, the financially superior C. & O. decided to rehabilitate the weaker B. & O. by a gradual acquisition rather than by an outright merger. From an investment standpoint, C. & O. wished to allocate its funds where the marginal return was greatest. C. & O. management calculated that, while the marginal return of consolidation arrangements with B. & O. management was relatively low, the marginal return of such an arrangement with C. & O. management could be substantial, provided that the costs of the interfirm transactions were not so great that the proper allocation of C. & O. funds could not occur.
The C. & O. has demonstrated that a strong railroad initially need not endanger its financial strength in assuming control over an inept one. By a purchase of the weaker carrier's stock issue, the stonger road is able to lease new cars to that carrier, improve its physical plant and assist in overhauling its managerial and sales techniques. Inasmuch as the B. & O. was experiencing serious financial and managerial problems, the C. & O. selected the consolidation path as being preferable to an outright merger. Thus a trial period was provided to determine whether an eventual merger would suit the best interests of each carrier.

Although most cases of merger proposals involve railroads whose principal routes closely parallel the lines of other carriers, C. & O.'s 5,100 miles of track in 1961 strictly paralleled B. & O.'s 5,800 miles for only 332 miles, such that the controlling arrangement was primarily an end-to-end affair. In its fiscal year 1961, B. & O. sustained an operating loss of more than $31 million. Bankruptcy seemed imminent, for the road also suffered from heavy fixed debt, critical car shortages, and a large percentage of bad order rolling stock. In addition, its vital artery between the eastern seaboard and the southwestern gateways lacked sufficient clearances for the newer, larger piggyback and auto-rack cars, an important and potentially very lucrative source of revenue. In contrast, C. & O.'s earnings were positive over the period 1957-1961, although it was suffering from gross revenue declines, as were most other railroads. Another factor was that C. & O.'s management considered that too great a percentage of its traffic had become dependent upon coal (which importance as a fuel was declining), and that its territory and
configuration lacked the growth potential necessary to sustain an increasing and profitable traffic flow. Eventual merger with an upgraded B. & O. would enable the C. & O. to diversify its traffic by forwarding merchandise more cheaply to and from B. & O.'s lines.

Furthermore, C. & O. coveted many B. & O. track rights to certain cities, e.g., Chicago, St. Louis, Pittsburgh, Washington and Baltimore. In short, C. & O. not only had the financial resources and managerial talent to rescue the B. & O. from an impending financial disaster, but it realized a definite opportunity to diversify and increase its own traffic. Both companies anticipated that the consolidation could eliminate more effectively many costly and time-consuming interchange agreements, shorten key coal and merchandise train runs, phase out many assembly yards at common points, reduce their collective motive power roster, and achieve other efficiencies. In the following pages is a discussion and analysis of the internal impacts of the C. & O./B. & O. consolidation. In Appendix A is a summary of the monetary benefits realized from the consolidation following its approval by the I.C.C.

B. Methodology of Planning Studies

The economic studies underlying the initial investigation of the C. & O./B. & O. merger were outlined and directed by a Committee consisting of the following: W. W. Conley, General Manager, B. & O.; W. K. Weaver, Regional Manager, C. & O.; L. T. Mayher, Senior Vice President, Robert Heller and Associates, Inc., and W. M. Wyer, President, Wyer, Dick & Co. Studies first began in June, 1960 under the direction of Messrs. Conley, Weaver and Mayher. Operating department sub-committees consisting of representatives from each road for the transportation, en-
gineering, signal, communications, mechanical and station departments were formed and committees made field inspections to determine savings which could be realized from consolidating facilities and operations at the points covered and submitted their findings and recommendations to Messrs. Conley and Weaver. After the recommendations for each project of the sub-committees were approved, representatives of the respective accounting departments applied appropriate costs and calculated the estimated savings. Accounting department representatives also validated the results by checking source documents and payrolls. Following the accounting validation of all projects, separate reports were prepared by each sub-committee. Finally, certain mechanical principles or general methods of estimating savings were adopted to govern the development of the studies.¹

¹These ground rules are summarized as follows:

A. No economies were included which could have been realized apart from control.

B. In setting up the proposed salaries and rates of pay for officers and employees for departments or offices which would be consolidated under control, the following principles were followed (See Appendix B):

(a) For department heads and assistants, the higher of the rates presently in existence was adopted.

(b) When rates of pay for other employees differed as between the two companies for the same classification, jobs with the higher rates were existing rates.

(c) The following allowances were added to estimated savings in basic salaries and wages, based on average percentages applicable to system totals:

<table>
<thead>
<tr>
<th></th>
<th>Operating Employees</th>
<th>Non-Operating Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vacations</strong></td>
<td>5.54%</td>
<td>5.06%</td>
</tr>
<tr>
<td><strong>Health &amp; Welfare</strong></td>
<td>-</td>
<td>5.25%</td>
</tr>
<tr>
<td><strong>Paid Holidays</strong></td>
<td>-</td>
<td>2.15%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5.54%</td>
<td>12.46%</td>
</tr>
<tr>
<td><strong>Railroad Retirement &amp; Unemployment Ins.</strong></td>
<td>8.88%</td>
<td>9.02%</td>
</tr>
<tr>
<td><strong>Combined Percent</strong></td>
<td>14.42%</td>
<td>21.48%</td>
</tr>
</tbody>
</table>

C. All estimates represent the ultimate realization even though it would not be possible in every instance to have realized the full potential at first.
A substantial portion of the operations and physical properties of both C. & O. and B. & O. are located within the states of Illinois, Indiana, Ohio, West Virginia, New York and Maryland wherein the lines of the two companies cross or meet at approximately twenty-five locations.\(^2\) With separate operation of the two companies as at present, services are usually performed at these so-called "common points" by two separate operating organizations except, of course, at points where coordination has already been achieved.

At several locations such as Potomac Yard, Virginia and Washington, D.C., coordination has been achieved and at several locations such as Wellsboro, Indiana; Kenova, West Virginia; and Sciotoville, Ohio, no savings would be realized under control because either one or both companies do not have forces or facilities which could be combined at these locations.\(^3\) There remain nine points at which consolidation of forces and facilities would result in substantial savings.

In order to estimate potential savings from consolidation, the following procedure was used: Field parties consisting of representatives of each company for the Transportation, Engineering, Mechanical and Freight Station Sub-Committees inspected the present facilities involved at each common point and determined which facilities should be retained for use and which might be retired or released for sale or rental. Statements were prepared showing the operating data at each point for the most recent representative period available. These statements covered switching operations both by yard engines and by road

\(^2\)See Table 13 at the end of this chapter.

\(^3\)Exact locations of some of these points can be determined by referring to any large atlas.
trains doing station switching at the smaller stations; they also covered passenger stations, freight stations, engine houses, car repair tracks, car inspection and miscellaneous operations. From these statements the sub-committees estimated the forces which would be needed for coordinated operation as compared with the total forces now required for separate operation and developed plans for new yard and facilities where such would be required.

Each sub-committee prepared a report summarizing the conclusions reached. The Engineering Departments prepared estimates of the salvage to be recovered from property retired, the estimated cost of new construction and maintenance of facilities to be abandoned or constructed, and the Accounting Department calculated the savings in operation and summarized the figures for each common point. These reports were reviewed by Wyer, Dick & Co., and a general accord was reached.

Appendix B contains a detailed discussion of the two major labor problems that represent hurdles for the C. & O./B. & O. and continuously are important considerations for any railroads that wish to merge. The first problem is that of the costs of labor protection and the second one is the general problem of existing union work-rules on which a lengthy analysis is included.

C. Objectives of the C. & O./B. & O. Evaluation

The case study approach presents many difficulties. Paramount among these are the choice of the problem areas and sufficient data for analysis. If one must rely largely on managerial evaluations, then another problem is that the conclusions are more likely to be qualitative than quantitative. The important areas of testimony before the I.C.C.
provide the basis for the analysis in this Chapter. Since most of the
evidence in the proceedings dealt with cost savings, the analysis here is
confined to that area.

The purpose of the first section is to review the operations at
all points common to both lines and to estimate the potential savings
from merger as a result of serving each point with one unified operating
organization. Eleven projects are selected on which the alternative
cost information is presented.

The second section presents a formal model which the C. & O./
B. & O. could utilize to develop the transition from potential merger
benefits to actual market results. The purpose of the model is to
provide a foundation against which the actual behavior of C. & O./B. & O.
management in realizing the cost savings (Section D) may be examined.

D. Internal Effects: Expected and Realized Cost Savings

Most of the economies resulting from the C. & O./B. & O. con-
solidation can be grouped into three general categories: managerial,
operational, and maintenance benefits. Some of the managerial economies
are difficult to ascertain and to quantify, although internal observa-
tions indicate that many quality improvements can be traced to the
organizational and environmental effects occasioned by the consolidation.
Examples of operational economies are shown in the discussions of the
eleven selected projects in the following section. Finally, an example
of maintenance economies is displayed in Appendix C, in which a pattern
is depicted for the selection of an optimal maintenance policy for a
specific class of equipment—locomotives. It is argued later that the
preferred maintenance policy could only be optimal under a structure of
consolidation, because without the consolidation it would not be possible for the companies to realize the benefits of: the increased utilization of locomotive units, the unification of repair shops, and more effective quality control.

In Appendix A is a calculation of the more important expected cost savings alleged by the combined railroads. A comparison is made on the included items between what was originally promised in the official I.C.C. testimony and what was actually realized five years later. It is interesting to note that, except for the maintenance categories where unexpected gains occurred, most realized benefits fell short of the original estimates. Perhaps this can be explained in two ways: either railroads in general tend to overestimate the cost savings and/or the time horizon necessary to realize the projected benefits is longer than five years. However, in the second part of Appendix A it is shown that many spillover benefits accrued from the combined companies merely as a result of derived consolidation effects.

In the original testimony for the consolidation of the C. & O. and B. & O., the cost savings which were expected to accrue annually from the consolidation of stations and terminals were estimated at $9.0 million although only a very small portion of this estimate was realized by the end of 1966 (see Appendix A). Most of the disparity between the expected and realized savings can be explained by a shifting of priorities, first, to other projects on the part of management, for example, locomotive maintenance and freight car rehabilitation, and second, merely to a miscalculation of the alleged savings. The original estimates

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4^Finance Docket No. 21160.
in the testimony are determined by railroad executives on the basis of proper analysis, but the figures can be misleading because of the lags of project implementation, changing business conditions, and managerial changes.

In the following section is a series of eleven projects that were made possible via the consolidation of the two companies. After the description and analysis of each two projects appear the tables of data to which the two corresponding projects pertain. At the end of this section is Table 12, in which the overall impacts of these projects on internal operations are shown.

1. **Selected Out-of-Pocket Costs in Handling Designated Traffic**

This section details a selection number of initial and representative group of projects in the internal transportation area in which there were prospects of considerable savings upon consolidation of C. & O./B. & O. facilities and operations. The group, of course, is not exhaustive, but it does include a sufficient and comprehensive list designated to test merger impacts. The calculations are based on excerpts from assorted, internal data and reports of the Planning Department of the C. & O./B. & O. Companies. In general, the purpose is first, to relate some of the methods and foundations on which managerial decisions are determined with respect to implementing alleged benefits presumed to accrue from consolidation and, second, to make an overall evaluation of the cost savings from the projects.

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*I am indebted to Dr. H. L. Laden, Director of Research Services, Joseph R. Schmidt, Assistant Director of Research Services, and Robert G. McGowan, Vice President, Planning Department for their generous criticism and assistance in providing access to the available records of the C. & O./B. & O. Railroad Companies.*
These projects are eleven in number, the first nine dealing with freight traffic, passenger trains and yard consolidations, and including consideration of routes, trains, yards and related subjects. Of the remaining two projects, one measures the effect of the first nine projects upon the combined diesel locomotive fleets; the other relates to benefits from alternate winter season operation of the respective C. & O./B. & O. coal dumping facilities in the Toledo, Ohio area. The beginning of the time period is 1964, the first full year after the authorized consolidation between the two railroads. The data for each project are provided at the end of the chapter. The analysis is based on the out-of-pocket and other specific costs enumerated below:

A) Road Train Service and Yard, Puller or Transfer Service:
   1) Crew Wages, Inc. Vacation Allowance,
   2) Locomotive fuel, lubricants and supplies, engine-house expenses and repairs,
   3) Payroll taxes applicable;
B) Yard Service Employees:
   1) Wages,
   2) Additives for specific positions under study;
C) Train Supplies and Expenses.

The portion of the total cost savings occasioned by the consolidation which this group of projects represents probably would constitute between 20 and 40 percent. A precise comparison with the total cost savings realized or with the estimated cost savings from the testimony cannot be made because of preference shifts and time lags. See Appendix A for a comparison between 1961 and 1966 data.

2. Assumptions of the Evaluation

The only joint facility expenses included herein are those which vary with traffic. Track maintenance is based on study of a five year period with prime consideration given to volume traffic. Per Diem is
based on the current rate of $2.88 per car day in cases where car days could be measured. The alternate operations and specified routes upon which the various projects are based will be subject to such arrangements as may be negotiated with either the railroads involved or the labor organizations affected. The costs due to use of joint trackage or facilities were based on existing unit charges. The summary statement which covers all 11 projects of this section, and appears in Table 12 at the end of this chapter, shows results as follows:

<table>
<thead>
<tr>
<th>Present Operation</th>
<th>$14,778,405</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Operation</td>
<td>8,688,953</td>
</tr>
<tr>
<td>Net Overall Savings</td>
<td>$6,089,452</td>
</tr>
</tbody>
</table>

Refer to Tables 1-12 for the more detailed calculations for each project. The figures in the tables are stated in units of thousands of dollars (with the exceptions of Tables 10 and 11, which are in total dollars).

Project No. 1: Louisville & Nashville (L & N) Lake Coal

This project refers to coal delivered by the Louisville and Nashville Railroad to the Chesapeake and Ohio Railway at K.C. Junction, Covington, Ky. This coal is moved by C. & O. to its lake coal dock, Toledo, Ohio, where it is dumped into lake boats for various lake ports to the North and Northwest. The volume of this coal during 1962-1964 averaged approximately 38,500 cars per year, this movement is largely confined to the period March through November, depending upon weather conditions.
Present Operations

This coal presently moves as follows:

K.C. Jct., Ky. to Stevens, Ky. via Transfer or Puller
Stevens, Ky. to Limeville, Ky. via Road Train to Russell
Limeville, Ky. to Parsons Yard, O. via Road Train from Russell
Parsons Yard, O. to Walbridge, O. via Road Train
Walbridge, O. to Presque Isle Docks via Transfer or Puller

The overall length of this route, which requires two transfer runs and three road trains, is 346 miles. The Stevens-Limeville run is by road trains running between Stevens and Russell which set off the Lake coal at Limeville, then continuing to Russell by any remaining cars. On the reverse movement, trains out of Russell with or without cars will pick up the lake coal empties at Limeville and handle on to Stevens. The Limeville-Parsons run is via road trains running between Russell and Parsons Yard, which pick up solid trains or fill out with L & N lake coal at Limeville, which lies about 15 miles west of Russell Yard.

Alternate Operation

Under alternate operation, this coal would be routed as follows:

K.C. Jct., Ky. to B & O Yard A, Cincinnati, Ohio, via transfer run
B & O Yard A to Lima, Ohio, via Road Train
Lima, Ohio to Walbridge, Ohio via Road Train
Walbridge, Ohio to Presque Isle, Ohio via Transfer Crew

The overall length of the above route, which requires two transfer and two road trains, is approximately 212 miles or about 134 miles less than via present route.

The tabular data for each project are given at the end of the Chapter. With each project number is its corresponding table number (for example, Table 6, contains the data associated with Project 6). Table 12 is a compilation of the data from the first eleven tables.
Costs of Operations

Joint facilities affected by volume of traffic or use are largely restricted to use of C & C Bridge, The Toledo Terminal and Dayton Union Terminal. The savings also included an estimate of 1 day per round trip, Per Diem at $2.88 per/car day (see Table 1).

Project No. 2:
Chicago Coal

This project refers to coal originating on C & O, or received from connections, east of Russell, Ky., and destined to the Chicago area. Included are deliveries to Illinois Central (I.C.) at Burnhan, Elgin Joliet and Eastern (E.J. & E.) at Griffith, and coal terminating in Chicago proper; also coal to other connections at Chicago. Based upon experience since 1956, the volume moving through Russell to Chicago will approximate 32,000 loads annually, of which 12,500 are destined for E.J. & E. at Griffith.

Present Operations

This coal presently moves as follows:

Russell to Stevens
Stevens to Cheviot
Cheviot to Peru
Peru to Burnham/Rockwell Yards

Road Trains
Transfer
Road Trains
Road Trains

The distance of this route, which requires three road train movements and one transfer move, is approximately 420 miles. The C. & O. follows the Ohio River between Russell and Stevens and the grades are most favorable; however, between Stevens and Cheviot there is a 1.91% grade, adverse to westbound trains extending from MP 1 (Miles Post 1) to MP 5, Cheviot Sub-division, within yard limits; in addition there is a 1.12% grade adverse to westbound trains extending from MP 25 to MP 31.5,
Miami Sub-division, which limits the length of coal trains west of Cheviot to 80 loaded cars of coal. In addition, helper service and yard crews are required on Cheviot Hill.

**Alternate Operations**

The B. & O. Chicago Division crosses the Columbus Sub-division of the C. & O. at Fostoria, Ohio and it is proposed to move coal from Russell to Chicago (including coal now moving to the E.J. & E. at Griffith, Indiana) via Russell-Fostoria-B. & O.-Chicago. Under alternate operations, this coal traffic would be routed as follows:

- Russell to Parsons (C. & O.) via Road Trains
- Parsons to Fostoria (C. & O.) via Road Trains
- Fostoria to Garrett (B. & O.) via Road Trains
- Garrett to Barr Yard (B. & O.) via Road Trains

The overall length of this route, which requires four road trains is approximately 431 miles. Although the distance of this proposed route is slightly more than the present route, this disadvantage will be more than offset by the more favorable grades of the proposed route. The cost of construction of interchange facilities at Fostoria to handle the volume of traffic is included in an Engineering Group Report. Joint Facility expenses include C. & C. Bridge and trackage and interlocker facilities in the Chicago area.

**Cost of Operations**

The cost under present and alternate routes are shown on statement following (see Table 2, p.102):

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs under present operations are.</td>
<td>$1,870,877</td>
</tr>
<tr>
<td>Costs under alternate operations are.</td>
<td>1,305,196</td>
</tr>
<tr>
<td>Net reduction</td>
<td>565,681</td>
</tr>
</tbody>
</table>

This reduction results from operation of longer trains over the alternate
compared with shorter trains operated over present route of the Chicago Division with the limiting grades previously described. Coal destined to Gary, Ind., is at present interchanged at Griffith to the E.J. & E. which receives approximately 18.6% of the road haul revenues, or about $ .885 per ton on coal originating at Holden, W. Va. This volume presently approximates 12,500 cars per year. Under the alternate operation, B. & O. would handle this coal directly to Curtis Yard, point of delivery to E.J. & E., which would handle directly to plant at Gary, Ind., which would reduce E.J. & E. proportion of road haul movement of this coal, thereby raising the question as to a new division of the freight rate.

**Project No. 3:**
**Manifest Between Chicago--Cincinnati (B. & O.) and Between Saginaw (Detroit)--Cincinnati via LaCrosse (C. & O.)**

**Present Operation--Phase 1**

This phase of Project No. 3 refers to the movement of auto parts and other high class manifest (i.e. high priority) traffic out of the Saginaw--Flint Area (and to some extent from Detroit), estimated at 5,634 loads per year, handled in preferential high speed trains via Plymouth, Grand Rapids, New Buffalo, LaCrosse and Cincinnati. The trains handling this traffic also move similar high grade traffic destined to various Chicago connections, particularly the Illinois Central (I.C.) and Rock Island (R.I.) railroads. The set-offs for Cincinnati are handled between New Buffalo--LaCrosse by a New Buffalo local. They are then expedited via a special Burnham. The distances involved in the present routing based on Plymouth, Mich., which is a point common to both the present and alternate route, are based on the following arrangement:
Plymouth--Grand Rapids via Road Train
Grand Rapids--New Buffalo via Road Train
New Buffalo--LaCrosse via Local Freight
LaCrosse--Peru via Road Train
(Out of Burnham [104 mile run])
Peru--Cheviot via Road Train
Cheviot--Cincinnati via Transfer Train

This present route, which requires four manifest trains, in whole or in part, one local freight train, and one transfer run, is approximately 500 miles.

Alternate Operation--Phase 1

Alternate routing of this traffic contemplates movement as follows:

Through Plymouth to Walbridge, via C. & O. Road Trains
Walbridge to Cincinnati, via B. & O. Road Trains

This route, which requires two road trains, is 260 miles long, or 240 miles shorter than the present route. This shorter mileage may be expected to provide improved service. The alternate routing of this traffic contemplates no extra road train runs by B. & O., which expects to absorb it in existing trains, running through from Walbridge Yard, Toledo, Ohio, to Cincinnati. However, the C. & O. expects to be able to eliminate ten trains per week on the Wabash Sub-division and seven trains per week on the Miami Sub-division, which were set up primarily to give preferential handling of this particular traffic. This would be induced by some re-scheduling made possible by such re-routing.

Present Operation--Phase 2

This phase of Project No. 3 refers to a B. & O. manifest train

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Manifest trains are high speed, high priority freight trains, that usually operate between major terminals and carry items such as automobiles, produce, meat, trailers-on-flat-cars (T.O.F.C.), and containers (C.O.F.C.).
which presently moves Chicago and Cincinnati as follows:

- Robey Street, Chicago--Garrett, Ind. via Road Train
- Garrett--Lima via Road Train
- Lima--Cincinnati via Road Train

This route, which requires three road trains, is 380 miles long. The amount of this traffic is estimated at 24,528 cars per year for both directions.

**Alternate Operation--Phase 2**

Alternate operation contemplates handling of this traffic between Barr Yard, which would be a common terminal for both C. & O. and B. & O., and Cincinnati, Ohio, as follows:

- Barr Yard--Peru via Road Train
- Peru--Cheviot via Road Train
- Cheviot--Cincinnati via Transfer Run

This route, which requires two road trains and one transfer run, is approximately 275 miles or 105 miles less than the present all B. & O. route. For cost savings data, see Table 3.

**Project No. 4: Chicago Terminal Area**

This area was considered as a separate and individual project not only to avoid necessity of proration of its activities, services and costs among the various projects which touch the Chicago Area in various ways, but principally because of certain duplication of facilities, services and operations which offer potential reductions in cost through consolidation.

**Present Operation**

Northern Region freight trains operate over trackage of other railroads into Chicago as follows:
The number of freight cars handled varies, but approximates 190,000 per year. Transfer crews handle approximately 15,000 freight cars per year over the B. & O. Chicago Terminal (B. & O.C.Y.) in and out of the freight house.

Central Region freight trains operate over trackage of other railroads into Chicago, as follows:

- Erie Railroad--H.Y. Tower, Ind.--Indiana--Illinois State Line
- C. & W.I. Railroad--Pullman Jct.--80th St. (alternate route)
- Belt Railway of Chicago--Pullman Jct.--Rockwell St. Yard

A description of the various facilities and the effect of such changes follows:

Rockwell Street Yard.--Located between Columbia Avenue on the east and the Hayford Junction crossing, Rockwell Street Yard, the final terminal for C. & O. in the Chicago area, is used by both Northern and Central Region trains. Cars arriving in road trains are classified and delivered either direct to connections or to the Belt Railway of Chicago (B.R.C.) for forwarding to connections or delivery. Cars received from the various connections are switched and classified for road movement. The yard is located on property leased for the B.R.C.; also leased are 16 Belt Railway Co. tracks, two car repair tracks, and extensions to Belt tracks nos. 14, 15, 16 and 17, car department service buildings and repair facilities, diesel engine house, fuel station and oil tanks, yard office, flood lights and bunk house.
The westbound receiving yard consists of nine tracks, with capacities varying from 30 to 48 cars. Total standing capacity is 340 cars. The classification-departure yard consists of thirteen tracks, with capacities varying from 34 to 53 cars: total standing capacity--615 cars.

Burnham Yard.--Burnham Yard, serving only Central Region trains, is located in the vicinity of 144th Street and Brainard Avenue, connecting with tracks of the Chicago and Western Indiana (C. & W.I.) Railroad over which C. & O. has trackage rights under Agreement dated April 15, 1952. There are six double ended tracks with a capacity of 330 cars, two short stub tracks, a ten car repair track and an engine ready track. Total standing capacity is 404 cars. Other improvements include a yard office, bunk cars for crews, car service building and freight car repair facilities, and diesel fuel oil and sanding facilities. When lake navigation is closed, trains are operated from Peru to Burnham in turn-around service, as required, to handle coal for the Chicago area. Two yard and transfer crews are assigned to Burnham.

Indiana Harbor Yard.--The yard serves only Northern Region trains and is located adjacent to the B. & O. main lines at Michigan Ave., East Chicago, Illinois. Yard and station buildings are leased from the B. & O. with the exception of No. 4 track which is owned by C. & O. There are four tracks with a total standing capacity of 125 cars. No yard crews are assigned, but in order to expedite the movement of important eastbound road trains, it is necessary that a road switcher be operated five days per week to switch and classify night deliveries.

Alternate Operation

The proposal under consideration, briefly, is that C. & O.
eliminate all of its yard facilities in the Chicago area and utilize B. & O. Chicago Terminal Barr Yard and its Robey St. (Forest Hill) freighthouse and T.O.F.C. facilities. The B. & O.C.T., a wholly owned subsidiary of B. & O. makes the same direct deliveries that are presently being made by C. & O. or by the B.R.C. with the following exceptions:

(1) C. & W.I. cars for these lines are handled via the Belt at Clearing by B. & O.C.T.

(2) Cars for the Illinois Central are handled via the Gulf, Mobile & Ohio by B. & O.C.T., delivery being made at Glen Yard and cars are received at Robey St.

The B. & O.C.T. owns 365 miles of track and holds an additional 214 miles of trackage rights over other lines. It provides direct railroad service to over 400 industries on its lines by means of 17 small classification yards located in close proximity to each of the industrial areas in Chicago. These yards have a combined capacity of more than 5,000 cars and the service is supplemented by 39 team tracks that can hold a total of 470 cars.

**Barr Yard.**--located on Chicago's far south side, is the main freight terminal for B. & O. in Chicago. This yard, constructed in 1947, covers 205 acres with a total standing capacity of about 3,600 cars and is of flat design. Its facilities include east and westbound receiving and classification yards, car repair yard, engine terminal, 200-ton track scale and a complete communication system. The eastbound yard consists of 15 classification tracks with a standing capacity of 1,146 cars and five receiving tracks with a standing capacity of 345 cars. The westbound yard consists of 26 classification tracks with a standing capacity of 1,208 cars and six receiving tracks with a capacity of 500
cars. B. & O.C.T. normally utilized 61 yard and transfer assignments. Under the alternate operation outlined herein, there would be a considerable readjustment in sections used, particularly of the B.R. of C., of which the C. & O. is a 2/13 owner; of the C. & W.I., which might be eliminated entirely; of B. & O. trackage Pine Junction to R.I. Jct.; and, of course, of Rockwell St. Yard, Burnham Yard and yard tracks at Indiana Harobr.

Costs of Operation

The alternate operation, effecting use of Barr Yard for all Chicago area traffic, is shown in Table 4, which indicates the following cost reduction:

<table>
<thead>
<tr>
<th>Present Cost</th>
<th>$1,994,273</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate Cost</td>
<td>743,304</td>
</tr>
<tr>
<td>Net Saving</td>
<td>1,250,969</td>
</tr>
</tbody>
</table>

C. & O. Road Train Service

The shorter distance which the road train will travel, Northern Region--Grand Rapids to Barr, instead of Rockwell, six miles less, and Central Region--Peru to Barr, instead of Rockwell, seven miles less, could produce savings amounting to approximately $85,000 per year on the basis that wages and locomotive expenses would reflect the shorter distance operated of approximately 5,200 trains per year.

C. & O. Yard Service

The savings in a C. & O. yard service is that obtained by eliminating two yard crew tricks\(^8\) at Burnham and eleven yard crew tricks at

\(^8\)In railway terminology, a "trick" is identical to a work-shift, or one of the three eight hour work periods during a day. In this case, the yard crew trick pertains to the men working in the yard, where engines and cars are switched.
Rockwell. Seven additional yard crews operating out of Barr Yard are considered adequate for handling the additional C. & O. cars. Expenses shown for C. & O. yard service employees, the ground forces in yards, and certain other position, covers wages, plus additives only. Under the alternate operation, no expenses for same are shown for C. & O. as this service would then be performed by Barr Yard personnel with such extra employees as would be necessary. Additional positions required by B. & O.C.T. to handle the increased work upon consolidation are included in the B. & O. alternate expense. Train supplies and expenses are based upon car miles. The amount shown as savings (or decrease) is the result of the shorter distance traveled per car. No track maintenance figures have been included in the C. & O. portion of expenses as the portion of the road on which the volume of traffic has decreased, based upon car miles, is all in joint operating territory and thus would be taken into account in the joint facility portion.

**Piggyback**

C. & O. piggyback business was estimated at 8,400 cars (16,404 trailers) per year. These cars are switched between Rockwell and Clearing and utilize two tracks of the Belt Railway of Chicago at Clearing. The switching charge of the Belt Railway of Chicago, $19.50 per car, plus track rental charges, would be eliminated upon the transfer of this business to Forest Hill.

Joint facility expenses shown for C. & O., which could be eliminated upon the use of Barr Yard, are as follows:

- **C.R.I. & P. at So. Chicago**--9.12 miles--$1.00 per train
- **B.R. of C.--Charges vary with use**
- **C. & W.I. Trackage, State Line--Pullman Jct.**--7.65 miles--Wheelage proportion of interest, taxes and operating costs, plus 10c for each loaded and empty car.
C. & W.I.--Pullman Jct.--80th St. Route--3.31 miles at $3.00 per train mile
N.Y.C.--Porter to Pine--17.90 miles, at $1.59 per train mile for the New Buffalo--Indiana Harbor turn

These savings in joint facility charges upon consolidation will be offset by additional B. & O.C.T. joint facility expenses of $22,012 on account of the required use of tracks of other railroads, with the overall result amounting to a net reduction in joint facility expense of $747,603. See Table 4.

Project No. 5:
Manifest Freight Lexington--Louisville Sub-division

Present Operation

This project covers C. & O. freight operations on the Lexington and Louisville Sub-divisions. Two manifest trains operate daily each way between Louisville and Russell, Ky., and one local freight operates on alternate days, except Sundays, between Ashland, Ky., and Lexington, Ky. The two operating sub-divisions are Lexington, between Russell and Lexington--127 miles in length, and Louisville, between Lexington and Louisville, a distance of 85 miles; however, the grades via B. & O. are much more favorable, with the maximum grade for westbound trains on the B. & O. being one percent between Mile Post 30 and Mile Post 42 on the St. Louis division compared to a 2.67 percent adverse grade westbound over Corey Hill, Mile post (MP) 556, C. & O. Lexington Subdivision. Operation on the Louisville Sub-division is on Louisville and Nashville trackage under an agreement made on March 23, 1895 covering trackage rights for a period of 100 years. The joint facility cost of $696,741 per year include $60,000 ($5,000 per month) rental of joint tracks. This may be subject to negotiation as the contract does not contain any termination clause.
The annual volume of the business on this territory is approximately 23,000 cars westbound into Louisville and 29,000 cars eastbound from Louisville. Other cars are handled between Lexington, Winchester, Olive Hill, and Russell. Only one C. & O. Yard (Netherland), besides Russell Yard, is utilized as the N.Y.C. performs all switching service for the C. & O. in the Louisville area.

Alternate Operation

Under alternate operation affecting C. & O., the manifest trains operating from Russell--Lexington--Louisville would be eliminated. A local freight train would operate daily in each direction between Russell and Lexington to handle local work and to assist on the cars presently handled by manifest trains in and out of Lexington. One yard crew trick at Lexington (Netherland) could be discontinued. This alternate operation is based on the movement of this Louisville business to and from Cincinnati by the C. & O. and movement from Cincinnati via North Vernon to Louisville via B. & O. and the K. & I.T. Railroad (Kentucky & Indiana Terminal Railroad Company), which is jointly owned by the B. & O., the Southern and the Monon. The N.Y.C. uses the B. & O. tracks under trackage rights between North Vernon and Jeffersonville, Indiana. The K. & I.T. has direct connections with its owner lines, and also with the I.C., Pennsylvania and L. & N. In addition, it has a connection through the Short Route Railway and Transfer Company with the N.Y.C. and C. & O., affording switching service to and from all lines entering Louisville. The length of the alternate route between Russell and Louisville is approximately 274 miles, as compared with the present 21½ mile route via Lexington.
Project No. 6:  
Wellston, Ohio-Jackson, Ohio Local Freight

The Jackson Sub-division of the C. & O. extends approximately 17 miles from Dundas to Jackson and roughly parallels the B. & O. for the entire distance. Junctions with B. & O. are at Dundas and Wellston and with the Detroit, Toledo and Ironton at Jackson. Present operations on this sub-division are handled by a local freight train which operates between Wellson, Hamden, and Jackson daily except Sunday. The crew on this local freight performs primarily switching duties with ore trains. In addition, the local freight, which operates between Logan and Pomeroy, Ohio, frequently makes side trips onto the branches as conditions require.

Very few cars are handled in this territory and the alternate proposal is that this sub-division be retired and all traffic handled by B. & O. This section only covers the operating portion of the proposal. The C. & O. cost of road train service amounts to $43,870 per year and includes crew wages, locomotive expenses and payroll additives. B. & O. states that this traffic can be handled in present B. & O. trains without additional train or yard expense. This would result in a train service expense reduction to C. & O. of $43,870 per year. See Table 6.

Project No. 7:  

B. & O. yard limits extend from Guyandotte to Kenova, W. Va., a distance of 11.7 miles with single track operation. Over this route B. & O. has two yard crews assigned seven days per week, 9:00 a.m. to 5:00 p.m., and 10:30 p.m. to 6:30 a.m. Train No. 93 is scheduled to arrive at Huntington, W. Va. at 5:00 a.m. daily and Train No. 92 departs
at 4:35 p.m. Train No. 81 arrives on Mondays, Wednesdays and Fridays at 12:25 p.m., and Train No. 82 departs Tuesdays, Thursdays and Saturdays at 7:35 a.m. B. & O. road trains originate and terminate at Huntington. The interchange with the N. & W. at Kenova and all work between Huntington and Kenova had been performed by yard crews. The B. & O. track parallels the C. & O. between Huntington and Kenova and much of the B. & O. switching is performed in 2nd Avenue.

C. & O. Operation--Huntington Area

Huntington is the headquarters of the Central Region of C. & O. and a point of major importance to C. & O. operation. The Huntington Yard extends from a point 1,106 feet east of Mile Post 501 to 247 feet west of Mile Post 505. There are four yards known as South Yard, 16th St. Yard, Shop Yard and River Yard. South Yard, consisting of ten stub-end tracks located south of the freight main tracks with ladder track just west of 16th Street Yard Office, can accommodate 275 cars and is used for setting off and picking up eastward trains.

16th Street Yard is located between the freight and passenger main tracks extending from 23rd Street to 3rd Street East, the hump, yard office and scale being located at 16th Street. There are five tracks east of the hump and seven classification tracks west of the hump. The yard will accommodate 825 cars and there is a 300 car pull-intrack parallel to the westbound freight main. The Shop Yard, with a capacity of 400 cars, is located between 23rd Street and 29th Street East and North of the freight and passenger main tracks, and serves the coach shops, diesel shops, back shops and storeroom. The River Yard, also with a storage capacity of 400 cars, is located on the north side of and parallel to the Ohio River, and is connected with 16th Street Yard by two belt tracks, one
at 3rd Street East, the other at 23rd Street East. The present B. & O./C. & O. interchange is located at 3rd Street, River Yard, and consists of a 33 car interchange track for receipt of cars from B. & O. and an 18 car track for delivery of cars to B. & O.

In order to consolidate the B. & O./C. & O. operation in Huntington, a connection between B. & O./C. & O. is required in the vicinity of the 29th Street, west of the Guyandot River. All B. & O. road trains would terminate and originate in C. & O.'s 16th Street Yard, and the present B. & O. interchange with the N. & W. at Kenova would be absorbed in the present C. & O. trains. Construction costs of a connection of B. & O. with C. & O. in the vicinity of 29th Street, as well as any other possible track rearrangements or retirements, are not considered herein. This would also apply to retirement of certain B. & O. trackage between Huntington and Kenova. The B. & O. crew wages and locomotive expenses, based on present 14 crews per week, amounts to $120,033 per year. The expense of six yard crew tricks per week would amount to $51,443, or a savings of $68,590 annually. There would also be a reduction on the work force comprising one interchange clerk, two yard clerks, and one operator, with an annual savings of $39,616. The result from Table 7 is a total savings of $99,206.

Project No. 8: B. & O. and B. & O. Passenger Trains Into and Out of Toledo and Detroit

Present Operation--C. & O.

C. & O. operates one train daily in each direction, No. 47 Westbound and No. 46 Eastbound. The distances of the routes are: Columbus-Toledo--123 miles; Toledo-Detroit--82 miles. These trains operate through
Fostoria to Rockwell Junction over C. & O. trackage and then into Toledo Union Station, over 2.5 miles of N.Y.C. trackage. Beyond Toledo, the trains then move via New York Central trackage through Alexis, 8.8 miles, and via Plymouth to Fort Street Union Depot, Detroit, over C. & O. rails.

**Present Operation--B. & O.**

B. & O. operates daily into and out of Toledo and Detroit:

- No. 53-54--Cincinnati-Detroit
- No. 57-58--Cincinnati-Detroit
- No. 19-20--Washington-Detroit

These trains presently operate through Toledo Union Station, using B. & O. trackage south of Toledo and New York Central trackage, Toledo to New York Central Station at Detroit. The passenger station facilities and the locomotive and car servicing facilities of the New York Central are used in Detroit.

**Alternate Operation**

B. & O. trains No. 19 and 20 operate through Fostoria with schedules at Fostoria, Toledo and Detroit, comparing closely with C. & O. trains No. 46 and 47 follows:

<table>
<thead>
<tr>
<th></th>
<th>Fostoria</th>
<th>Toledo</th>
<th>Detroit</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 47 WB or NB</td>
<td>4:04 AM</td>
<td>5:25 AM</td>
<td>7:30 AM</td>
</tr>
<tr>
<td>No. 19 WB or NB</td>
<td>5:10 AM</td>
<td>6:20 AM</td>
<td>7:50 AM</td>
</tr>
<tr>
<td>No. 46 EB or SB</td>
<td>8:58 PM</td>
<td>7:55 PM</td>
<td>6:00 PM</td>
</tr>
<tr>
<td>No. 20 EB or SB</td>
<td>8:38 PM</td>
<td>7:25 PM</td>
<td>6:00 PM</td>
</tr>
</tbody>
</table>

The consists\(^9\) of Nos. 19-20 are comparable with trains Nos. 47 and 46 and it is feasible to consolidate the two trains from this standpoint and the standpoint of schedules. The Project is based on consolidation of

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\(^9\) A "consist" is the group of locomotives pulling the train. It refers to the number and type of units and the amount of horsepower. In general, the terrain over which the train is to move dictates the type of locomotives to be used.
Trains Nos. 47 and 19 and 46 and 20 between Fostoria and Detroit. Under this plan, C. & O. trains Nos. 46-47 would operate between Columbus and Fostoria, using C. & O. crews and locomotives, 89 miles, and would terminate and originate at that point. This plan further contemplates consolidation at that point. This plan further contemplates consolidation of the consist of C. & O. No. 47 and B. & O. No. 19, and the de-consolidation of C. & O. No. 46 and B. & O. No. 20 at Fostoria. Operation of the consolidated trains would be over B. & O. trackage, Fostoria-North Baltimore, Tontagany, Toledo, 53 miles. This is longer than the C. & O. 34 mile route--Fostoria-Toledo, but is necessary to protect B. & O. intermediate passenger service, since there are no regular stops by C. & O. It also includes the operation of B. & O. trains Nos. 53-54, 57-58, which trains would continue operation south of Toledo without change and would operate with same consists but over C. & O. route Toledo-Detroit.

The consolidated trains would operate from the B. & O.-Fostoria passenger station, which would combine passenger operations now handled at separate stations. This would permit the retirement of the C. & O. passenger station. The consolidated trains Fostoria-Toledo, would use B. & O. crews and power. The alternate operation between Toledo and Detroit would continue the use of N.Y.C. trackage between Toledo Union Station and Alexis, for all C. & O./B. & O. trains, including the newly consolidated ones.

The alternate operation between Alexis-Detroit would be designed over the present C. & O. route and it would be used by all C. & O. and B. & O. trains. The C. & O. route, Toledo-Detroit, at 82 miles, is 25
25 miles longer than the 57 miles of the present B. & O. route--Toledo-Detroit. Such alternate operations would include the use of Union Belt at Detroit trackage from 1 1/2 miles west of Michigan Ave. to 18 1/2 Street, 7.8 miles, and Fort Street Union Depot and its trackage from 18 1/2 Street, 1.2 miles, into the Fort Street Union Depot.

Cost of Operation

The costs of operation, excluding track rearrangement and additional facilities for handling trains at Fort Street Union Depot, Detroit and at Fostoria, but including additional switching requirements at these two points are as follows:

<table>
<thead>
<tr>
<th>Operation Type</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present Operation</td>
<td>$2,930,789</td>
</tr>
<tr>
<td>Alternate Operation</td>
<td>2,328,278</td>
</tr>
</tbody>
</table>

Net Reduction . . . $ 602,511

This reduction was primarily due to reduced joint facility expenses at Toledo Union Station, and also to reduce passenger station expense at Detroit by operation at Fort Street Union Depot instead of MC Station. See Table 8.

Project No. 9: Rossford-Walbridge Yard Consolidation

1) B. & O. Operation

Rossford Yard, Toledo, Ohio, is the principal B. & O. yard in this area. This yard, combined with B. & O.'s West Side Yard, has a layout of 109 tracks with a capacity of approximately 5,050 cars. It handles manifest trains from the South and East, coal for dumping at Lakefront, cars to and from the South and East, coal for dumping at Lakefront, cars to and from industries and connections, and iron ore loaded in cars at Lakefront for southbound movements.
Basic crew assignments during the lake season—from April 1st to December 1st—are comprised of 15 yard crews, four commercial pullers, and two Lakefront Dock pullers. During the winter season, 16 crew assignments are worked—12 yard crews and four commercial pullers. Approximately 385,000 cars per year are handled in and out of Rossford Yard by road trains. In addition, there is a considerable volume of interchange traffic handled to and from connections in the Toledo area, as well as coal for dumping at Lakefront in puller service.

2) C. & O. Operation

Toledo is a major terminal of the C. & O. with facilities at Walbridge and Presque Isle Docks. The combined facilities comprise 331 tracks with a capacity of approximately 17,700 cars.

Walbridge is a 6,500 car capacity classification yard where trains are classified for movement to the Northern Region, Presque Isle Dock and Toledo connections. Puller crews located at Walbridge deliver and pull cars to and from the various foreign line connections. On the Walbridge 68 track classification yard, lake coal is classified by consignment and moved to Presque Isle Dock. The Eastbound 19 track yard, with a capacity of 2,500 cars, is used to classify all eastbound traffic. The arrival yard, comprising 11 tracks with a 1,350 car capacity, is used for storage of lake coal which is classified at Russell, Parsons, and at Walbridge. Yard "D", having 11 tracks with an 800 car capacity, is used for the receipt of and forwarding of cars for Northern Region trains.

Iron ore comes to Toledo from Lake Superior ports and is loaded into cars by three Hulett unloading machines. Between 100 and 125 cars are assembled and handled into Walbridge by puller crews where it is inspected.
and forwarded east to the mills at Ashland, Portsmouth and Jackson, Ohio. In an average year, approximately 850,000 cars are handled at Walbridge. There are 35 basic yard crew assignments at Walbridge and Presque Isle per day. During Lake Coal Season (April to December), 33 additional assignments are required to handle the dock and puller service, as well as the general yard work at Walbridge.

Alternate Operation

Present track connections at Bates and Walbridge are such that Toledo Division B. & O. trains may operate into and out of Walbridge Yard and to or from Lakefront property without any new physical connection.

Cost of Operation

The costs of road train service include only the locomotive expenses in operating road trains over the additional four miles between Bates and Walbridge. Yard crew expense is predicated on present operations at Rossford and the additional crews required at Walbridge, between April 1st and December 1st, to handle the work previously performed at Rossford. The only additional clerical help needed at Walbridge is two yard clerks per trick, seven days per week. The amount shown for train supplies and expenses reflects and increase due to cars, formerly handled at Rossford, traversing an additional four miles in road trains between Bates and Walbridge. Increased joint charges are also predicated on this basis.

The costs under present and alternate operations are shown below (and in Table 9):

Cost under present operation . . $1,918,011
Cost under alternate operation . . 726,412
Net reduction . . $1,191,599
Project No. 10:
Effect of Consolidation Upon Diesel Locomotive Requirements as Affected by C. & O.--B. & O. Coordination

The savings estimated under the various projects Nos. 1 through 9 exclude any references to effect upon locomotive requirements. However, due to rerouting or rearranging of traffic, the number of road freight runs have been reduced, or eliminated in some cases, and increased for alternate routes. The same is true for yard power and transfer runs by the withdrawing or addition of rerouted traffic.

The effect of these requirements, based on an analysis of such road freight and yard and puller changes, on both the B. & O. and C. & O., is shown in Table 10.

Project No. 11:
Estimate of Savings Through Combined Dumping of C. & O.--B. & O. Lake Coal, Toledo, Ohio, at Respective Docks of Each, in Alternate Winter Seasons

C. & O.'s costs directly applicable to operating its coal dock facilities during the 2 1/2 month period January through mid-March, averages for 1959 and 1960, $180, 194, plus $22,779 for the ground crews (including yardmasters, yard clerks and the office forces), the total of which is $202,973. This amount could be saved is the coal were dumped at B. & O.-Pen Central, Lake Front Facilities.

It is estimated that the additional expense of dumping this C. & O. coal at Lakefront would amount to $110,920. Accordingly, the net savings to the C. & O. would amount to $92,053, or an average of $46,026 per winter season. The B. & O.'s share of the cost, based on its tonnage dumped at the B. & O.-N.Y.C. facilities during the same winter season previously mentioned averages $60,636 per year. This is the amount B. & O.
expenditures might be reduced by not dumping its coal at its present facilities. This reduction would be partially offset by additional costs of $38,078 at the C. & O. facilities, for switching and for such overtime as may be required to handle same through those dumpers. Such added cost of dumping B. & O. coal at Presque Isle was based on the assumption that 65 percent of the tonnage would be dumped during straight time, which would not increase C. & O. costs and that the remaining 35 percent of the tonnage on overtime and on Saturdays and Sundays (this would increase C. & O. costs). An additional switch crew for one trick was also added twice a week.

This additional C. & O. expense is based on:

2 crews per week--11 weeks @ $150.00 = $3,300
Additional operating cost--Coal dumper = 34,778

Total $38,078

Thus, the net savings to the B. & O. would amount to $22,558, or an average of $11,279 per year. The combined savings for such alternate year operation would total to $57,305 per year. The cost of thawing a car at either facility would be the same. No allowance has been included in the foregoing for possible reduction in maintenance of machines (see Table 11).

E. Concluding Comments on the Eleven Projects

By taking advantage of the relatively quick approval from the Interstate Commerce Commission to consolidate, the C. & O. and B. & O. railroad companies were able to implement a number of cost saving projects which have been described in the previous section. As mentioned earlier, the portion of total cost savings from the consolidation reflected by the above
eleven projects is estimated at between 20 and 40 percent. A summary of these results is presented in Table 12. The remaining cost savings which were generated by the consolidation occurred principally from spillover effects or from operating areas where benefits were just not anticipated at the time of the testimony. Some evidence of these effects is given in Appendices A and C.

It is asserted that most of these unanticipated effects could not have occurred without the merger, but to support this point here with strong empirical evidence is not possible. The type of behavior which results from the merger psychology is deemed to be responsible for the participants to effectuate these cost savings, and it is claimed that the significant, internal impacts which did occur in addition to the above projects is sufficient evidence to support the view that the C. & O./B. & O. case led to an increase in economic efficiency.

F. Merger Efficiencies and Actual Markets: Pricing Norms

Statistical evidence was presented in the previous section to reflect the experiences of the C. & O. and B. & O. companies in the post-merger situation. Detailed information concerning the backgrounds of the projects, the constraints, and decision strategies was provided in order to identify the way in which an organizational decision is conceived as a series of choices usually between two alternatives. From this framework evolved an identification of some concepts of the companies' organizational goals, expectations, and methods of choice. The result is a detailed experience of individual decision-making behavior within the context of the larger, corporate organization.
The next step is to construct a more general model of organizational decision-making which can predict not only price, output, and other decisions but also patterns of decision-making that are generally consistent with observable behavior. It is in this realm that a model will be developed which will indicate the conditions under which the C. & O. and B. & O. would find merging certain operations efficient and the conditions under which other operations should be left separate.

One of the principal outcomes of the case study is that the participants were motivated to merge by the stimulus of access to broader markets. Many other mergers are predicated on this particular consideration and the reasons for this will be examined in Chapter V. But for the present purposes, the model is to be limited to the C. & O./B. & O. case. In order to allow some extensions to a more general range of situations, some of the conditions and most of the examples are hypothetical. At all times, though, the behavior of the model in a particular operation is consistent with the general behavior of the C. & O./B. & O. companies implicit in the ways in which the projects described above were implemented.

A further task to accomplish is to extend the implications of the C. & O./B. & O. model to the industry as a whole. The next chapter provides the setting by which one can examine how closely the behavior of the model of the C. & O. B. & O. conforms to the general behavior of most railroads implicit in the theory to be discussed below. Since there may not be any reason to suggest that different pricing policies are developed for merger but that the stronger firm's control over broader markets is the motivating force, a detailed investigation into the circumstances to the participants under which merging operations is efficient or inefficient is warranted.
If merger is a means and not an end, then only efficiently merged services are of economic and policy interest. Such services improve overall distribution efficiency by reducing transportation costs, improving its quality, or both. Empirical evidence (as in the preceding section) can confirm or disconfirm the efficiency opportunities offered by merger. It is the translation from potentiality to market reality which is the major concern of the balance of this chapter. This section spells out the elements and relationships reflected in a normative model which describes an ideal set of conditions and responses for this translation. As "normative" implies, the conditions of the model can only be met by complete knowledge, perfectly rational behavior on the part of carriers (namely, the C. & O. and B. & O. railroads) and shippers, and the absence of serious frictions; however, the model provides a useful backdrop against which actual behavior of the C. & O./B. & O. decision-making process may be examined.

The underlying premise of this model is that the gains of merger can best be achieved through private profit incentives rather than regulatory requirement. Viewed as a constraint on decision-making processes, regulation is for the present held in reserve. Translating efficiency opportunities into market realities is essentially a function of the pricing mechanism; in other words, prices determine carrier profits and the attractiveness of the services to shippers—and thus whether the services will be offered and purchased. The central feature of the model is a pricing rule designed so that efficient coordinated services will provide increased total carrier profits, incentive divisions among the participants, and savings in overall distribution costs.
1. **Normative View of Pricing**

Prices are crucial, since their relationship to costs incurred in providing associated services determines the "markup" or profit margins which the railroads realize. The relationship between the rate and the cost for a given service as compared with that for another service which the railroad might offer determines its relative profitability and its attractiveness as a marketing alternative. Prices represent a key determinant of the amount of service which will be sold and the total profits realized. Rates are also a key variable for shipper consideration in determining distribution system design and transportation selections. Choices are not made on the basis of price alone; service qualities are also a key factor, particularly in the effect on overall distribution costs. In this normative approach, rates for available alternatives are evaluated in terms of comparable qualities.

Given the foregoing functions of the price mechanism, consideration of the characteristics of a pricing system designed to achieve the goals of the normative model is warranted. The normative criterion is the preservation of efficiency in the market by offering and employment of coordinated services which minimize the sum of transport (or movement) costs (MC) and of the non-transport components of distribution system costs (NTC) which are predicated on comparative service quality.¹⁰

¹⁰Consolidated (merger) services (subscript c) are thus economically superior to separate (nonmerged) services (subscript s) when \( MC_c + NTC_c < MC_s + NTC_s \), or where \( MC_c - MC_s < NTC_c - NTC_s \), or where \( MC_s - c > NTC_c - s \). (The s-c and c-s notations are employed as a simplifying device to represent differences in the terms to which they are related). In symbolic terms, efficiency preservation requires that where \( MC_c + NTC_c < MC_s + NTC_s \), price relationships will encourage railroads to offer and shippers to employ the coordinated \( c - c \); that is, \( R_c + RDC_c < R_s + RDC_s \) where \( R_c \) and \( R_s \) represent the merged and nonmerged rates, respectively.
There are other normative criteria which might be applied:

the interpretation of the theory of welfare economics which dictates that
prices must be equated with marginal costs to achieve the most efficient
use of resources. The present criterion is consistent with welfare theory
in some of its efficiency aspects; however, it is not concerned with total
resource use within the economy nor with aspects of income distribution
that are key elements of welfare theory. Another normative criterion
that has been advanced is that prices of alternative or competitive out-
puts should be proportional to marginal costs. Application of this cri-
teron can easily defeat the efficiency objectives as defined for this
discussion. The same is true of the proposition that rates should be
equated with "fully distributed" costs, which involve the arbitrary alloca-
tion of untraceable overheads to particular services. A number of pricing
features are required to serve the normative goal of preserving economic
efficiency. The most significant of these features are discussed below:

a. Recognition of Component Transport Functions: The concept of merger
involved employment of the facilities or services of more than one tech-
nological input in the performance of a total transport mission. It is
apparent that certain patterns of merger, particularly those organized
by shippers or middlemen, would be facilitated by a pricing system which
embraces charges for particular functions rather than for a total package.
This method facilitates selection of the best combination of components
for particular situations.

b. Appropriate Relationships to Cost. The most efficient service among
a set of alternatives is identified by the sum of movement costs and associa-
ted nontransport costs. Transport costs become a key element and must be
reflected in service prices. Where costs for coordinated service are
higher, rates must be correspondingly higher if attractive markups and
profits are to be attained. In other words, rates must be structured so
as not to defeat or to overwhelm a cost advantage enjoyed by merged services.

c. Appropriate Reflection of Demand. In a market setting involving the
sub-situation of alternative separated and merged services, demand for
the latter is determined by its quality in terms of the alternatives. With
a given price for an alternative, the sale of merged services at a given price is determined by its relative quality (as reflected in NTC measures); along with costs, NTC values determine comparative efficiency, requiring their full reflection in coordinated service rates. Demand conditions must be properly identified and measured to ensure that superior merged services are not priced out of the market.

d. Appropriate Market Definitions. Viable pricing to achieve the goals of the normative model must also ensure that the market relevant for the establishment of a particular price is properly identified and described; with markets insufficiently "confined" and inadequately "defined," rates based on one set of cost and demand conditions may affect charges for other movements with different governing factors and create unfavorable spillover effects. These unfavorable profit implications in the spillover area may inhibit the offering of economical merged services.

e. Incentive Divisions Among Participants. Although some forms of merger can be accomplished by a single firm, existing industry organization and institutional arrangements generally require joint production by two or more companies. It is accordingly necessary that gains from increased profit opportunities offered by efficient merger be distributed among the railroads to provide full incentive for participating. Divisional arrangements must reflect the costs incurred in producing merged services plus the foregone profits from separate company alternatives which merger displaces.

The pricing model employed here explicitly embraces or assumes the foregoing characteristics. The effectiveness of pricing procedures in fostering efficiency further requires rational shipper evaluation of alternative rates through translation of comparative service quality into the monetary terms of overall distribution system costs. Merged services must be properly evaluated by shippers as well as rationally priced by the railroads.

2. Normative Pricing Rule and Railroad Profits

"Economically superior" services\textsuperscript{11} are those which minimize the sum of movement (railroad) costs (MC) and nonmovement costs incurred in distribution systems which depend on the character and quality of the non-

\textsuperscript{11} A shorthand expression used throughout this discussion.
transport inputs (NTC). Although efficiency is concerned primarily with costs, the profitability of merged services to railroads and the attractiveness for shippers depend on relative rates. Indifference on the part of shippers may be anticipated when the sum of the rates and the nontransport costs associated with each alternative is equal, since total distribution costs are then the same. Stated alternatively, indifference is indicated when the disparity in rates approximates the differences in NTC values. The absolute ceiling on the merged service rate is established by the demand factor represented by its comparative quality when related to rates applying on the separated-company alternatives. More precisely, the ceiling is measured by the separate-company rates plus or minus the difference in the NTC values associated with the alternative services. If the merged service is superior, its rate may be higher by the amount of that difference; if inferior, it must be correspondingly lower. If the merged service rate is less than the ceiling, that service offers minimum total distribution costs and it will be rationally selected by the shippers. Stated symbolically, the normative pricing rule is as follows:

$$R_c < R_s + NTC_{s-c}$$

By the same token, railroads will rationally offer merged services when the resulting profits exceed those afforded by alternative nonmerged services. This pricing rule, which makes "economically superior" merged services attractive to shippers, can be applied to make such services

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12 Expressed symbolically as $R_c + NTC_c = R_s + NTC_s$, or $R_c - R_s = NTC_c - NTC_s$, where $R$ refers to the rate and NTC to non-transport costs, as before. These relationships and some properties of the associated prices are set forth in greater detail in Merrill J. Roberts, "Transport Costs, Pricing and Regulation," in Transportation Economics, (National Bureau of Economic Research, 1965), pp. 8-37.

13 Max. $R_c = R_s + (NTC_s - NTC_c)$. 
universally profitable to participating carriers.

Assume at the outset that a single company provides all of the services over a specified area. Employing this assumption in effect focuses on the system as a whole and ignores for the present the fortunes of individual firms as reflected in such considerations as market shares, traffic diversion, and rate divisions. This initial view portrays the case of "internal" merger (a combination of technologies within a single firm) by a company that controls all of the traffic involved. (An example might be the offering of C. & O's TOFC Plan for traffic moving exclusively in boxcars).

When the previously enunciated pricing rule is applied to economically superior merged services, the result is a higher unit "markup" (margin above cost) than can be gleaned from the separate company alternative. The markup will be greater for the alternative having the net advantage in cost and quality comparisons. If, for example, the merged service shows a cost advantage of $1.00 per unit and a quality disadvantage (NTC differential) of $1.25, the resulting markup would be lower by $0.25. Where the merged service is economically superior, it must by definition have a cost advantage which exceeds a quality disadvantage, or a service advantage which overbalances a cost disadvantage. It follows that the permissible markup for the merged service must be greater.\(^{14}\)

\(^{14}\)The shipper indifference rule for whichever service is desired, 
\[ R_C + NTC = R_S + NTC_S, \]
may be restated as
\[ (MC_C + MU_C) = (MC_S + MU_S) + (NTC_S - NTC_C) \]
where MU is the markup, or
\[ MU_C = (MC_S + MU_S) + (NTC_S - NTC_C) - MC \]
or
\[ MU_C = [(MC_S - MC_C) + (NTC_S - NTC_C)] + MU_S \]
When the merged service is economically superior, the bracketed term is necessarily positive since a cost (MC) advantage must exceed a qualitative (NTC) disadvantage, or a service advantage must exceed a cost disadvantage,
The foregoing relationships depict the situation when the merged service rate is set at the indifference level. To attract traffic to the merged alternative, it is necessary to shrink the markup sufficiently to make the service attractive to (rational) shippers and to establish an incentive for its adoption. The profitability implications of this shrinkage depend on the inducement required and on the markup gap between the merged and separate company services (when the rate for the former is set at the indifference level). This in turn is a function of the relationship between the costs and qualities of the two alternatives.15 If the merged service is superior in both respects, the opportunity for improving units profits (with attractive rates for the merged service) will, of course, be greater than if these superiority measures are in opposition and offsetting.

With the higher unit markup, profits from the merged service will exceed those yielded by the alternative separate company service unless there is an offsetting shrinkage in volume associated with the service charge. Assuming rational shipper responses, it is not logical to expect that development of a superior service priced to reduce distribution costs would result in an output drop. More likely, volume would expand, further enhancing the profitability margin of the merged offering and possibly yielding greater profits under merger even where unit mark-

with this term positive, it is evident that $MC_c > MU_s$. Alternatively stated, $MU_c - MU_s$ must be positive if (as is necessarily the case where the merged service is superior) $MC_c < MC_s + NTC_{s-c}$.

15 That is, the size of the balance between $MC_{s-c}$ and $NTC_{s-c}$. 
up is less. The basic significance of these profit indications lies in their suggestion that internal diversion of traffic from a single-mode to more efficient coordinated services should not be a cause for concern.

While the single-firm case is straightforward, the problem becomes more complex when the interests of separate firms are considered. The situation of two (or more) carriers which must cooperate because neither can perform the complete transportation mission—because of geographical relationships or overwhelming economic considerations—can be ignored. The relevant profitability question arises when potential cooperators on a particular service route are active competitors for the traffic involved.

Although the introduction of rival firms offers complications, the profitability results are essentially identical with those outlined above. The abstract profit potential of superior merged services for several participating carriers is established by a simple extension of the previous reasoning. Consider first the extreme case where one firm alone offers the nonmerged service while the merged offering requires joint effort with another railroad. The economic superiority of the merged service insures the opportunity for an increased "markup" this "cushion," in turn provides a base for larger profit margin than the one firm could realize acting alone, plus a profit contribution for the other firm.

If the participating carriers are to fare better in profit terms

---

16 This relationship could prevail for an economically superior merged service only if shrinkage in the rate for the offering required for its acceptance \( I_c \) consumed all of the unit profit advantage established above. Stated symbolically, it would occur only if \( I_c > MU_c - MU_s \).

17 \( R_c - MC_s > R_s - MC_s \); see footnote 8.
under merger, the proceeds realized (or the rate charged) must cover the
share of the cost attributable to each and at the same time yield a
larger unit markup than is afforded by the alternative separate company
service. In this case, where the second railroad does not participate
in the nonmerged service, its profit requirements are governed exclusively
by merger costs. The rate established for superior merger services under
the specified pricing rule meets the markup requirement. Since the
merger service rate is the sum of costs and markup and its markup (under
superior efficiency) exceeds that achieved by the nonmerged alternative,
the rate is necessarily greater than the sum of the merged service costs
and the nonmerged markup. The inequality creates a profit increment
that can be shared by the two participants to mutual advantage.

Availability of these mutually satisfying profit opportunities
can be illustrated by a hypothetical case with the following assumption:

\[
\begin{align*}
MC_{s-c} &= $0.15 \\
MC_s &= $0.10 \\
NTC_{c-s} &= $0.08 \\
MC_c &= $0.15 \\
I_c &= $0.02
\end{align*}
\]

In this illustration, the unit profit or markup is increased by $0.05
as the net effect of a cost saving of $0.15, a service quality disability
of $0.08, and a rate shading \(I_c\) of $0.02 to induce the use of the merged
service. The carrier controlling the traffic will fare better under
merger provided its share of the unit profit exceeds $0.10. This result
can be achieved from the $0.05 markup increase (as in each case of

\[R_c > MC_c + (MU_{c1} + MU_{s2})\]

In this case (representing no participation by railroad 2), \(MU_{s2} = 0\).

\[\text{Symbolically, } R_c > MC_c + MU_{c}, \text{ and } MU_c > MU_{s1}.\]

It follows that \(R_c > MC_c + MU_{s1}\).
The attractiveness of merger to the separate railroads will obviously depend on how the profit increment is divided. The minimum share of carrier 1 is given by \( MC_{c1} + MU_{s1} \) and for carrier 2 by \( MC_{c2} + MU_{s2} \) (=0). In percentage terms, carrier 1 must receive a division \( D_1 \) described as

\[
D_1 > \frac{MC_{c1} + MU_{s1}}{R_c}
\]

Significantly, the benefits from participation are independent of the role of two firms in the merged offering, since the crucial variable is unit profit and not the absolute share of the rate. For example, if merger services costs are $0.04 and the rate is $0.55, the significant measure is not the share of the rate received by each participant, but the margin above its portion of the cost. If the carrier initially controlling the traffic incurs costs of only $0.05 out of the $0.40 total, improvement in its position requires simply that its revenue share be at least $0.16 (that is, $0.05 cost plus markup of at least $0.11, or slightly more than the previous margin of $0.10). Similarly, the other carrier will fare better from merger provided it receives at least $0.36 (its cost of $0.35 plus $0.01 markup, in lieu of $0.00). These minimum requirements exhaust only $0.52 of the $0.55 rate, leaving a margin of $0.03 for negotiation.

Further complexities are introduced when two railroads share in the market by offering competitive single-mode services. It is necessary to consider traffic volumes and market shares to determine the influence of these variables on the emerging conclusions. Unit margins must be accompanied by volume weights to observe their effect on relative pro-
fits and to establish that the profitability opportunities outlined are not disturbed by the introduction of this variable.

Under the efficiency requirements and specified pricing rule, the profit sum will be increased by efficiently merged services provided the volume is not less than the sum of the separate-company volumes (although profits may be greater even with smaller volume with sufficient unit margins). Profit incentive requires that the proceeds of merger (the rate multiplied by the volume) exceed the sum of the amounts under which each participant fares as well as with the separate offerings. The point of indifference occurs when the cost of the merged service (unit costs incurred by each multiplied by the volume) and the foregone profits of the nonmerged service (measured by the respective unit markups and volumes) just are covered. The proceeds of merger will necessarily be sufficient to meet these minimum requirements and to add a profit increment for each participant (provided a traffic decline is not occasioned) if the unit markup for the merged service exceeds that for each of the nonmerged alternatives. As previously established, this will be true under the stipulated pricing rule if the merged service meets the necessary qualifications of economic superiority over both of the separate-company alternatives.\(^{20}\) Regardless of the volumes and pre-merger market shares, the

\(^{20}\)The necessary condition is:

\[
R_c \cdot V_c > (MC_{c1} + MC_{c2}) V_c + MU_{s1} + MU_{s2} \cdot V_{s2} \quad \text{(where } V \text{ is volume)}
\]

which may be restated (by combining \(MC_{c1}\) and \(MC_{c2}\))

\[
(R_c - MC_c) V_c > (MU_{s1} \cdot V_{s1} + MU_{s2} \cdot V_{s2}).
\]

The condition is met since

\[
MU_c \cdot V_c > MU_{s1} \cdot V_{s1} + MU_{s2} \cdot V_{s2} \quad \text{(where } V_c \neq V_{s1} + V_{s2}).
\]
inauguration of efficient coordinated services permits the participants to increase their profits.

3. Conclusion

Reviewing the anatomy of rates covered by the normative pricing rule, the first characteristic is that the rates are cost oriented because movement costs are a vital element of the rate computations. Where merged services costs are higher than those for a nonmerged alternative, a definitive relationship between costs and rates must be stated; in this case, the cost discrepancy must be more than offset under the efficiency requirement by a service quality advantage (lower NTC). Under these relationships, markup requirements dictate and demand conditions permit a higher rate for the merged service to match the higher costs; stated in symbolic terms, if $MC_c > MC_s$, and with $MU_c > MU_s$ established,$^{21}$ these factors can be totaled to prove that $RC_c > RC_s$.

Where costs are lower under merger, however, the specific rate-cost relationships depend on quality differences (NTC differentials). If these respond in opposite directions, lower costs accompany lower rates as above; however, a cost advantage accompanied by a substantial service advantage may yield a combination of higher rates and lower costs where demand is also reflected. Under these circumstances, the high-cost alternative is a poor substitute and of little market interest. While the pricing rule is concerned with overall distribution efficiency, the pricing system covered also preserves efficiency within transportation by encouraging traffic allocations in accordance with the lowest resource.

---

$^{21}$When the pricing rule is applied to economically efficient services, this will occur.
Rates generated by the pricing rule are equally demand-oriented and, while completely sensitive to relative transport costs, become conditioned by comparative service quality and limited by the rates for alternative services. In this sense, the rates are predicated on "value of service" as measured by viable shipper options which reflect true market validity. This demand orientation ensures that efficiently merged services will not be priced out of the market.

In conclusion, this model simply portrays a "shall we do it" decision rule that is commonly employed by some enlightened transportation firms. Upon determination of "what shippers want" and the "type of service that will sell," this decision rule requires answers to these key questions:

1. What can be charged for the proposed service as measured by its attractiveness to shippers and by the going (or potentially attainable) prices for competitive alternatives?

2. What will it cost to provide the service?

3. What is its worth? Can profit be earned on present services or on some other alternative?

Viewed in this light, the model simply formalizes and establishes basic relationships among these decision factors.

The preceding analysis and hypothetical illustrations cover the extreme range involving pre-merger market divisions. These relationships argue strongly that superior merged services priced according to the realistic rule advanced will increase overall profits. The profit pool can be distributed among participants, placing each in a better position

\[ R_c = P_S + NTC_{S-c} \]

\[ 22 R_c < P_S + NTC_{S-c} \]

\[ 23 \text{In this case, the C. & O./ B. & O.} \]
than under separate, nonmerged services. Furthermore, it pays a railroad to accept a partner even if the former controls all of the nonmerged volume. In fact, this discussion has been approached conservatively since no allowance has been made for volume increases that might accrue in the long run from the introduction of a service calculated to reduce distribution costs. This modification would be important subject matter for further research.

The preceding analysis has been developed in terms of the C. & O./B. & O. case and the evidence can be interpreted accordingly. In order to insure that the impacts of mergers in the local case study can be integrated into an industry wide analysis, it is necessary now to consider merger impacts in terms of the industry evidence.
<table>
<thead>
<tr>
<th>Item</th>
<th>C&amp;O</th>
<th>B&amp;O</th>
<th>Combined C&amp;O--B&amp;O</th>
<th>Net Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Altern.</td>
<td>Present</td>
<td>Altern.</td>
</tr>
<tr>
<td>1. Road Train Service</td>
<td>$497.7</td>
<td>$ -</td>
<td>$ -</td>
<td>$369.0</td>
</tr>
<tr>
<td>2. Yard Puller or Transfer Serv.</td>
<td>478.1</td>
<td>307.5</td>
<td>-</td>
<td>165.9</td>
</tr>
<tr>
<td>3. Yard Service Employees</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4. Train Suppl. &amp; Expenses</td>
<td>191.8</td>
<td>7.7</td>
<td>-</td>
<td>110.4</td>
</tr>
<tr>
<td>5. Track Maintenance</td>
<td>226.4</td>
<td>-</td>
<td>-</td>
<td>149.5</td>
</tr>
<tr>
<td>6. Per Diem</td>
<td>110.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Joint Facility Expenses</td>
<td>-</td>
<td>107.0</td>
<td>-</td>
<td>29.2</td>
</tr>
<tr>
<td>Total</td>
<td>$1,505.0</td>
<td>$422.3</td>
<td>$ -</td>
<td>$824.3</td>
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### TABLE 2

SELECTED OUT OF POCKET COSTS OF HANDLING DESIGNATED TRAFFIC ($ thousands):

CHICAGO COAL

<table>
<thead>
<tr>
<th></th>
<th>C&amp;O</th>
<th>B&amp;O</th>
<th>Combined C&amp;O--B&amp;O</th>
<th>Net Change Increase</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Road Train Service</td>
<td>$1,006.6 $ 230.2</td>
<td>$ - $ 408.6</td>
<td>$1,006.6 $ 638.8</td>
<td>$ - $ 367.7</td>
<td></td>
</tr>
<tr>
<td>2. Yard Puller or Transfer Serv.</td>
<td>333.2 114.9</td>
<td>- 98.3</td>
<td>333.2 213.2</td>
<td>- 119.9</td>
<td></td>
</tr>
<tr>
<td>3. Yard Service Employees</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td></td>
</tr>
<tr>
<td>4. Train Suppl. &amp; Expenses</td>
<td>193.5 94.4</td>
<td>- 104.9</td>
<td>193.5 199.4</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>5. Track Maintenance</td>
<td>228.4 111.5</td>
<td>- 142.1</td>
<td>228.4 253.6</td>
<td>25.1</td>
<td></td>
</tr>
<tr>
<td>6. Per Diem</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td></td>
</tr>
<tr>
<td>7. Joint Facility Expenses</td>
<td>109.0 -</td>
<td>- -</td>
<td>109.0 -</td>
<td>109.0</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$1,870.8 $ 551.1</td>
<td>$ - $ 754.0</td>
<td>$1,870.8 $1,305.1</td>
<td>$ - $ 565.6</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 3

SELECTED OUT OF POCKET COSTS OF HANDLING DESIGNATED TRAFFIC (\$ thousands)
MANIFEST BETWEEN CHICAGO--CINCINNATI--B&O AND BETWEEN
SAGINAW, DETROIT--CINCINNATI VIA LACROSSE--C&O

<table>
<thead>
<tr>
<th></th>
<th>C&amp;O</th>
<th>B&amp;O</th>
<th>Combined C&amp;O--B&amp;O</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increase</td>
<td>Decrease</td>
<td>Increase</td>
</tr>
<tr>
<td>1. Road Train Service</td>
<td>$ 464.5</td>
<td>$ 138.9</td>
<td>$ 600.1</td>
</tr>
<tr>
<td>2. Yard Puller or Transfer Serv.</td>
<td>44.1</td>
<td>103.0</td>
<td>49.8</td>
</tr>
<tr>
<td>3. Yard Service Employees</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4. Train Suppl. &amp; Expenses</td>
<td>40.5</td>
<td>53.5</td>
<td>67.1</td>
</tr>
<tr>
<td>5. Track Maintenance</td>
<td>47.8</td>
<td>63.2</td>
<td>90.8</td>
</tr>
<tr>
<td>6. Per Diem</td>
<td>16.2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Joint Facility Expenses</td>
<td>-</td>
<td>33.6</td>
<td>3.1</td>
</tr>
<tr>
<td>Total</td>
<td>$ 613.3</td>
<td>$ 392.6</td>
<td>$ 811.2</td>
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### TABLE 4
SELECTION OUT OF POCKET COSTS OF HANDLING DESIGNATED TRAFFIC ($ thousands):
CHICAGO TERMINAL AREA

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>C&amp;O</th>
<th>B&amp;O L</th>
<th>Combined C&amp;O--B&amp;O</th>
<th>Net Change Increase</th>
<th>Net Change Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Road rain Service</td>
<td>$124.3</td>
<td>-</td>
<td>$124.3</td>
<td>$ -</td>
<td>$124.3</td>
</tr>
<tr>
<td>2.</td>
<td>Yard Puller or Transfer Serv.</td>
<td>682.2</td>
<td>-</td>
<td>682.2</td>
<td>267.1</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Yard Service Employees</td>
<td>238.4</td>
<td>-</td>
<td>238.4</td>
<td>183.1</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Train Suppl. &amp; Expenses</td>
<td>11.0</td>
<td>-</td>
<td>11.0</td>
<td>11.0</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Track Maintenance</td>
<td>-</td>
<td>-</td>
<td>250.9</td>
<td>250.9</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Per Diem</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Piggyback--BRC Charge</td>
<td>168.4</td>
<td>-</td>
<td>168.4</td>
<td></td>
<td>168.4</td>
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<td>8.</td>
<td>Joint Facility Expenses</td>
<td>769.6</td>
<td>-</td>
<td>769.6</td>
<td></td>
<td>747.6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>$1,994.2</td>
<td>$ -</td>
<td>$1,994.2</td>
<td></td>
<td>$743.3</td>
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<table>
<thead>
<tr>
<th>Partial</th>
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<tr>
<td>1. Road Train Service</td>
<td>$1,074.4</td>
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<td>2. Yard Puller or Transfer Serv.</td>
<td>54.7</td>
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<td>3. Yard Service Employees</td>
<td>28.9</td>
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<tr>
<td>4. Train Suppl. &amp; Expenses</td>
<td>79.4</td>
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<tr>
<td>5. Track Maintenance</td>
<td>56.2</td>
</tr>
<tr>
<td>6. Per Diem</td>
<td>-</td>
</tr>
<tr>
<td>7. Joint Facility Expenses</td>
<td>696.7</td>
</tr>
<tr>
<td>Total</td>
<td>$1,990.5</td>
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</table>
### TABLE 6

**SELECTED OUT OF POCKET COSTS OF HANDLING DESIGNATED TRAFFIC ($ thousands):**

**WELLSTON, OHIO, JACKSON, OHIO LOCAL**

<table>
<thead>
<tr>
<th></th>
<th>C&amp;O</th>
<th>B&amp;O</th>
<th>Combined C&amp;O--B&amp;O</th>
<th>Net Change</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Present Altern.</td>
<td>Present Altern.</td>
<td>Present Altern.</td>
<td>Increase</td>
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<tr>
<td>1. Road Train Service</td>
<td>$43.8</td>
<td>$ -</td>
<td>$ -</td>
<td>$ -</td>
</tr>
<tr>
<td>2. Yard Puller or Transfer</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3. Yard Service Employees</td>
<td>-</td>
<td>-</td>
<td>NO ADDITIONAL</td>
<td>-</td>
</tr>
<tr>
<td>4. Train Suppl. &amp; Expenses</td>
<td>-</td>
<td>-</td>
<td>B&amp;O YARD OR TRAIN EXPENSES</td>
<td>-</td>
</tr>
<tr>
<td>5. Track Maintenance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. Per Diem</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Joint Facility Expenses</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$43.8</strong></td>
<td><strong>$ -</strong></td>
<td><strong>$ -</strong></td>
<td><strong>$43.8</strong></td>
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## TABLE 7

SELECTED OUT OF POCKET COSTS OF HANDLING DESIGNATED TRAFFIC ($thousands):
HUNTINGTON YEAR AND TRANSFER CREWS

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<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ - $ -</td>
<td>$ - $ -</td>
<td>$ - $ -</td>
<td>$ - $ -</td>
<td>$ - $ -</td>
<td>$ - $ -</td>
<td>$ - $ -</td>
<td>$ - $ -</td>
</tr>
<tr>
<td>2. Yard Puller or Transfer Serv.</td>
<td>- -</td>
<td>120.3</td>
<td>51.4</td>
<td>120.0</td>
<td>51.4</td>
<td>-</td>
<td>$68.5</td>
<td></td>
</tr>
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<td>3. Yard Service Employees</td>
<td>- -</td>
<td>30.6</td>
<td>-</td>
<td>30.6</td>
<td>-</td>
<td>-</td>
<td>$30.6</td>
<td></td>
</tr>
<tr>
<td>4. Yard Supplies &amp; Expenses</td>
<td>- -</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>5. Track Maintenance</td>
<td>- -</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6. Per Diem</td>
<td>- -</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>7. Joint Facility Expense</td>
<td>- -</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$ 150.6</strong></td>
<td><strong>$ 51.4</strong></td>
<td><strong>$ 150.6</strong></td>
<td><strong>$ 51.4</strong></td>
<td><strong>$ -</strong></td>
<td><strong>$ 99.2</strong></td>
<td><strong>$ -</strong></td>
<td><strong>$ -</strong></td>
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<tr>
<td></td>
<td>C&amp;O</td>
<td>B&amp;O</td>
<td>Combined C&amp;O--B&amp;O</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Altern.</td>
<td>Altern.</td>
<td>Increase</td>
<td>Decrease</td>
</tr>
<tr>
<td>1. Road Train Service</td>
<td>$332.8</td>
<td>$416.9</td>
<td>$409.5</td>
<td>$350.5</td>
<td>$742.3</td>
<td>$767.4</td>
<td>$25.0</td>
<td>$-</td>
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<td>2. Yard Puller or Transfer Serv.</td>
<td>-</td>
<td>13.6</td>
<td>-</td>
<td>18.6</td>
<td>-</td>
<td>32.3</td>
<td>32.3</td>
<td>-</td>
</tr>
<tr>
<td>3. Yard Service Employees</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4. Car Repairs &amp; Train Suppl. &amp; Expenses</td>
<td>176.2</td>
<td>118.8</td>
<td>255.9</td>
<td>33.8</td>
<td>432.2</td>
<td>452.6</td>
<td>20.4</td>
<td>-</td>
</tr>
<tr>
<td>5. Track Maintenance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. Dining Car Crew Wages</td>
<td>32.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>32.7</td>
<td>-</td>
<td>-</td>
<td>32.7</td>
</tr>
<tr>
<td>7. Joint Facility Expenses</td>
<td>508.8</td>
<td>960.8</td>
<td>1,214.6</td>
<td>115.0</td>
<td>1,723.4</td>
<td>1,075.8</td>
<td>-</td>
<td>647.5</td>
</tr>
<tr>
<td>Total</td>
<td>$1,050.6</td>
<td>$1,510.2</td>
<td>$1,880.1</td>
<td>$817.9</td>
<td>$2,930.7</td>
<td>$2,328.2</td>
<td>$-</td>
<td>$602.5</td>
</tr>
<tr>
<td></td>
<td>C&amp;O</td>
<td>B&amp;O</td>
<td>Combined C&amp;O--B&amp;O</td>
<td>Net Change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------</td>
<td>------------------</td>
<td>------------------</td>
<td>------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>Altern.</td>
<td>Present</td>
<td>Altern.</td>
<td>Present</td>
<td>Altern.</td>
<td>Increase</td>
<td>Decrease</td>
</tr>
<tr>
<td>1. Road Train Service</td>
<td>$</td>
<td>$ 20.5</td>
<td>$</td>
<td>$</td>
<td>$</td>
<td>$ 20.5</td>
<td>$ 20.5</td>
<td>$ -</td>
</tr>
<tr>
<td>2. Yard Puller or Transfer Serv.</td>
<td>-</td>
<td>517.6</td>
<td>1,639.3</td>
<td>-</td>
<td>1,639.3</td>
<td>517.6</td>
<td>-</td>
<td>1,121.6</td>
</tr>
<tr>
<td>3. Yard Service Employees</td>
<td>-</td>
<td>53.2</td>
<td>276.4</td>
<td>-</td>
<td>276.4</td>
<td>53.2</td>
<td>-</td>
<td>223.1</td>
</tr>
<tr>
<td>4. Yard Supplies &amp; Expenses</td>
<td>-</td>
<td>111.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11.0</td>
<td>11.0</td>
<td>-</td>
</tr>
<tr>
<td>5. Track Maintenance</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. Per Diem</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Joint Facility Expenses</td>
<td>-</td>
<td>123.7</td>
<td>2.2</td>
<td>-</td>
<td>2.2</td>
<td>123.7</td>
<td>121.4</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>$ -</td>
<td>$ 726.3</td>
<td>$1,918.0</td>
<td>$ -</td>
<td>$1,918.0</td>
<td>$ 726.3</td>
<td>$ -</td>
<td>$1,191.6</td>
</tr>
</tbody>
</table>
### TABLE 10
EFFECT OF C&O--B&O CONSOLIDATION ON DIESEL LOCOMOTIVE REQUIREMENTS (annual dollars)

<table>
<thead>
<tr>
<th>No. Units--Type--Value</th>
<th>Interest 5%</th>
<th>Depreciation 4.5% Yard</th>
<th>Total 6.0% Road</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>C&amp;O</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 - GP 9/7 @ $183,240 = $2,015,640</td>
<td>$100,782</td>
<td>$120,938</td>
<td>$221,720</td>
</tr>
<tr>
<td>8 - F7 @ 167,947 = 1,343,576</td>
<td>67,179</td>
<td>80,615</td>
<td>147,794</td>
</tr>
<tr>
<td>5 - 100HP @ 102,892 = 514,460</td>
<td>25,723</td>
<td>23,151</td>
<td>48,874</td>
</tr>
<tr>
<td>1 - Baldwin@ 180,284 = 180,284</td>
<td>9,014</td>
<td>10,817</td>
<td>19,831</td>
</tr>
<tr>
<td><strong>Total - C&amp;O Reduction</strong></td>
<td>$202,698</td>
<td>$235,521</td>
<td>$438,219</td>
</tr>
<tr>
<td><strong>B&amp;O</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduction:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - GP @ $183,240 = $366,480</td>
<td>$18,324</td>
<td>$21,989</td>
<td>$40,313</td>
</tr>
<tr>
<td>2 - 100HP @ 102,892 = 205,784</td>
<td>10,289</td>
<td>9,260</td>
<td>19,549</td>
</tr>
<tr>
<td><strong>Total - B&amp;O Reduction</strong></td>
<td>$28,613</td>
<td>$31,249</td>
<td>$59,862</td>
</tr>
<tr>
<td><strong>Total Decrease - C&amp;O - B&amp;O</strong></td>
<td>$231,311</td>
<td>$266,770</td>
<td>$498,081</td>
</tr>
<tr>
<td></td>
<td>Expense</td>
<td>After Consolidation</td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21/2 Winter</td>
<td>1st Year</td>
<td>2nd Year</td>
</tr>
<tr>
<td></td>
<td>(Average)</td>
<td>Months</td>
<td>Months</td>
</tr>
<tr>
<td>Present Operations:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C&amp;O Coal at C&amp;O Docks</td>
<td>$ 202,973</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E&amp;O Coal at Lakefront Docks</td>
<td></td>
<td>60,636</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$ 263,609</td>
<td></td>
</tr>
<tr>
<td>Alternate Operations:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C&amp;O and E&amp;O Coal at C&amp;O Docks</td>
<td></td>
<td>$ 241,051</td>
<td></td>
</tr>
<tr>
<td>C&amp;O and E&amp;O Coal at Lakefront Docks</td>
<td></td>
<td>$ 171,556</td>
<td></td>
</tr>
<tr>
<td>Savings</td>
<td></td>
<td>$ 22,558</td>
<td>92,053</td>
</tr>
<tr>
<td>After Consolidation--Average Per Year--Savings</td>
<td>$ 57,305</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 12
SUMMARY (BASIS: 1964 FIGURES)
SELECTED OUT OF POCKET COSTS OF HANDLING DESIGNATED TRAFFIC
($thousands)

<table>
<thead>
<tr>
<th>Project No.</th>
<th>Description</th>
<th>C&amp;O Present</th>
<th>C&amp;O Alternate</th>
<th>B&amp;O Present</th>
<th>B&amp;O Alternate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L&amp;N Lake Coal</td>
<td>$1,505.1</td>
<td>$422.3</td>
<td></td>
<td>$824.3</td>
</tr>
<tr>
<td>2</td>
<td>Chicago Coal</td>
<td>1,870.8</td>
<td>551.1</td>
<td></td>
<td>754.1</td>
</tr>
<tr>
<td>3</td>
<td>Mfst.-Chgo. Division</td>
<td>613.3</td>
<td>392.6</td>
<td>811.2</td>
<td>107.9</td>
</tr>
<tr>
<td>4</td>
<td>Chicago Terml. Area</td>
<td>1,994.8</td>
<td></td>
<td></td>
<td>743.3</td>
</tr>
<tr>
<td>5</td>
<td>Lex.-Lou. Sub-Divs.-Frt.-Mfst.</td>
<td>1,900.5</td>
<td>602.1</td>
<td>319.9</td>
<td>1,110.5</td>
</tr>
<tr>
<td>6</td>
<td>Wellston-Jackson Local</td>
<td>43.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Huntg. Yard</td>
<td></td>
<td></td>
<td>150.6</td>
<td>51.4</td>
</tr>
<tr>
<td>8</td>
<td>Passgr. Trains Postoria-Toledo-Detroit</td>
<td>1,050.6</td>
<td>1,510.3</td>
<td>1,880.1</td>
<td>817.9</td>
</tr>
<tr>
<td>9</td>
<td>Rossford-Walbridge Yard Consolidation</td>
<td>-</td>
<td>726.3</td>
<td>1,918.0</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Effect upon Diesel Loco. Requirements</td>
<td>438.2</td>
<td></td>
<td>59.8</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Toledo Coal Dock Operation</td>
<td>101.5</td>
<td>55.5</td>
<td>30.3</td>
<td>19.0</td>
</tr>
</tbody>
</table>

$9,608.3  $4,260.3  $5,170.1  $4,428.6
### Table 12—Continued

**Summary (Basis: 1964 Figures)**

**Selected Out of Pocket Costs of Handling Designated Traffic**

*(in $ thousands)*

<table>
<thead>
<tr>
<th>Project No.</th>
<th>Description</th>
<th>Present</th>
<th>Alternate</th>
<th>Increase</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L&amp;N Lake Coal</td>
<td>$1,505.1</td>
<td>$1,246.6</td>
<td>$-</td>
<td>$258.4</td>
</tr>
<tr>
<td>2</td>
<td>Chicago Coal</td>
<td>1,870.7</td>
<td>1,305.2</td>
<td>-</td>
<td>565.7</td>
</tr>
<tr>
<td>3</td>
<td>Mfst.-Chgo. Division</td>
<td>1,424.5</td>
<td>500.6</td>
<td>-</td>
<td>923.9</td>
</tr>
<tr>
<td>4</td>
<td>Chicago Terml. Area</td>
<td>1,994.8</td>
<td>743.3</td>
<td>-</td>
<td>1,250.9</td>
</tr>
<tr>
<td>5</td>
<td>Lex.-Lou. Sub-Divs.-Frt.-Mfst.</td>
<td>2,310.4</td>
<td>1,712.6</td>
<td>-</td>
<td>597.7</td>
</tr>
<tr>
<td>6</td>
<td>Wellston-Jackson Local</td>
<td>43.8</td>
<td>-</td>
<td>-</td>
<td>43.8</td>
</tr>
<tr>
<td>7</td>
<td>Huntg. Yard</td>
<td>130.6</td>
<td>51.4</td>
<td>-</td>
<td>99.2</td>
</tr>
<tr>
<td>8</td>
<td>Passgr. Trains</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fostoria-Toledo-Detroit</td>
<td>2,930.7</td>
<td>2,328.2</td>
<td>-</td>
<td>602.5</td>
</tr>
<tr>
<td>9</td>
<td>Rossford-Walbridge Yard Consolidation</td>
<td>1,918.0</td>
<td>726.3</td>
<td>-</td>
<td>1,191.7</td>
</tr>
<tr>
<td>10</td>
<td>Effect upon Diesel Loco Requirements</td>
<td>498.0</td>
<td>-</td>
<td>-</td>
<td>498.0</td>
</tr>
<tr>
<td>11</td>
<td>Toledo Coal Dock Operation</td>
<td>131.8</td>
<td>74.5</td>
<td>-</td>
<td>57.3</td>
</tr>
</tbody>
</table>

**Combined C&O—B&O**

$14,778.4  $8,688.9  $-  $6,089.4
### TABLE 13

**MILES OF TRACK BY STATE, 1963**

<table>
<thead>
<tr>
<th>State</th>
<th>C &amp; O</th>
<th>B &amp; O</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Miles</td>
<td>Percent</td>
<td>Miles</td>
</tr>
<tr>
<td>New York</td>
<td>34</td>
<td>1%</td>
<td>181</td>
</tr>
<tr>
<td>Delaware</td>
<td>-</td>
<td>-</td>
<td>34</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>-</td>
<td>-</td>
<td>976</td>
</tr>
<tr>
<td>Maryland</td>
<td>-</td>
<td>-</td>
<td>318</td>
</tr>
<tr>
<td>District of Columbia</td>
<td>3</td>
<td>-</td>
<td>22</td>
</tr>
<tr>
<td>Virginia</td>
<td>733</td>
<td>14%</td>
<td>31</td>
</tr>
<tr>
<td>West Virginia</td>
<td>1,013</td>
<td>20%</td>
<td>1,367</td>
</tr>
<tr>
<td>Ohio</td>
<td>460</td>
<td>9%</td>
<td>1,849</td>
</tr>
<tr>
<td>Indiana</td>
<td>309</td>
<td>6%</td>
<td>559</td>
</tr>
<tr>
<td>Illinois</td>
<td>39</td>
<td>1%</td>
<td>517</td>
</tr>
<tr>
<td>Kentucky</td>
<td>688</td>
<td>13%</td>
<td>4</td>
</tr>
<tr>
<td>Missouri</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Michigan</td>
<td>1,473</td>
<td>29%</td>
<td>48</td>
</tr>
<tr>
<td>Canada</td>
<td>339</td>
<td>7%</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,091</td>
<td>100%</td>
<td>5,910</td>
</tr>
</tbody>
</table>
CHAPTER V

THE IMPACT OF MERGERS IN THE RAILROAD INDUSTRY ON THE RATE OF TECHNICAL CHANGE AND ON SCALE

The purpose of the following statistical analysis, in general, will be to assess the desirability of mergers in the railroad industry. This is done, first, by testing the hypothesis that railroads which have merged, on the average, have experienced significantly higher rates of technical change than have the railroads which have not merged; and second, by testing for the existence of increasing returns to scale in the industry. A deterministic model is used to estimate the degree of technical progress, denoted by a shift in the aggregate production function of all major railroads\(^1\) over a specified time period (in this case, 1954-1967, the period of the current merger cycle).

A. Analytic Framework

The theoretical foundations of the analysis on the interactions among the following: the process of merging, the rates of technical progress experienced by the railroads, the size of railroads, and the existence of scale factors. Analysis of the links among these items is done for the purpose of being suggestive and opening up new vistas rather than

\(^1\)The I.C.C. uses the standard of "Class I" railroads to refer to the largest railroads in the United States. In 1954, 106 railroads were in this category; in 1967, the number was 78.
being exhaustive.

In view of the present state of affairs in the railroad industry, one must consider the grounds on which merger may be supported as an alternative to nonmerger. The possible impacts on performance, on the internal structure of the railroads, and on the competitive structure must be indicated. Perhaps this most usefully can be approached by briefly stating several statistically verifiable propositions with respect to the reasons why historically railroads have merged.

1. **Mergers allow railroads to be larger size firms.**

The merger of two firms ordinarily will result in a newly sized firm which exceeds the size of either premerged firm (only in the case where the shakeout effect is so great will this not be true). Largeness or size may be calculated by several variables: ton-miles, number of employees, density, operating revenues, and so on. Although it is possible that different implications might result depending on which measure is selected, in the present analysis a strong assumption is made that ton-miles and operating freight revenues may be used interchangeable as a proxy for size. Proposition 1 must be constrained to exclude any possible cases where abandonments, reduction in employees, and displacement of management might actually reduce size.

2. **Larger size railroads experience higher rates of technical progress than smaller railroads.**

This is based on some concept of size class, where average rates of technical progress can be measured for different sized groups. The verification of this proposition does not preclude any smaller individual railroad from having a higher rate of technical advance than any larger one.
3. Railroads which have merged experience higher rates of technical progress than those which have not merged.

Mergers are undertaken when the expected net benefits of the joint railroads are estimated to be greater than the average of the benefits which would accrue to the railroads if there was no merger. One must be careful at this point to realize that it is important to distinguish between whether it has been the larger railroads or the more rapidly growing ones that tend to merge. Also, the amount of the statistical bias concerning the tendency to merge must be determined. Additional considerations on these distinction are necessary and will be treated.

4. Those railroads which do merge experience higher rates of technical progress after merger than before merger.

This might be due to the merger process itself, to the efficiencies that might be derived (as discussed in Chapter III), or to the I.C.C. constraints (that is, because of a public interest requirement a previously weaker firm with new management as a result of an I.C.C. ordered merged might yield a higher rate of return than would have occurred if market factors alone would not have induced a merger).

If increasing returns to scale exist in the industry, then larger scale operations can be utilized in order to derive the technical progress gains. One alternative is for the railroads to increase their operations independent of merger. But here, because of limitations on the supply of capital and labor, the optimum size might be unattainable. With merger and its resulting managerial efficiencies, optimum scale is more likely to be attained.

Provided the above statements are valid, and assuming that higher rates of technical progress are more desirable than lower rates, it is inferred that mergers induce increased allocative efficiency.
In essence, the above four statements will be subjected to empirical verification, which can only be performed if something is known about the nature of the production function in the industry. In this context the following discussion is intended to establish a general formulation of the relationship between railroad output and its corresponding inputs.

B. The Nature of the Production Function

While the problem herein is not concerned with such an aggregated set of data, the selection of the appropriate form of an industry production function still remains a primary consideration. It will be assumed that the production function for the railroad industry is similar in form to the more aggregative models mentioned below and to the model postulated in a previous paper by Mansfield for the railroad industry, in which he estimated the rate of technical change in the industry to be approximately 3 percent for the period 1917-1959. In a broader study which analyzed economy-wide data, Solow estimated the rate of technical change at 2.5 percent over an equivalent period. Both of these approaches assume that all technical change was capital embodied, that is all innovations had to be embodied in new plant and equipment in order to become effective. Solow's original paper defined and estimated technical progress to be disembodied,

---


i.e., output increases were realized by reorganization of industry, improvement of managerial skills, and so on, rather than by improved quality of factor inputs. Disembodied technical progress is usually measured by a pure timeshift in the production function, whereas embodied technical progress is measured by weighting capital and labor indices for quality changes. A few papers attempt to synthesize the disembodied technical progress and capital embodied technical progress approaches in one production function, but most studies explicitly assume that the increase in efficiency (technical progress) is due to improvements which are embodied in new capital.

Furthermore, Solow et. al. have demonstrated that the explicit assumption that technical progress is embodied in new physical equipment can be incorporated into a constant elasticity of substitution (CES) production function. The CES model is less restrictive than the CD model in that the latter implies that the elasticity of substitution is not only a constant, but also is equal to one.

---

5Strictly speaking, technical progress could be embodied in improved quality of labor, as well as improved quality of capital or both.


8For a generalized Cobb-Douglas form the marginal rate of substitution between K and L is

$$\frac{\partial Q}{\partial K} = \frac{a}{K}, \quad \text{and} \quad r = a+b$$

$$\frac{\partial Q}{\partial L} = \frac{b}{L}, \quad \text{and} \quad r = a+b$$
The CD model with embodied technical progress is preferred in this analysis because it is simpler to assume an elasticity of substitution of one for capital and labor as long as an additional assumption can be made, namely that the merger analysis results would be be significantly biased with this restriction.9

After an empirically consistent production function is specified and verified, conclusions will be drawn on the following topics: how well the companies would have fared without the merger; what characteristics are involved in the companies that merge in the first place; what kinds of problems would exist when the post-merger result is inefficient relative to pre-merger companies, namely, do inefficiency factors impede takeover candidates or do perspective merger companies sense that diseconomies of scale would occur that would severely mitigate the beneficial effects. It is hoped that the following industry analysis will shed some light on what has occurred in the rail sector with respect to productivity and scale effects. However, the difficulty of imputing these effects solely to the merging process remains as the primary task of the analysis.

where $a$ and $b$ are the elasticities of output with respect to $K$ and $L$ and where $r$ (the sum of $a$ and $b$) is a measure of returns to scale such that: increasing, constant, or decreasing returns to scale would prevail if $r$ exceeded, equalled, or was less than one, respectively. Hence, if the ratio of $a$ to returns to scale, "$r$", is restricted to be the same for each output group, the marginal rates of substitution will be invariant with respect to output level at each given factor ratio. See Marc Nerlove, Estimation and Identification of Cobb-Douglas Production Functions (Baltimore: Johns Hopkins University Press, 1965), pp. 10ff.

9 The CES model allows for the separation of the different types of technical progress. The attention here is directed not to which type of technical progress has occurred within a particular industry, but to how much technical progress has occurred, regardless of the conventional ways to which it can be imputed.
The assumption is made that embodying technological change exclusively in capital makes no difference in the long run,\(^{10}\) that is, since technological change traditionally is measured by a shift in the production function, the distinction between embodied technical change (either in capital or in labor) and disembodied technical change diminishes in importance. In the present case, it is essential that the short run results provide good estimates of the long run relations. Past evidence has indicated that a Cobb-Douglas type model, which is restricted to yield constant returns to scale, does accomplish this.\(^{11}\) A time series analysis of 14 years is probably not long run, but it does seem reasonable to assume that its estimates will be reflective of long run considerations.

C. Justification for the Model

The most popular form of production function has been the linear in logs, or generalized Cobb-Douglas (CD) type. Since its introduction in 1928, no single form has been more widely used.\(^{12}\) The reasons for this are several: it is simple to explain; it is a plausible form in that it displays constant returns to scale and diminishing returns to a factor; it is relatively easy to handle in connection with questions of aggregation; and it is easily estimated by standard regression techniques. Most recent studies

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\(^{11}\) See Lave, *op. cit.*, pp. 105-06; and Zvi Griliches, "The Sources of Measured Productivity Growth: U.S. Agriculture 1940-60," *Journal of Political Economy*, LXXI (October, 1963), pp. 331-42. Griliches does argue, however, that this model may tend to give indications of returns to scale where none exist.

have developed modified CD models, or have demonstrated new applications of the model. In the following analysis, an extension of the usage of the CD model will be manifest by (1) using a microeconomic production function for the industry as a whole, and (2) using a split concept of two functions for those companies which are essentially merged railroads and those which are unmerged. In fact, in economic theory the concept of the microeconomic production function has a more secure foundation than that of the aggregate production function which has a somewhat more dubious validity because of aggregation and non-homogeneity problems. So, as a starting point, the model used here is a modified CD one involving a vintage production function, which indicates that for each vintage (v) of capital there is assumed a CD constant returns to scale production function showing the relationship between: output produced by capital of vintage v, Q(v, t); the surviving capital of vintage v, K(v, t); and the labor input working with capital of vintage v, L(v, t).

\[ \text{(i) Cobb-Douglas: } \ln Y_i = \ln a_0 + a_1 \ln K_i + a_2 \ln L_i + u_{1i} \]

\[ \text{(ii) Constant Elasticity of Substitution (CES): } Y_i^\rho = g^\rho (\kappa_i^\rho + \rho (1-\delta) L_i^\rho + \omega_{2i} \]

\[ \text{(iii) Variable Elasticity of Substitution (VES): } \ln Y_i = \ln g + a(1-\delta) \ln K_i + (\alpha \rho) \ln L_i + (\rho - 1) K + \omega_{3i} \]

\[ \text{13 See Ibid., pp. 18-19; and also refer to Appendix D for a special case of handling aggregation problems. In this case, the microeconomic production function will be still very aggregative.} \]

\[ \text{14 To classify the nature of the problem of choosing the proper form of the production function, consider the following example taken from a paper by J. B. Ramsey, where the basic problem was to attempt to infer which, if any, of the five alternative production functions was the true model for the population under study. The relevant population was a set of aggregate industrial output and aggregate capital and labor inputs by states for U.S. manufacturing. The alternative models were:} \]
In this study the approach will be to hypothesize the overall beneficial impacts of merger on the industry by (1) measuring the rates of technical progress, regardless of embodiment of disembodiment, assuming constant returns to scale and, alternatively, (2) estimating the degree of returns to scale, given specified rates of technical progress. Either approach is designed to demonstrate an equivalent result, namely, that mergers in the industry on an aggregate basis induce increased efficiencies.

(iv) Generalized Production Function (GPF):
\[ \ln Y_i + e_i = \ln a_0 + a_1 \ln K_i + a_2 \ln L_i + u_{i1} \]

(v) Quadratic Production Function (QP):
\[ Y_i = a_0 + a_1 L_i + a_2 K_i + a_3 L_i^2 + a_4 K_i^2 + a_5 L_i K_i + u_{i2} \]

for \( i = 1, 2, \ldots, N \),

where \( u_{i1} = 1, 2, \ldots, 5 \), are the disturbance terms, \( Y_i \) is the value of aggregate output of manufacturing industry in each state in a particular year, \( K_i \) is the value of capital services, and \( L_i \) is the labor input in terms of employment by state. J. B. Ramsey, "Models, Specification Error, and Inference: A Discussion of Some Problems in Econometric Methodology," Michigan State University Econometrics Workshop Paper No. 6714, 1967, pp. 2-21. In Ramsey's study, the procedure followed was to apply a variety of specification error tests to each of the regression models (i) to (v) in order to test the null hypothesis that each model \( K = (i, ii, \ldots, v) \) was a true model. His conclusion was that at the 10 percent significance level all models except the GPF were rejected, i.e., model (iv) was the true model for the data observed. But he admits limitations in this conclusion, viz., that even if "the GPF is the true model ... one would be hesitant to conclude that... (iv) was the appropriate aggregate production function, because there are differences between what was structurally proposed in the GPF model and what is theoretically suggested were developed, a set of observations of these indicies might indicate that the GPF model is not a true model form which the sample was drawn in Ramsey's study. If one's economic or technical knowledge does not suggest any alternatives, he is saddled with conjecture. In fact, this usually will be the case, because one would formulate specific alternatives if his theory was sufficiently explicit."
A model that postulates constant returns to scale would be suspected to overstate the growth resulting from technical progress when confronted with data generated by a generally growing system subject to increasing returns. A number of studies have, in fact, emphasized the combination of improvements in factor qualities and increasing returns in explaining more general, aggregate growth in the United States. The relationship of economic progress to the size of firms long has been the subject of speculation in economic literature, and it is in this context that mergers in the railroad industry and their impacts on technical progress shall be examined.

D. Technological Change in the Railroad Industry and the Implications of Reorganization on Efficiency:

1. Derivation of the Industry Production Function

The approach used herein is an extension and modification of a model proposed by Edwin Mansfield in his railroad study mentioned above. The following sequence of steps depicts the derivation of a production function in the railroad industry. The overall expression for measuring output in this industry will be:

For capital installed at time \( v \), still in existence at time \( t \); the output (in vintage terms) derived at time \( t \) from this capital can be prescribed as:

\[
Q_v(t) = e^{\lambda v} L_v(t)^a K_v(t)^b
\]

\[15\] For a study which discovers sharply increasing returns to scale using a CD model applied to aggregate data, see A. A. Walters, "A Note in Economies of Scale," Review of Economics and Statistics, XLV (November, 1963), 425-27.

\[16\] Griliches, loc. cit.
where

\( K_v(t) = I(v) e^{-(t-v)r} \)

and where

- \( a \) - elasticity of output with respect to labor
- \( b \) - elasticity of output with respect to capital
- \( t \) - current time period (in annual terms)
- \( v \) - original year of production (vintage)
- \( I(v) \) - total amount of equipment produced in year \( v \) (or gross investment in year \( v \))
- \( r \) - rate of depreciation of capital
- \( Q \) - output (annual ton miles)
- \( L \) - labor input (annual number of hours worked)
- \( K \) - capital input
- \( \lambda \) - rate of technical change
- \( E \) - efficiency parameter

The eventual expression which is desired is \( Q(t) \), the production function for total output produces at time \( t \). This measure will account for the effects of vintage, depreciation, and technical changes or current output (that is, time \( t \)). Given the following assumptions:

1. All capital of a given vintage, \( v \), is identical
2. \( r \) is the same for all capital regardless of \( v \) (i.e., is assumed to depreciate over time at a constant rate—which is what equation (2) indicates).
3. Capital of a more recent vintage is not merely different but better.
4. Continuous time; and
5. The total railroad labor force is allocated efficiently among various vintages of capital;
Equation (1) must be reformulated so that it can be integrated over all vintages with respect to time. Defining the marginal product of labor is as

\[ m(t) = aE \lambda^v L_v(t)^{a-1} K_v(t)^L \]

and using (2) to solve for \( L_v(t) \) in (3), such that

\[ L_v(t) = \left[ \frac{(aEm(t)^{-1})}{1/(1-a)} e^{-tbr/(1-a)} \right] I(v)^{b/(1-a)} e^{(\lambda+br)v/(1-a)} \]

Since the term enclosed by the braces is a constant per unit of time, it can be set equal to \( g(t) \), which yields

\[ L_v(t) = g(t) I(v)^{b/(1-a)} e^{(\lambda+br)v/(1-a)} \]

If (5) is substantial back into (1)

\[ Q_v(t) = R(t) I(v)^{b/(1-a)} e^{(\lambda+br)v/(1-a)} \]

Setting \( R(t) \) to the first term in brackets on the right hand side of (6) and substituting (2) into (6) yields

\[ Q_v(t) = R(t) I(v)^{b/(1-a)} e^{(\lambda+br)v/(1-a)} \]

and since

\[ L(t) = \int_0^t L_v(t) \, dv \]

and

\[ Q(t) = \int_0^t Q_v(t) \, dv \]

it can be shown that, by integrating over all vintages and from (4), (6), (7), (8), and (9) that

\[ L(t) = g(t) - Z(t) \]

\[ Z(t) = \int_0^t I(v)^{b/(1-a)} e^{(\lambda+br)v/(1-a)} \, dv \]

and that

\[ Q(t) = E g(t)^a e^{-tbr} z(t) \]

and since, from (10), \( g(t) = L(t) + Z(t) \), then

\[ Q(t) = E e^{-tbr} L(t)^a Z(t) (1-a) \]

which is the production function for total output produced at time (t).
2. Estimation Procedures

The reduced form of (12) can be developed with the aid of some algebraic manipulation:

If an efficiency index can be defined as:

(13) \( S(t) = Q(t)^{(1/(1-a))} L(t)^a/(1-a) \)

Substitution from (12) provides

(14) \( S(t) = E^{1/(1-a)} e^{-tbr/(1-a)} Z(t) \)

which differentiated with respect to time yields

(15) \( DS(t)/dt = -br S(t)/(1-a) + E^{1/(1-a)} e^{-tbr/(1-a)} I(t)^b/(1-a) e^{(A+br)t/(1-a)} \)

which when rearranged gives

(16) \( dS(t)/dt + brS(t)/(1-a) = E^{1/(1-a)} I(t)^b/(1-a) e^{-tbr + (A+br)t} + (1-a) \)

Taking logs yields the reduced form

(17) \[ \ln \left( \frac{dS(t)/dt + rS(t)}{I(t)} \right) = \ln E + \frac{\lambda t}{(l-a)} \]

assuming that \( a + b = 1.0 \)

The explanatory variable is time \( t \) since the remaining terms on the right hand side of (17) are constants. The dependent variable is an amalgam of items which can be calculated in the following way:

(1) Use data regarding \( Q(t), L(t), \) and \( a \) and compute \( S(t) \);

(2) Substitute \( \Delta S(t) \), the discrete variable, for \( dS(t)/dt \);

(3) Insert data on \( I(t) \) and \( r \);

(4) Estimate the left hand side of equation (17); and

(5) Regress this result against time, and the product of the regression coefficient and \( (1-a) \) will be an estimate of \( \lambda \), the desired rate of technical change.
E. Impact of Mergers in the Industry on the Rate of Technical Change

Econometric analyses of the structure of technical change contain the following possible sources of specification error: (1) a confusion between scale factors and the rate of technical change; (2) a confusion among the bias in technical change, the bias in scale factors, and factor substitution; (3) a confusion between embodied and disembodied technical change; and (4) a bias in measured technical change due to improper depreciation practices. If the data are purely aggregate, only stringent assumptions will allow identification of the technical change parameters and a test of these assumptions is not generally possible. But a micro-economic study of vintage activities, using combined cross-section and time series data, has the advantage of providing some identification of these effects and tests of their significance.

The rate of technical change ($\lambda$) for both of the rail groups is designed to encompass economies in three areas: managerial, operational, and maintenance. In the aggregate growth models, managerial or organizational benefits usually have been categorized as disembodied effects. In this study, the principal objective is to observe whether any economies have resulted such that they can be reasonably imputed to the merger effects. So, if the managerial, operational, and maintenance benefits are grouped into a single technical progress category and if merged railroads can realize significantly higher rates of growth than unmerged ones, then the difference can be explained by the process of merger itself, regardless of the areas which benefit.

The assumption of neutral-technical change is an important one because a railroad that attempts to improve technology in a particular area cannot determine very precisely the kind of technical change, if any that
will result from many of its efforts. But to the extent that a railroad can influence the results, much research has been devoted to solving the problem of whether the company aims for labor-saving, capital-saving, or neutral technical change.\footnote{17} If the elasticity of substitution between the inputs is not one, attempts to achieve the greatest possible reduction in average total cost will present to management a choice of the type of technical change which will depend upon the percentage of total costs represented by labor costs and on the relative costs of inducing various types of technical change.\footnote{18} However, the evidence is too weak to support the conclusion that "...technical change is labor-saving because new techniques are intricate and round-about."\footnote{19} Therefore, an assumption of neutral technical change is reasonable as long as none of the empirical evidence on the alternatives warrants otherwise.

What is really sought is a proxy for the merger effect per se, such that the production function in equation (1) would have another multiplicative term $e^M$ where $M$ represents the merger effects, as distinct from technological effects, which would be assumed to increase exponentially. Then, the total shift of the production function would be represented by two factors $(X+M)$. But the difficulty is that these two effects cannot be estimated independently, so we are left with a combination of effects, including the

\footnote{17}{See especially Edwin Mansfield, The Economics of Technological Change (New York: W.W. Norton & Co., Inc., 1968), pp. 19-21.}

\footnote{18}{In the macroeconomic sense, the determination of whether or not technical change is labor-saving or capital-saving depends on whether it tends to lower or raise the relative share of output accruing to the input of labor. See \textit{Ibid.}, p. 21.}

\footnote{19}{\textit{Ibid.}, p. 22.}
merger effects. Consider two railroads, A and B, identical in all respects. If A merges, and if its consequent rate of technical change increases, then this effect might indeed be imputed to merging, that is, \((\lambda + M)_A\) post-merger would be greater than pre-merger such that the residual change is imputed to M. Also, if \((\lambda + M)_A\) exceeds \(\lambda_B\) over time, it is inferred that the increased technical change which A experiences is due to the merger. It is in this context that the analysis will be conducted.

1. Sources of the Data:

For the period 1954-1967, the company data used were as follows: for the variable \(Q(t)\) - annual ton-miles; for \(L(t)\) - annual number of hours worked; and \(I(t)\) - annual gross investment. In all cases, the number of observations was 14, representing the time series transgenerated data, each year of which was determined from the groupings of data under the merger railroads and the unmerged ones, as indicated in Table 14. In Equation (13) the variable \(S(t)\) was defined as a specified relationship between \(Q(t)\) and \(L(t)\) such that the estimation of the dependent variable in Equation (17) could be simplified. This equation was then fitted to two groups of data: railroads which have merged, Equation (18) and those which have not, Equation (19). The results are that \(\lambda_m\) in Equation (18) and \(\lambda_u\) in Equation (19), where the subscripts \((m, u)\) refer to the merged and unmerged railroads, respectively, are significantly different from zero and significantly different from each other at the 5 percent level.

A switch in status from an unmerged railroad to a merged one is determined by the year in which the merger of that railroad was formally approved by the I.C.C. Even in its initial year of formal operation, a merger could be said to show a meaningful effect, because of the length of the
## TABLE 14

### CLASS I RAILROADS BY MERGER STATUS

#### Merged Railroads and Year of Merger

<table>
<thead>
<tr>
<th>Railroad</th>
<th>Year of Merger</th>
</tr>
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<tbody>
<tr>
<td>Chicago &amp; Northwestern (pre-1954)</td>
<td></td>
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<tr>
<td>Kansas City Southern (pre-1954)</td>
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<tr>
<td>Southern (pre-1954)</td>
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<tr>
<td>Southern Pacific (pre-1964)</td>
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<tr>
<td>Louisville &amp; Nashville (1957)</td>
<td></td>
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<tr>
<td>Norfolk &amp; Western (1959)</td>
<td></td>
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<tr>
<td>Virginian (1959)</td>
<td></td>
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<tr>
<td>Duluth Missabe &amp; Iron Range (1960)</td>
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<tr>
<td>Soo Line (1960)</td>
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<tr>
<td>Erie-Lackawanna (1961)</td>
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<tr>
<td>Chicago, Milwaukee, St. Paul &amp;</td>
<td>(1962)</td>
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<tr>
<td>Pacific (1962)</td>
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<tr>
<td>Lehigh Valley (1962)</td>
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<tr>
<td>Pennsylvania R. R. (1962)</td>
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<tr>
<td>Atchison Topeka &amp; Santa Fe (1963)</td>
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<tr>
<td>Chesapeake &amp; Ohio (1963)</td>
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<tr>
<td>Detroit, Toledo &amp; Ironton (1963)</td>
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<tr>
<td>Atlantic Coast Line (1963)</td>
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<tr>
<td>Baltimore &amp; Ohio (1963)</td>
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<tr>
<td>Illinois Central (1963)</td>
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<td>St. Louis-San Francisco (1963)</td>
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<tr>
<td>Seaboard Air Line (1963)</td>
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<tr>
<td>Central of Georgia (1964)</td>
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<tr>
<td>Reading (1964)</td>
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<tr>
<td>Texas &amp; Pacific (1964)</td>
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<tr>
<td>New York, Chicago &amp; St. Louis (1964)</td>
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<tr>
<td>Wabash (1964)</td>
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<tr>
<td>Chicago &amp; Eastern Illinois (1965)</td>
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<tr>
<td>Missouri Pacific (1965)</td>
<td></td>
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<tr>
<td>Chicago, Burlington &amp; Quincy (1966)</td>
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</tbody>
</table>

#### Essentially Unmerged Railroads

<table>
<thead>
<tr>
<th>Railroad</th>
<th></th>
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<tbody>
<tr>
<td>Bangor &amp; Aroostook</td>
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<tr>
<td>Bessemer &amp; Lake Erie</td>
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<tr>
<td>Boston &amp; Maine</td>
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<tr>
<td>Central of New Jersey</td>
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<tr>
<td>Central of Vermont</td>
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<tr>
<td>Chicago &amp; Great Western</td>
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<tr>
<td>Chicago, Rock Island &amp; Pacific</td>
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<tr>
<td>Clinchfield</td>
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<tr>
<td>Delaware &amp; Hudson</td>
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<tr>
<td>Denver &amp; Rio Grande</td>
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<tr>
<td>Elgin Joliet &amp; Eastern</td>
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<tr>
<td>Florida East Coast</td>
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<tr>
<td>Forth Worth &amp; Denver</td>
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<tr>
<td>Grand Truck Western</td>
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<tr>
<td>Great Northern</td>
<td></td>
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<tr>
<td>Gulf, Mobile &amp; Ohio</td>
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<tr>
<td>Long Island</td>
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<tr>
<td>Missouri-Kansas-Texas</td>
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<tr>
<td>Monon</td>
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<tr>
<td>New York, New Haven &amp; Hartford</td>
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<tr>
<td>Northern Pacific</td>
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<tr>
<td>Northwestern Pacific</td>
<td></td>
</tr>
<tr>
<td>Pittsburgh, &amp; Lake Erie</td>
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<tr>
<td>Richmond, Fredericksburg &amp; Potomas</td>
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<tr>
<td>St. Louis Southwestern</td>
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<tr>
<td>Spokane Portland &amp; Seattle</td>
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<tr>
<td>Union Pacific</td>
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<tr>
<td>Western Maryland</td>
<td></td>
</tr>
<tr>
<td>Western Pacific</td>
<td></td>
</tr>
</tbody>
</table>

Sources: I.C.C. Bureau of Economics and Transport Statistics; and the I.C.C. Finance Dockets. For a complete listing of the important merger cases in the last decade, see Appendix E.
time interval from the original application date to the formal approval date is sufficiently long (on the average spanning four years) such that the companies involved have been anticipating the merger over that period and have been adjusting accordingly. For example, prior to 1959 both the Norfolk and Western and the Virginian were autonomous operations; but the data of both companies can be reasonably observed in a merger framework, beginning with 1959, their formal approval date, since internal planning for their merger had begun as early as 1954 and the year in which formal application was made was 1956. In many cases the process is not quite so smooth, but it is assumed that the non-conformity cases are minimal. As an example, consider the Southern Railway System, which during the current wave of merger activity (which began around 1956) did not participate actively in a merger acquisition until 1964 (see Appendix E for a summary of recent merger proposals). The Southern owned several smaller railroads that were acquired prior to this period and were operated on paper as autonomous organizations, but it is asserted in this paper that these smaller roads should be treated as merger railroads. Consequently, the Southern appears in the merged column, undated, as do the Chicago and North Western and the Southern Pacific, both of which evidently had grown more evidently via the process of merger than other roads.

In Appendix E are listed many different kinds of mergers. Some of the mergers are between large systems, such as the New York Central and the Pennsylvania; some are between large carriers and medium ones, such as the Norfolk and Western and the Virginian; others are between medium size railroads such as the Erie and the Delaware, Lackawanna & Western; and still others represent additional types of combinations. So, the data to which Equation (18) was fitted represent as a first approximation a "merger" group,
which has participated in some sense in the merger wave since the mid-1950's. The fact that a railroad had been involved in a merger as a matter of managerial choice is the factor that distinguishes it from the railroads in the unmerged group. It is precisely this element of managerial discretion which is hypothesized to result in the differential impacts of performance, namely, increased technical change.

2. Statistical Results:

In this model, as well as in older ones, a constant returns to scale model is used first, such that the sum of the elasticities of output \((a+b)\) is 1.0. A value of 0.85 was selected for \(a\), which is close to the ones used in two other studies of the railroad industry by Klein \((a=0.89)^{20}\) and by Mansfield \((a=0.86)^{21}\). For the railroads which have merged, the results here are

\[
\ln \left[ \frac{dS(t)/dt + rS(t)}{I(t)} \right] = -172.3 + 0.31t \quad (0.17)
\]

\(n = 14\)

\(R^2 = .783\)

such that the product of the regression coefficient and \(1/(1-a)\) will yield an estimate of \(\lambda_m\), which numerically turns out to be 0.0472 or a 4.72 percent annual rate of technical change over the sample period.

For those unmerged roads, the resulting regression is

\[
\ln \left[ \frac{dS(t)/dt + rS(t)}{I(t)} \right] = -131.5 + 0.10 \quad (0.03)
\]

\(n = 14\)

\(R^2 = .729\)

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20 See Lawrence Klein, A Textbook of Econometrics (Evanston, Ill.: Row, Peterson, and Co, 1953), p. 239.

21 See Mansfield, op. cit., p. 176.
such that \( \lambda_u = 0.0156 \) or a 1.56 percent rate of technical change, which indicates that both those railroads for the years prior to a merger and those which did not merge in any way whatsoever during the sample period jointly experienced an annual rate of technological improvement of 1.56 percent. The difference between \( \lambda_m \) and \( \lambda_u \) is statistically significant at the five percent level. In both cases, a depreciation rate of 0.04 was chosen, which as the next section indicates, proves to be a reasonable selection.

This represents a changing sample size such that the merged group is continuously growing from 1954-67 and the unmerged group diminishing over the same period. These facts per se do not incur a serious statistical bias, although the merged sample is weighted more heavily in terms of size of railroads in the last few years than the unmerged. But this effect is mitigated somewhat because in the early years of the sample there is a much larger number of railroads in the unmerged group. Within the merged group, the differences in the types of mergers are not so important as the fact that the companies did show some propensity to consolidate. Therefore, it is assumed that a distribution of merger effects is such that no one type is going to dominate any other. The majority of mergers occurred in the 1962-63 period, so that the data for railroads in the merged sample increased substantially after that period and, correspondingly, the data for the unmerged group decreased. It is further assumed that the effects of size of the railroads in each group tend to cancel each other out as the horizon of the

---

22 The reasons for this peak merger activity can be explained in terms of the response by the railroads to the general business conditions of 1961-62, in terms of the increasing tendencies of firms to merge as a corporate phenomenon, and in terms of the maximizing behavior of railroads: to grow if they had been profitable, or to continue to operate if they had deficits.
sample period increases toward 1968. This seems reasonable since the 1962-63 period represents the mode and something close to the median in terms of the frequency of mergers for the overall period.

F. An Alternative Method for Measuring Merger Impacts in the Railroad Industry: Pre-Merger and Post-Merger

A second test of productivity effects is attempted by observing the before and after situations of five selected mergers. The particular cases are designed to be representative of five different but more important types of mergers. The merger cases and a brief discussion of the salient highlights from the I.C.C.'s viewpoints are outlined on the following five pages. The five mergers are:

(1) Nashville, Chattanooga & St. Louis into Louisville & Nashville (1957),
(2) Virginian into Norfolk and Western (1958),
(3) Erie and Delaware, Lackawanna & Western into Erie-Lackawanna (1960),
(4) Duluth, South Shore & Atlantic and Minneapolis, St. Paul & Sault Ste. Marie and Wisconsin Central into Soo Line (1961),
(5) The C. & O./B. & O. (1963) -- which is the case study appearing in Chapter III.

Collecting data for the pre-merger situation was no problem. So a cutoff period of seven years was considered appropriate, since this would seem to be a reasonable amount of time for the brunt of the merger effects to be discernible.

A time normal distribution of merger effects as related to productivity is assumed. Time zero is the year of merger between the railroads and the period of analysis ranges from seven years prior to the merger to seven years after the merger (except in the C. & O./B. & O. case, since the merger effectively occurred in 1963, the post-merger data are only for five years).
<table>
<thead>
<tr>
<th>Case</th>
<th>L. &amp; N.--N.C. &amp; St. L</th>
<th>N. &amp; W.--Virginian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merger</td>
<td></td>
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<tr>
<td>F.D. No.</td>
<td>18845</td>
<td>20599</td>
</tr>
<tr>
<td>295 I.C.C.</td>
<td>457</td>
<td>307 I.C.C. 401</td>
</tr>
</tbody>
</table>

**Date of decision**
- 1957
- 1959

**Advantages claimed by applicants**
- Better service; more efficient and economical single-line operations; need to compete more vigorously with all transportation modes, including railroads (the Southern especially) in this connection applicants cite the vast expenditures of Fed'l. monies for improvements of inland waterways, for improved and/or new highways (the $101 million for highway improvement over a ten year period gives "some idea of the impact of the railroads . . .when it is borne in mind that . . .such amount is more than four times the total value of all Class I railroads built up over more than 100 years", according to applicants); aid in developing industrial territories; more open routes and additional gateways and interchange points; longer hauls; substantial increases in traffic volume and revenues; operating economies; better solicitation; tremendous savings in all areas of operation.

**Disadvantages claimed by interveners, etc.**
- City of Nashville contends that most of the alleged economies can be obtained by cooperative effort of the two roads rather than by merger, that commercial interests of Nashville would suffer labor organizations oppose because of adverse effect on displaced employees; elimination of existing competition between the 2 roads would result in deterioration rather than improvement of service; the present agreement between...
<table>
<thead>
<tr>
<th>(L. &amp; N.--N.C. &amp; St. L.)</th>
<th>(N. &amp; W.--Virginian)</th>
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<tbody>
<tr>
<td><strong>Disadvantages claimed by interveners etc.</strong></td>
<td><strong>Advantages to public outweigh disadvantages to Nashville; merger would enhance adequacy of service and would constitute best use of facilities; anticipated accomplishments from merger would give assurance of a stronger and financially more stable railroad, result in desirable corporate simplification.</strong></td>
</tr>
<tr>
<td><strong>Basis of I.C.C. decision</strong></td>
<td><strong>Basis of I.C.C. decision</strong></td>
</tr>
<tr>
<td><strong>Public interest criteria--remarks</strong></td>
<td><strong>Public interest criteria--remarks</strong></td>
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<tr>
<td><strong>Estimate of savings:</strong></td>
<td><strong>Estimate of savings:</strong></td>
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<tr>
<td><strong>Amount</strong></td>
<td><strong>Amount</strong></td>
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</table>

- The 2 roads in connection with the solicitation of traffic and the establishment of routes and services violates sec. 5.
- Operating economies; motor and water competition. More adequate efficient, and economical transportation service to the public (Standards of New York Central Securities Corp. v. United States, 287 U.S. 12, 25.) Public interest would not be affected by slight lessening of competition.
- The policy has been to operate the 2 companies in harmony so that the interests of both the public and the stockholders would be best served; single ownership and control will tend toward more economical and efficient operation which will inure to benefit of shipping public; with the properties merger, a much wider choice of industrial sites will be offered the public. (I.C.C. apparently considers that meeting motor water, and air (subsidized transportation) competition is a prime factor.
- The communities served by the Virginian will enjoy better rail service more adequate facilities, and improved opportunities for attracting new industries which many localities sorely need. Merger will plainly result in a larger, stronger company, which is obviously in the public interest. Grants and exchanges of trackage rights are in the public interest. No increase in total fixed charges. Usual conditions protect employees.

- Approximately $3,250,000 in reduced operating expenses; tax savings of approximately $120,000, and "general miscellaneous" savings aggregating $354,200. These annual savings will not be fully realized, however, for several years following the merger.
- In excess of $12,000,000 annually (within 5 years after merger), prior to Federal income tax deductions.
Estimate Estimates reached by applicants after extensive study of overlapping and duplicative efforts. Source of estimate, and comments

Study, based on 1958 traffic (with wages and price adjustments to March 1959 levels), by committee composed of N. & W. officials, aided by key Virginian personnel, supported by extensive and detailed evidence presented to the Commission. Since 1958 was a "relatively poor one trafficwise," the estimate of annual savings is correspondingly low.
Erie—D.L. & W.
Merger

F.D. No. 20707
312 I.C.C. 185

Date of
decision
1960

Advantages
Increased operating efficiency and substantial savings will result from unification.

Disadvantages
Stock distribution unreasonable to Lackawanna stockholders; RLEA claimed employment, rather than "in lieu" compensation should be guaranteed for 4 years. Intervener railroads disagree with rerouting study by Wyer, Dick & Co., and traffic loss to connecting lines.

Basis of
I.C.C.
decision
Both roads are financially weak. Competition would be preserved while at the same time economies would be realized. Roads would benefit from elimination of competition with each other. Better service; elimination of duplicate facilities; better use of motive power; consolidation of facilities; savings in

D.S.S.A.—M.St.P. & S.S.M.
(Soo) and Wisc. Central
Merger

F.D. No. 21108
312 I.C.C. 341

1960

Benefits to security holders; substantial annual savings; reduction of expenses thru consolidation of operating and maintenance facilities and abandonment of duplicating trackage and facilities; more efficient use of motive power; increase in car supply; increased efficiency and economy in overall operations. Availability of single-line service benefits shippers. Stronger and healthier railroad would benefit City of Marquette and improve conditions within the area (Upper Peninsula of Michigan).

Abandonment of repair stations or cutback in services might cause unemployment and adversely affect the already-depressed economic situation of the City of Marquette.

Emergence of a single road operating properties would permit integration of 3 separate services; unified company better able to meet present competition with other modes of transport which have successfully diverted portions of rail traffic; greater financial stability; service available to public would be materially upgraded; interveners
**Basis of Decision**

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<td>traffic and general expenses; reduction in traffic and general expenses; reduction in costs; create opportunity for greater industrial development. concede Marquette and surrounding area would benefit by a stronger healthier railroad, that such a system would tend to improve conditions.</td>
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**Public Interest Criteria**

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<tr>
<td>The statutory criteria are carefully spelled out. Conditions for routing carefully spelled out.</td>
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**Remarks**

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<td>Certain abandonments and new connecting trackage is in public interest.</td>
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**Estimate of Savings**

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<td>$13 million annually, prior to Federal income tax deductions, and approximately $6 1/4 million after such deductions. However, the full potential would not be realized until the 5th year after merger.</td>
<td>Approximately $1,200,000 annually, prior to deduction of Federal income taxes, upon consummation of the merger.</td>
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**Amount**

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**Source of Estimate, and Comments**

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<tr>
<td>Estimates based on extensive and detailed studies submitted to the Commission by the applicants.</td>
<td>Detailed studies submitted to the Commission by the applicants.</td>
</tr>
</tbody>
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<tr>
<td>Estimates based on extensive and detailed studies submitted to the Commission by the applicants.</td>
<td>Detailed studies submitted to the Commission by the applicants.</td>
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**Comments**

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<tr>
<td>Detailed studies submitted to the Commission by the applicants.</td>
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</tr>
</tbody>
</table>
Also assumed is a normal distribution of business conditions effects over the firms, although a qualification on this point will be made later.

The log-liner relationship which was expressed in Equation (17), namely, 
\[ \ln \left[ \frac{dS(t)/dt + rS(t)}{I(t)} \right] = \ln \beta + \frac{t}{(1-a)} \]  
was applied in the same fashion as equations (18) and (19) were used to test the merged and unmerged railroads in the preceding section. Here, equation (17) is used (1) for the pre-merger data and (2) for the post-merger data to test the null hypothesis that there is no significant difference between the rates of technical change before and after merger. In both cases the sample size was seven, a number which implies dangers in making inferences from small sample sizes. The sample could not be larger in a meaningful way for the reasons mentioned above.

By labeling the left-hand side of equation (17) as \( \ln Y \), the results were as follows (for \( n = 7 \))

1. **Pre-merger situation**
   \[ \ln Y = -1.04 + 0.063t \quad R^2 = .52 \]
   
   
   \( (0.048) \)

2. **Post-merger situation**
   \[ \ln Y = -1.07 + 0.554t \quad R^2 = .35 \]
   
   \( (0.323) \)

From the post-merger data, equation (17) yields a value of the regression coefficient associated with the explanatory variable \( t \) (time) as 0.554. The regression coefficient is composed of \( \lambda / (1-a) \), as previously, and multiplication of it by \( (1-a) \) where \( a = 0.85 \), yields an estimate of \( \lambda \), the rate of technical progress. In this case \( \lambda = 0.0829 \) or an 8.29 percent annual rate of technical growth. For the pre-merger case, \( \lambda \) is merely a 0.94 percent (or less than one percent) rate of technical change. See Figure 3. The
results seem to suggest a sharp difference in performance following a merger. These results can be compared with those in the preceding section for those railroads which have not merged at all.

The interpretation of this difference between the rates of technical change before and after merger is subject to some limitations. First, four of the railroads in the sample (the N. & W., L. & N., Soo, and C. & O.) are among the most profitable railroads in the industry. Since most of their successful performance, which is part accrues from effective management, has occurred in the last decade after merging, this might cause an upward bias on the merged rate of technical change parameter. Second, the B. & O. and both members of the Erie-Lackawanna (E-L) merged experienced extremely poor years prior to merger. The E-L merger in general has not been very successful to date, although its performance since 1960 has been superior than prior to merger. The net effect of the B. & O and E-L situations prior to merger would be to underestimate the rate of technical change for that group, since these represent three of the twelve railroads in the pre-merger group.

And third, 1961 was a disastrous year for most railroads in terms of operating net income. But, among the best performers in the industry were the N. & W., L. & N., and Soo, all of which had merged by the end of that year. The B. & O., as yet unmerged in 1961, experienced a $30 million net loss. The net effect on the rates of technical change for the two groups was to cause a downward bias on rate for the unmerged group. Despite these limitations, one can conclude that, if for no other reason than merger, the railroads in the sample experienced as a group sharply higher rates of technical progress following their respective mergers. Since the mergers occurred
over a variable period of time, it may be asserted that these improvements could not have happened in the absence of merger.

Figure 3

Plot of $\ln\left[\frac{\Delta S(t)/dt + rS(t)}{I(t)}\right]$ against time (t), for Five Pre- and Post-Merged Railroads

G. Measurement of Merger Impacts through the Distribution of Railroad Firms by Size:

A third method in this analysis is to segregate the railroads by size to determine whether there were significant differences over time in the rates of technical progress experienced by large, medium, and small carriers. If large railroads experienced significantly higher rates of technical change than smaller railroads, then a case can be developed to allow smaller size
railroads the opportunity to become larger through merger so that the benefits of increased technical change can be realized. This argument needs to be posited in conjunction with the previous statements on merger conditions, technical change, and size in order that an unequivocal conclusion regarding the desirability of mergers be reached.

It is assumed that railroad management intends to maximize revenues, which empirically are derived from distance, weight, and commodity class factors. Since the focus has been on freight operations in this study, it is suggested that "operating freight revenues" represents the best proxy for size distinction. It is likely that most of the alternate proxies, mentioned in Chapter II, could substitute for operating freight revenues and not affect or distort the distribution of the three-level classification. However, if density were used, a line such as the Florida East Coast might be considered a medium class road; if ton-miles were used instead, a line such as the Bessemer and Lake Erie would be in a larger class; and if passenger revenues were included, lines with heavy commuter traffic would end up with larger "size." But, it is argued that these distortions tend to be minimal, and that operating freight revenues can be considered a satisfactory proxy.

In Table 15 is the list of railroads grouped by the size in terms of operating revenues derived from freight traffic for 1968. Essentially, the breakdown has the following class limits: large—over $175 million; medium—between $150 million and $175 million; and small—less than $50 million. The frequencies in each class are 19, 12, and 23, respectively for large, medium, and small Class I railroads.

On the premise that mergers induce increases in size (ignoring for the
TABLE 15

OPERATING FREIGHT REVENUES:
CLASS I RAILROADS--1968
(in millions of dollars)

<table>
<thead>
<tr>
<th>Large Size Railroads</th>
<th>Medium Size Railroads</th>
<th>Small Size Railroads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atchison, Topeka &amp; Santa Fe</td>
<td>Boston &amp; Maine</td>
<td>Bangor &amp; Aroostook</td>
</tr>
<tr>
<td>Baltimore &amp; Ohio</td>
<td>Denver &amp; Rio Grande</td>
<td>Bessemer &amp; Lake Erie</td>
</tr>
<tr>
<td>Chesapeake &amp; Ohio</td>
<td>Grand Trunk Western</td>
<td>Central of Georgia</td>
</tr>
<tr>
<td>Chicago, Burlington &amp; Quincy</td>
<td>Gulf, Mobile &amp; Ohio</td>
<td>Central of New Jersey</td>
</tr>
<tr>
<td>Chicago, Milwaukee, St. Paul &amp; Pacific</td>
<td>Missou-Kansas-Texas</td>
<td>Central Vermont</td>
</tr>
<tr>
<td>Chicago, Rock Island &amp; Pacific</td>
<td>New York, New Haven &amp; Hartford</td>
<td>Chicago &amp; East. Illinois</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clinchfield</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Delaware &amp; Hudson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Detroit, Toledo &amp; Ironton</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duluth, Missabe &amp; Iron Range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elgin Joliet &amp; Eastern</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Florida East Coast</td>
</tr>
<tr>
<td>Atchison, Topeka &amp; Illinois Central</td>
<td>606.7 Louisville &amp; Nashville</td>
<td>13.0 Fort Worth &amp; Denver</td>
</tr>
<tr>
<td>Baltimore &amp; Ohio</td>
<td>413.1 Erie Lackawanna</td>
<td>36.1 Kansas City Southern</td>
</tr>
<tr>
<td>Chicago, Milwaukee, St. Paul &amp; Pacific</td>
<td>378.3 Great Northern</td>
<td>48.8 Lehigh Valley</td>
</tr>
<tr>
<td>Chicago, Rock Island &amp; Pacific</td>
<td>247.2 Norfolk &amp; Western</td>
<td>40.6 Long Island</td>
</tr>
<tr>
<td></td>
<td>244.3 Northern Pacific</td>
<td>7.8 Maine Central</td>
</tr>
<tr>
<td></td>
<td>236.7 Seaboard Cost Line</td>
<td>44.9 Monon</td>
</tr>
<tr>
<td></td>
<td>221.7 Southern Pacific</td>
<td>30.1 Northwestern Pacific</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pittsburgh &amp; Lake Erie</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Richmond, Fredericksburg &amp; Potomac</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27.2 Spokane, Portland &amp; Seattle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32.5 Western Maryland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>37.1 Florida East Coast</td>
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<td></td>
<td></td>
<td>25.1</td>
</tr>
</tbody>
</table>

moment the effects on density), it would be interesting to observe how the railroads in each size class have performed over the 1954-1967 period. If higher rates of technical change are associated with merged railroads, and if mergers result in larger size railroads, then one can associate higher rates of technical change with larger size railroads.

So, an approach similar to the preceding two is used in that the log-linear relationship in Equation (17), that is,

\[
\ln \left[ \frac{dS(t)/dt + rS(t)}{I(t)} \right] = \ln \lambda_i + \frac{X_{i,t}}{(1-a)}
\]

was applied to obtain an estimate for of each class size, By labeling the left-hand side of Equation (17) as \( \ln Y_i \), (where \( i = 1, 2, 3 \) for large, medium, and small size, respectively) the results were as follows (for \( n = 14 \)):

1. Large size railroads
   \[
   \ln Y_1 = -1.23 + 0.282t
   \]
   \( R^2 = .68 \)

2. Medium size railroads
   \[
   \ln Y_2 = -1.09 + 0.182t
   \]
   \( R^2 = .49 \)

3. Small size railroads
   \[
   \ln Y_3 = -1.22 + 0.170t
   \]
   \( R^2 = .70 \)

The coefficients of time in the large and small size railroads are significant at the 5 percent level, but the coefficients in the medium size group is only significant at the 10 percent level. Each coefficient of the explanatory variable (time) is composed of \( \lambda_i / (1-a) \), which upon multiplication by \( (1-a) \), since \( a = 0.85 \) by assumption, yields estimates of \( \lambda_i \) (where \( i = 1, 2, 3 \) as above). The results are that \( \lambda_1 = 0.0423 \) or a 4.23 percent annual rate.
of technical change, \( \lambda_2 = 0.0273 \) or 2.73 percent, and \( \lambda_3 = 0.0255 \) or 2.55 percent. The rates of technical change for the medium size (\( \lambda_2 \)) and for the small size railroads (\( \lambda_3 \)) are not significantly different from each other at the 10 percent level. But the rate of technical change for the large size railroads (\( \lambda_1 \)) is significantly different from both \( \lambda_2 \) and \( \lambda_3 \) at the 5 percent level. This suggests that the large railroads experienced a significantly higher annual rate of technical growth than the medium or small size carriers for the sample data over the relevant time period.

H. Impacts of Mergers in the Railroad Industry on Scale

The alternative method of estimation for applying the model in order to test scale effects would involve merely multiplying both sides of Equation (17) by \( I(t)^{b/(1-a)} \) prior to taking natural logs and then regressing the remainder on the left-hand side against both the investment and time variable on the right-hand side of Equation (16) such that the result is:

\[
\ln \left[ S(t) + rS(t) \frac{b}{(1-a)} \right] = \ln E^{1/(1-a)} + \ln I(t)^{b/(1-a)} + \lambda t/(1-a)
\]

In using Equation (17), outside estimates or trial values are taken of \( a, b, \) and \( r, \) and from the data on output, employment, and investment described above, values for the variable appearing on the left-hand side are computed. This variable is regressed on \( t \) by ordinary least-squares methods, and for each set of outside estimates one obtains an estimate of \( \lambda / (1-a) \) and therefore of \( \lambda. \) See Table 16 on the following page.

Equation (20) is used in a similar fashion, except that only two outside estimates are required: the product \( br \) and \( a.^{23} \) In this case the

---

dependent variable on the left-hand side is calculated and regressed on both ln I(t) and t, which will yield estimates of \( b/(1-a) \) and \( \lambda/(1-a) \).

Using an outside estimate of \( a \), estimates are obtained for \( b \) and \( \lambda \); from the outside estimate of \( br \), an estimate of \( r \) is obtained upon dividing \( br \) by the \( b \) obtained above. In this procedure, the combinations designated in Table 16 by an x were used as outside estimates for \( a \) and \( b \), three values for \( r \) were applied, viz., 0.02, 0.04, and 0.06. Thus the procedure involved 3 different regressions on the data. Estimates of the parameters are based on a priori information.

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>0.15</th>
<th>0.25</th>
<th>0.40</th>
<th>150</th>
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</thead>
<tbody>
<tr>
<td>.60</td>
<td>-</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>.75</td>
<td>X</td>
<td>X</td>
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<td>.85</td>
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<td>-</td>
<td>X</td>
<td>X</td>
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and not on the observation of the workings of the model, which precluded the use of an iterative procedure that would generate trial values schematically. Only the results of the regressions using \( r = 0.04 \) and \( r = 0.06 \) are reported in subsequent tables, since regressions assuming \( r = 0.02 \) yield extremely poor information, which seems reasonable since the time interval is relatively short (\( t = 14 \)) because the life of capital would be fifty years if \( r = 0.02 \) since expected capital life is equal to \( 1/r \). In this case, one should expect \( r \) not to be less than 0.04 on an a priori basis and by observing the history of railway equipment life.
The sum of \( a \) and \( b \) for any given \( r \) provides an index of measure of scale effects. If \( a + b = 1.0 \), the result is constant returns; if the sum exceeds one, the result is increasing returns. In essence, the regressions cannot be summarized easily, except to say that the findings seem to lend substantial support to the indication of increasing returns in the industry.\(^{24}\) If the results are tenable, then an argument in behalf of mergers in the industry in general is substantiated. If one insists on constant returns to scale, the results show that for a given \( r \), the lower is the value of \( b \), the higher will the rate of technical change (\( \lambda \)) become. See Tables 17 and 18.

\begin{table}[h]
\centering
\caption{Regression Estimates--Equation (17)*}
\begin{tabular}{lcccc}
\hline
\( r \) & \( b \) & \( a \) & \( 0.60 \) & \( 0.75 \) & \( 0.85 \) & \( 0.93 \) \\
& & & \( \lambda \) & \( R^2 \) & \( \lambda \) & \( R^2 \) & \( \lambda \) & \( R^2 \) & \( \lambda \) & \( R^2 \) \\
\hline
0.04 & 0.15 & --- & --- & .036 & .67 & .044 & .76 & --- & --- \\
0.04 & 0.25 & .034 & .57 & .040 & .71 & .045 & .82 & .040 & .74 \\
0.04 & 0.40 & .038 & .64 & .043 & .69 & .049 & .92 & .040 & .74 \\
0.04 & 0.50 & .042 & .62 & .045 & .73 & --- & --- & --- & --- \\
\hline
\end{tabular}
\end{table}

\(^{24}\) This study uses a completely different approach than a pioneering one performed by Healy in 1957, who claimed to find no evidence of increasing returns in the railroad industry. See Kent T. Healy, The Effects of Scale in the Railroad Industry (New Haven, Conn.: Committee on Transportation, Yale University, 1961). The general consensus of opinion has been that Healy's partial correlation methods biased his results and limited his conclusions. Recent studies suggest the existence of increasing returns in the industry.
In this section, the same trial values were used for $a$ as in the previous section and for the product $br$ seven values were used beginning with zero and ascending to 0.030 by steps of 0.005. The result is a computation of 28 regressions on this set of data, in accordance with Equation (20).

If there is to be any confidence in the results of the model, poor results should occur when nonsensical a priori values are tried. For example, it would be interesting to see what occurs when one postulates that $r = 0$ and the $br = 0$. Since the life of capital is $1/r$, it is unlikely to suggest that capital lasts forever if $r = 0$ and/or that the marginal product of capital is zero if $b = 0$. In the case for $br = 0$, the regression coefficient was negative regardless of the trial value of $a$, which would indicate a negative value for $br$ and a zero value for $r$ (see Table 19). Indeed, poor results do occur.

### Table 18

Regression Estimates—Equation (17)*

<table>
<thead>
<tr>
<th>$r$</th>
<th>$b$</th>
<th>$a$</th>
<th>$\lambda$</th>
<th>$R^2$</th>
<th>$\lambda$</th>
<th>$R^2$</th>
<th>$\lambda$</th>
<th>$R^2$</th>
<th>$\lambda$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.06</td>
<td>0.15</td>
<td>---</td>
<td>---</td>
<td>0.06</td>
<td>0.15</td>
<td>0.06</td>
<td>0.15</td>
<td>0.06</td>
<td>0.15</td>
<td>0.06</td>
</tr>
<tr>
<td>0.06</td>
<td>0.25</td>
<td>.029</td>
<td>.36</td>
<td>.031</td>
<td>.58</td>
<td>.039</td>
<td>.65</td>
<td>.033</td>
<td>.61</td>
<td></td>
</tr>
<tr>
<td>0.06</td>
<td>0.40</td>
<td>.031</td>
<td>.44</td>
<td>.042</td>
<td>.63</td>
<td>.041</td>
<td>.81</td>
<td>.032</td>
<td>.65</td>
<td></td>
</tr>
<tr>
<td>0.06</td>
<td>0.50</td>
<td>.037</td>
<td>.52</td>
<td>.043</td>
<td>.63</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

* Relaxing the constraint that $a + b = 1.0$
Table 19

"t-values" for the Coefficient of $\ln I(t)$--Equation (20)**

<table>
<thead>
<tr>
<th>$b$</th>
<th>$0.60$</th>
<th>$0.75$</th>
<th>$0.85$</th>
<th>$0.93$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.0$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$0.005$</td>
<td>-</td>
<td>-</td>
<td>$0.70$</td>
<td>$0.92$</td>
</tr>
<tr>
<td>$0.010$</td>
<td>$0.21$</td>
<td>$1.65$</td>
<td>$1.91$</td>
<td>$1.87$</td>
</tr>
<tr>
<td>$0.015$</td>
<td>$0.44$</td>
<td>$2.88$</td>
<td>$6.44$</td>
<td>$2.02$</td>
</tr>
<tr>
<td>$0.020$</td>
<td>$0.65$</td>
<td>$2.92$</td>
<td>$6.46$</td>
<td>$2.41$</td>
</tr>
<tr>
<td>$0.025$</td>
<td>$1.26$</td>
<td>$4.98$</td>
<td>$10.38$</td>
<td>$4.11$</td>
</tr>
<tr>
<td>$0.030$</td>
<td>$1.67$</td>
<td>$14.21$</td>
<td>$42.30$</td>
<td>$4.40$</td>
</tr>
</tbody>
</table>

(-) indicates a negative value with "t-values" < 1.0
* Relaxing the constraint that $a + b = 1.0$

The table of the signs and standard errors of the regression coefficient $\lambda/(1-a)$ is not reported since the sign turns out to be correctly positive and the multiple of the regression coefficients to their standard errors always exceeds 2, and in most cases exceeds 7.

By changing the depreciation rate, $r$, Table 20 suggests that the data tend to adapt themselves to the model by raising estimates for $b$ and lowering them for $\lambda$, that is, more growth could be attributed to increases in capital quantity and less to technical change. The best fits (as measured by the highest $R^2$) occur in the southeast portions of Table 20, namely with those combinations of $a$ and $b$ which yield increasing returns. In fact, the highest $R^2$ ($= .79$) occurs with the combination $a = 0.85$, $b = 0.43$, and $r = 0.07$. The size of the $r$ estimate, which in Equation (17) was never higher than $0.06$ by assumption, shows less than six years ($1/r$)--a relatively short time.
general, the higher combinations of a and b coupled with the lowest r tend to yield the best results.

The question of whether there are increasing or decreasing returns to scale, and over what range of output, has an important bearing on the institutional arrangements necessary to secure an optimal allocation of resources. If increasing returns to scale exist in the industry (as implied by high values of a and b) over the relevant range of output, then it can be argued that these companies should either receive subsidies or be allowed to resort to price discrimination to cover costs at socially optimal outputs. Also, the extent of returns to scale is a determinant of investment policies in a growing industry, such that firms could plan to increase capacity at a faster rate if evidence of increasing returns existed.

Table 20
Regression Estimates--Equation (20)

<table>
<thead>
<tr>
<th></th>
<th>0.60</th>
<th>0.75</th>
<th>0.85</th>
<th>0.93</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>r</td>
<td>λ</td>
<td>R²</td>
<td></td>
</tr>
<tr>
<td>0.010</td>
<td>X X</td>
<td>.046</td>
<td>.44</td>
<td></td>
</tr>
<tr>
<td>0.015</td>
<td>X X</td>
<td>.045</td>
<td>.45</td>
<td></td>
</tr>
<tr>
<td>0.020</td>
<td>X X</td>
<td>.039</td>
<td>.40</td>
<td></td>
</tr>
<tr>
<td>0.025</td>
<td>.37</td>
<td>.08</td>
<td>.034</td>
<td>.43</td>
</tr>
<tr>
<td>0.030</td>
<td>.27</td>
<td>.11</td>
<td>.044</td>
<td>.54</td>
</tr>
</tbody>
</table>

X--indicate "t-values" less than one. See Table 19

The values of $R^2$ provide actually only one criterion for "good" estimates. A priori values may not be the correct ones, but they do provide a starting point. At best, a wider range of a priori estimates would seem to be a
logical extension of this analysis. At minimum, this analysis represents an extension of the analysis of growth models approached from a microeconomic viewpoint by being applied to the railroad industry. In general, the evidence tends to support the hypothesis that increasing returns to scale do exist in this industry.

I. Conclusions

Merger impacts are evaluated in terms of acceptable structure and performance characteristics which one associates with classical industrial organization theory. In this framework, the performance measure is the rate of technical change and the structure measure is the size of the railroad.

Three models were developed in this Chapter to indicate the relationship between:

1. the rates of technical change for railroads which merged and for those which remained essentially unmerged (Section D);
2. the rates of technical change for selected railroads which merged before their mergers and after their mergers (Section E); and
3. the rates of technical change over time for large, medium, and small size railroads (Section F).

The empirical evidence suggests that the best performances were given by (in terms of the three preceding items): merged railroads, railroads after they merged, and large size railroads, respectively. These conclusions follow from the statistical results derived in Sections D, E, and F above.

Finally, the model developed in Section D was modified to test whether there was any evidence for nonconstant returns to scale in the industry. The results which were reported in Section C, suggest two alternative conclusions depending on which criterion is specified: (1) that increasing returns
to scale in the industry tend to exist, if $R^2$ (the coefficient of determination) is used as a criterion; and (2) significantly higher rate of technical progress has been evidenced by the larger railroads, if (the time shift of the industry production function) is used as a criterion.

All four approaches are designed to test an equivalent hypothesis, namely, that mergers in the railroad industry on the average can be linked with increased technical change. Especially, in terms of the series of propositions discussed at the beginning of the Chapter, the evidence tends to support the associations of mergers with larger size operations, larger size railroads with increased technical change, and mergers with increased technical change. Also, the evidence suggest the existence of increasing returns to scale by which larger size operators could benefit. The policy outcome of these links is to suggest that an economical way by which railroad firms can become larger is to expand by merger.

The parameters of technical change included a sum of the so-called embodied and disembodied effects. What this indicates with respect to the railroad industry structure is that the effects of technical change are separated into managerial, operational, and maintenance factors. The usual objection to introducing these elements separately into the theory of the firm is that such considerations, if not unimportant, are analytically evasive. Since their importance is an empirical question, it can hardly be dismissed so easily. In order, however, to assess their influence, it was necessary to develop an analytical basis for examining these effects jointly under the label of technical change.

The evidence presented is intended to be suggestive rather than definitive. Such as it is, it generally supports the implications of the growth-by-merger approach in the railroad industry. If subsequent results
confirm the present findings (the Penn-Central case not withstanding\textsuperscript{25}), the case for merger in the railroad industry becomes much more compelling. With this feature in mind, a structural approach by which the I.C.C. can adjudicate any merger is presented in the following Chapter.

\textsuperscript{25}Actually, the current experience of the Penn-Central dilemma (if the problems are chiefly management and diversification based) presents a strong case for future efforts to focus on the managerial factor in technical change. An investigation into the effects of discretion on managerial behavior in this case would appear to be warranted.
A. Interpretation of the Statistical Evidence

In the railroad industry, as in other regulated industries, the evaluative aspects of how well railroads perform take on an additional feature, namely, how the regulatory commission for that industry should perform per se. For example, what criteria does the Interstate Commerce Commission utilize to adjudicate mergers? What are the relationships between the merger decisions and the performance aspects of the railroad companies? Do delays in the procedures of merger testimony detract from or mitigate against any of the performance aspects? If so, is there a better approach for handling merger cases which the I.C.C. could adopt? These questions and others provided the impetus by which a systematic approach to evaluating mergers in the railroad industry was undertaken. The focus was on the behavior of the railroad companies in view of structural considerations, technical change, merger related effects, and other efficiency aspects. In this respect, the study has observed only what I.C.C. has formulated as criteria and how the railroads have performed in light of those criteria.

Placed in the context of the railroad industry merger cases, the analysis in this study provides some understanding of and explanation for events that did in fact occur. The analysis of individual cases in
Chapter V displays the post-merger effects and provides a basis on which comparisons of mergers can be made. Also, the more aggregate analysis in the same chapter demonstrates the interrelationships among all railroads which is necessary so that public policy implications can be considered. At the same time, the analysis in Chapter IV has predictive power. It suggests, for example, in what types of merger situations the participants can be anticipated to have been most efficient and where least.

In terms of the explanation of the merger events in the railroad industry since 1957, the evidence suggests some interesting results. Despite the prominence of a few well-publicized problems, the net effects of mergers in the railroad industry have been desirable. As long as one is aware of the kinds of biases involved, the evidence suggests: (1) that merged railroads have performed better than nonmerged ones; (2) that railroads which do merge perform better after merger than before merger; and (3) that large sized railroads, independent of merger, perform better than smaller size ones.\(^1\) In addition, a separate test was conducted to examine the existence of economies of scale in the industry. The results of this test suggested that some economies do exist, which can be used as further support, concommitant with the other analyses, for allowing mergers.

The principal conclusions of this study emanated from the analyses of: (1) the regulatory aspects (especially in Chapter II); (2) the specific case study in Chapter IV; and (3) the industry analyses in Chapter V. The analyses are conducted at two levels: (1) the "micro-micro" level, where specific inquiries are made into the performance of

\(^1\)If these results are valid, then a case can be established for allowing mergers which ordinarily result in larger size firms.
the company itself (such as in the case study, and in the separate cases in Chapter V); and (2) at the "macro-macro" level, where the focus is on the linkages and interrelationships among specific railroad companies, the industry itself, the I.C.C., and the public policy implications. At both these levels of analysis, sets of conclusions are presented and provide the basis for which attempts will be made to indicate whether these conclusions tend to reinforce one another.

The main purpose of this chapter is to advance a possible explanation for the public policy implications which can be expected to occur in light of the empirical results of merger effects in the railroad industry. When each of the three sets of conclusions above is considered conjunctively, an overall conclusion regarding the impacts of mergers can be assessed as follows:

1. In the regulatory area: Delay costs tend to whittle away some of the benefits to the merger participants and to the general public (see Chapter II).

2. In the case study: The C. & O./B. & O. consolidation resulted in a net gain to the participants as anticipated from the testimony. However, some of the expected benefits were not effectuated, although there were many more unanticipated (or perhaps indirect) benefits which were realized. This is an issue on which the merger model in Chapter IV in no specific sense leads to an identifiable set of consequences, but in some general sense the syndrome behavior imputed to the regulatory commission for the delays may have relevance for understanding the merger effects. The highly conjectural character of this discussion should nevertheless be recognized.
In general, this phenomenon of some expected effects not being realized and many unexpected ones occurring was found to apply in practically all merger cases. There are two candidates as reasons which possibly can explain why this phenomenon occurs. The first is simply that railroads are not quite so precise in their estimates as the testimony suggests. The second, and perhaps more important, is that the delays in the proceedings do have some positive benefits, in that different opportunities for the rail companies most likely arise as time passes. But why cannot the original benefits be effectuated? Here, it is asserted that the delays serve as a drag on railroad implementation, which is independent of the unanticipated effects. In this sense, the results of the C. & O./B. & O. case are consistent with those of other cases and with the implications of the regulatory procedure for adjudicating mergers.

3. In the industry study: Here a series of propositions were subjected to statistical testing to determine the interrelationships between merger (structure) and technical change (performance). In Chapter V, the industry models were based on the verification of each proposition. There propositions were:

(a) Mergers allow railroad companies to be large size firms.
(b) Independent of merger, larger size railroads experience higher rates of technical change than smaller railroads.
(c) Railroads which have merged experience higher rates of technical change than those which have not merged.
(d) Railroads which do merge, experience higher rates of technical change post-merger than pre-merger.
(e) Economies of scale appear to exist in the railroad industry which can be utilized most efficiently by larger size firms.
The first four propositions were tested with the assumption of a constant returns to scale production function for each of the models. The fifth proposition (testing for economies of scale) relaxes this restriction and uses an iterative scheme to observe whether in fact economies of scale do exist, independent of merger effects. This relaxation of the restriction is consistent with the methods employed in the other four propositions which are designed to measure merger impacts. The relationship between the fifth proposition and the first four is that, if mergers lead to larger size firms which in turn induce higher rates of technical change, then an environment by which firms can become larger must prevail. This is exactly the specification which the existence of scale economies satisfies.

The main conclusion of the industry section is that mergers historically have induced higher rates of technical change. The results of this industrial section are consistent with those provided in the case study and in the regulatory study. In fact, the case study is an integral part of the overall industry study so that conclusions of these two areas clearly are in harmony. One of the implications of the industry section in conjunction with the regulatory area is that the results were quite favorable for merger in view of the regulatory delays. What this suggests is that the merger results would be more favorable if more effective coordination were to occur between the I.C.C. and the railroads.

None of this is to suggest that a complete explanation for the empirical results has been supplied. It is sufficient to observe that the evidence provides some tentative support for the propositions advanced here and that the findings are consistent with one another. It
also suggests that, if a better-specified model in the regulatory sector would provide more rigorous results, additional research in this area appears warranted.

B. Some Additional Considerations

During the time period of this study, three significant factors have occurred and must be treated simultaneously. These would be (1) the delay problem in adjudication; (2) the Penn-Central exception; and (3) the significant results accomplished despite the detracting problems. What the data suggests is that despite problems (1) and (2), favorable results still were evident. If delay costs could be minimized and if problems endemic to the Penn-Central case would be controlled more effectively, then the benefits to merger cases easily would be significantly greater. When the numerous litigations in the current cases are concluded, the data will be on record and can be used to test this and other predictions of the analysis and the statistical models utilized in this study.

None of these quantifications diminishes the present importance attaching to the nature and scope of competition from other modes and its effects on the long-range development of railroad services. In past merger cases, the I.C.C. has undertaken only limited recognition of the intermodal competitive effects, primarily because this criterion lies partly outside the standards which by statute must be considered in these cases. It is, therefore, suggested that intermodal competition be established as a criterion in all future rail consolidation proceedings.

When the railroads (and in this case, the C. & O./B. & O.) set out
to measure the cost of the prolonged proceedings of a consolidation case, some events occur easily, such as the previously analyzed projects. No cost analysis, however, can adequately be a gauge for what might be the most vital long run cost—the loss of intelligent, youthful management talent who simply cannot afford to make time while doubt and apprehension concerning the merger outcome increase. The areas of manpower that are the most loss-susceptible are, not surprisingly, the ones where transfer of skill comes most readily, for example, law, industrial engineering, data-processing, marketing, to name a few. Unfortunately, these are the types of skills upon which the companies and the railroad industry must depend upon heavily for future development. Not all manpower losses are pre-merger or precisely related to delay and indecision factors, for the post-merger record in some instances also is scattered with departures of talent, some of whom by recognizing the values of their skills did not react favorably to the cajoling assurances of railroad life. Their marginal returns were simply higher elsewhere. If a new method is developed to expedite the merger process, the marginal returns to management in terms of span of control and satisfaction would be increased.

C. Concluding Remarks

The introduction to this study pointed out the timeliness of a review of three principal problems: (1) the determination of a precise concept of what is indicated by the public interest in railroad merger proceedings; (2) the need for an appraisal of the criteria utilized by the I.C.C. in the proceedings; and (3) the need for an expediting of the adjudication process. The brief review of the merger history traced
major motivating factors in both past rail mergers and current proposals and also outlined the present trends in this area. A later chapter discussed two types of criteria which are applied in the cases by the I.C.C.: (1) the statutory ones which the I.C.C. is required to consider; and (2) the "ad hoc" ones which the Commission has adopted over time to be applied as the case may merit. Guidelines enunciated in landmark court decisions were identified and the fundamental standard of consistency with the public interest was noted. The study then proceeded to describe the use of these criteria in a series of selected consolidation proceedings, where the objective was to explore the basic criteria used, the components of such criteria, and how and why the criteria were applied to resolve various questions. Then a lengthy evaluation of mergers was presented which considered the impacts on costs and services, where several propositions were stated which strongly suggested that, on the average, mergers induced cost reductions and better service activities. It is in this context that the results should be interpreted as an additional basis on which the I.C.C can formulate its policy decisions in the future.

With respect to the empirical results of this study, several inferences can be made to suggest the kinds of paths which the Interstate Commerce Commission may follow with respect to its merger policy. One possible choice for the I.C.C. is to continue its past policy of adjudicating merger applications on a case-by-case approach. This was the basic tenet underlying the analysis in Chapters IV and V. Another is to consider the railroad industry as a structural arrangement with different levels of decision-making activities. In this sense, merger
impacts could be analyzed in terms of the changes in the overall resulting structure. The approach then introduces a dynamic aspect and the method which is asserted as especially relevant for studying these impacts is that of optimal control theory. Although a thoroughgoing study of this method requires a carefully constructed and rigorously developed model, the approach to the dynamics of discretionary and decision-making behavior proposed here should prove useful to the I.C.C. if such an analysis is refined.

Irrespective of the policy choice of the I.C.C., the post-merger structural and performance behavior of firms in the railroad industry warrants additional investigation. This is especially true in light of the perpetual problems in the passenger sector of railroad activities. For example, it only requires casual observations to see that passenger and freight service are not chosen to be complimentary services in the eyes of any railroad management. Clearly, there is a substantially adverse impact of passenger deficits on the merger advantage of freight operations. One of the slight limitations of this study is that the analyses has been confined to freight operations. The implications of the empirical results in view of this limitation is that railroads...
perform rather efficiently in freight sector. The justification for considering freight operations alone is that, on the average, freight revenues account for 96 percent of total revenues. In this respect, passenger activities are relatively insignificant. A further implication of the findings is that railroads would be much better off if they were allowed to concentrate on freight traffic.\(^3\)

The proposition that mergers in the railroad industry are responsible for more efficient operations has appeared sporadically in the literature. In the more general, periodical literature, mergers have been portrayed as resulting in both desirable and, more recently, undesirable effects. Yet the arguments have tended to be imprecise, lacked predictive content, and consequently failed to be convincing. It is the attempt of the present study to overcome some of these shortcomings by developing a formal analysis in which the merger effect is made central to the analysis. To the extent that this attempt has had any success, it is hoped that the strategy employed in this study may suggest itself for possible use elsewhere, for example, in other transportation sectors.

\(^3\)With the advent of the National Railroad Transportation Corporation (Railpax) expected in late 1971, this event should come to pass. Railpax is a Comsat type enterprise, with joint private and federal government ownership and operation.
APPENDIX A

C. & O. - B. & O. COORDINATION PROGRAM

ANNUAL SAVINGS (1961-1966)

Section (1):
The following is a summary of the status of actual benefits "realized" by the end of 1966 from the C. & O. / B. & O. affiliation in comparison with the savings presented in the I.C.C. Control Case in 1961:

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Testimony (Millions of Dollars)</th>
<th>Achieved (Millions of Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Consolidation of Stations &amp; Terminals</td>
<td>$9.0</td>
<td>$.4</td>
</tr>
<tr>
<td>2) Elimination of Duplicate Lines</td>
<td>.1</td>
<td>.2</td>
</tr>
<tr>
<td>3) Elimination of Duplicate Passenger Train Service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) Consolidation of Offices</td>
<td>2.3</td>
<td>.5</td>
</tr>
<tr>
<td>5) Rehabilitation and Pooling of Diesel Equipment plus Improved Maintenance</td>
<td>.2</td>
<td>7.7</td>
</tr>
<tr>
<td>6) Rehabilitation and Pooling of Freight Car Equipment with</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consequent Savings in Maintenance</td>
<td>12.0</td>
<td>10.1</td>
</tr>
<tr>
<td>Per Diem</td>
<td>8.3</td>
<td>9.0</td>
</tr>
<tr>
<td>7) Roadway Improvements -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tunnel Clearances</td>
<td>1.9</td>
<td>.6</td>
</tr>
<tr>
<td>Traffic Control Systems</td>
<td>2.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Accident Prevention Devices</td>
<td>.2</td>
<td>.5</td>
</tr>
<tr>
<td>Mechanization and Improvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of Repair &amp; Servicing Facilities</td>
<td>2.5</td>
<td>1.4</td>
</tr>
<tr>
<td>8) Other Capital Projects</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$44.0</strong></td>
<td><strong>$32.0</strong></td>
</tr>
</tbody>
</table>

Section (2):

Current C. & O. / B. & O. planning efforts provide for additional annual benefits, based on projections undertaken in mid-1966. These benefits fall into the following major categories:

<table>
<thead>
<tr>
<th>Description</th>
<th>Annual Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Coal and Industrial Development Project</td>
<td>$7.4</td>
</tr>
<tr>
<td>Improved Passenger Operations (including discontinuances)</td>
<td>4.4</td>
</tr>
<tr>
<td>Traffic Reroutes</td>
<td>5.0</td>
</tr>
<tr>
<td>Consolidation and Improvement of Facilities (principally terminals)</td>
<td>8.2</td>
</tr>
<tr>
<td>Organizational Consolidations</td>
<td>6.7</td>
</tr>
<tr>
<td>Equipment Utilization - Locomotives and Cars</td>
<td>5.0</td>
</tr>
<tr>
<td>Computer Systems - Direct Savings Only</td>
<td>2.7</td>
</tr>
<tr>
<td>Improved Maintenance Practices</td>
<td>3.0</td>
</tr>
<tr>
<td>Improved Operating Practices</td>
<td>4.5</td>
</tr>
<tr>
<td>Other Projects</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$55.0</strong></td>
</tr>
</tbody>
</table>


The current planning program reaches beyond the C. & O. / B. & O. coordination projects; it involves all departments and all areas of company activity. At the present time it consists of about 150 specific planning projects which are being actively pursued.
A. Costs of Labor Protection:

A general agreement between a majority of the Class I railroads and the brotherhoods as to treatment of employees deprived of employment, or otherwise adversely affected through coordination or consolidation, was reached in May, 1936, and has become known as the "Washington Agreement."¹ In 1940, Section 5(2) of the Interstate Commerce Act, which permits the control of one carrier by another carrier subject to approval of the Interstate Commerce Commission, was amended to provide that the Commission shall require a fair and equitable arrangement to protect the interest of the railroad employees affected. Certain allowances to affect employees were specified in the Act and these differ from the provisions of the Washington Agreement. Under some conditions the Interstate Commerce Act is more favorable to affected employees than the Washington Agreement, but under other conditions the Washington Agreement tended to be favorable.²

¹ For a thorough description of the agreement, see William N. Leonard, Railroad Consolidation Under the Transportation Act of 1920, pp. 233-34, 270.

² A specification of the details of both agreements would be a cumbersome process, so it is sufficient to point out that the disparities were minimal.
The Washington Agreement provides for four types of payments to employees affected by consolidation for varying periods not to exceed five years:

1. A "displacement allowance" equal to the difference in compensation received by those employees who are placed in a worse position but do not lose their jobs;
2. A "consolidation allowance" equal to 60 per cent of average compensation, reduced by compensation in other employment, for varying periods depending on length of service for employees deprived of employment;
3. A "separation allowance" or lump sum payment varying in amount with length of service may be elected in lieu of a consolidation allowance;
4. A "moving allowance" covering moving and travel expense and loss on the sale of a home.

Under the Interstate Commerce Act, as interpreted by the Commission and the courts, the same four types of payment may be made for periods equal to length of service but not to exceed four years.

Attempts were made to estimate the increased costs that would result from payments under the Washington Agreement or Interstate Commerce Act to employees deprived of employment or otherwise adversely affected by consolidation of forces. The labor problems encountered under consolidation are partially alleviated in that employees on only certain seniority rosters are affected. Generally, however, the vacating of jobs on one railroad by the usual attrition process could not be used as a basis for providing jobs for employees of the other railroad who may be deprived of employment. There may be cases where viable jobs created by attrition on rosters other than those affected on one road might be used to provide jobs for employees deprived of employment under consolidation on that road and this would probably
have been done whenever possible. It was assumed that it would first be necessary to recall furloughed employees on rosters not affected. Studies, therefore, were based on the effects of control related to the specific seniority rosters affected and at locations where work was consolidated it was assumed that the work would be divided as between the two companies on the basis of the ratio of present employment by crafts.

The I.C.C. relied on its authority under the Interstate Commerce Act in its order dated May 17, 1944, in Oklahoma Ry. Co. Trustees Abandonment, and for some years assumed that any allowance for employee benefits under authority of the Interstate Commerce Act should be taken as the maximum allowance permissible. This position was assailed by the labor organizations and following the decision of the Supreme Court of the United States in Railway Labor Executives Association v. United States, dated March 27, 1950, it has been accepted that the Interstate Commerce Act represents minimum rather than maximum protection and that agreements between employers and employees can provide for greater protection.

In one of the most important recent cases, that of the consolidation of the Louisville & Nashville, and the Nashville, Chattanooga & St. Louis, decided on March 1, 1957, the I.C.C. proposed conditions

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2 257 I.C.C. 177 (1944). These became known as the "Oklahoma conditions."
3 339 U.S. 142 (1950).
giving the protection afforded by the Washington Agreement reduced payments to dismissed employees to the extent that they received compensation in any other employment or under employment insurance laws, with minimum protection being that afforded by the so-called "Oklahoma conditions" mentioned above. This has the effect of giving the employees the better provisions of each set of conditions. These same conditions, which are known in combination as the "New Orleans" conditions, were also included in the Commission's order dated September 13, 1960, authorizing merger of the Erie and Lackawanna Railroads.5

For the purpose of the C. & O. / B. & O. proceedings, the Interstate Commerce Act provisions were applied except where the Washington Agreement conditions as modified in the Louisville & Nashville case afforded more protection. Even though the number of jobs abolished was estimated by roads in each individual study, there is no way to determine the effect upon specific personnel. Assumptions had to be made as to how many of those employees deprived of employment at their location would elect to take a separation allowance rather than transfer to another location in the same seniority district or wait until vacancies would be created by attrition in subsequent years.

A summary of employees affected was calculated and payments to employees were chargeable to operating expenses and thus became

5 Finance Docket No. 20707 (1960).
a deduction at the current rate of 52% in computing Federal income taxes. The total cost of employee protection was estimated at $6,113,803 based on C. & O. tax savings only and would be reduced to $3,648,154 if advantage could be taken of B. & O. tax savings as shown in Table 1. Interest at 5% on these amounts is included as an annual charge against savings from coordination.

B. The Problem of "Work Rules" in the Merger Process:

The history of domestic railroads is closely associated with strong labor organizations and several generations of collective bargaining agreements (buttressed by federal legislation), which have won for employees in the industry substantial economic advantages, among which "job rights" are probably the most important. These "rights" are protected by "working rules" or by national (or state) legislation; they represent a valuable economic asset and cannot simply be wished away. It is, therefore, paramount to assess the reasons for the failure of the railroad industry to make a more orderly and rapid adjustment to technological innovations, especially those associated with mergers, and particularly with regard to various work rules relating to the use of manpower.7

At this point a contra distinction should be made between two of the dominant types of work rules: the "make-work" rule and the

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## APPENDIX II - TABLE 21

**Estimated Payments to Employees Deprived of Employment or Otherwise Adversely Affected by Control**

*(Based on C & O and B & O Tax Savings)*

<table>
<thead>
<tr>
<th>YEARS AFTER CONTROL</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Employees Taking Separation Allowance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C &amp; O</td>
<td><strong>$ 289,868</strong></td>
<td><strong>$ 137,029</strong></td>
<td><strong>$ -</strong></td>
<td><strong>$ -</strong></td>
<td><strong>$ -</strong></td>
<td><strong>$ 426,897</strong></td>
</tr>
<tr>
<td>B &amp; O</td>
<td><strong>259,596</strong></td>
<td><strong>437,437</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>697,033</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>549,464</strong></td>
<td><strong>574,466</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>1,123,930</strong></td>
</tr>
<tr>
<td><strong>2. Employees Taking Consolidation Allowance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C &amp; O</td>
<td><strong>402,426</strong></td>
<td><strong>629,400</strong></td>
<td><strong>537,163</strong></td>
<td><strong>526,829</strong></td>
<td><strong>223,522</strong></td>
<td><strong>2,319,340</strong></td>
</tr>
<tr>
<td>B &amp; O</td>
<td><strong>306,484</strong></td>
<td><strong>493,706</strong></td>
<td><strong>855,849</strong></td>
<td><strong>1,086,646</strong></td>
<td><strong>415,491</strong></td>
<td><strong>3,158,176</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>708,910</strong></td>
<td><strong>1,123,106</strong></td>
<td><strong>1,393,012</strong></td>
<td><strong>1,613,475</strong></td>
<td><strong>639,013</strong></td>
<td><strong>5,477,516</strong></td>
</tr>
<tr>
<td><strong>3. Employees Transferred</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C &amp; O</td>
<td><strong>36,750</strong></td>
<td><strong>3,500</strong></td>
<td><strong>20,125</strong></td>
<td><strong>5,250</strong></td>
<td><strong>2,625</strong></td>
<td><strong>68,250</strong></td>
</tr>
<tr>
<td>B &amp; O</td>
<td><strong>715,750</strong></td>
<td><strong>28,875</strong></td>
<td><strong>58,625</strong></td>
<td><strong>47,250</strong></td>
<td><strong>29,750</strong></td>
<td><strong>880,250</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>752,500</strong></td>
<td><strong>32,375</strong></td>
<td><strong>78,750</strong></td>
<td><strong>52,500</strong></td>
<td><strong>32,375</strong></td>
<td><strong>948,500</strong></td>
</tr>
<tr>
<td><strong>4. Employees in Worse Position</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C &amp; O</td>
<td><strong>3,875</strong></td>
<td><strong>6,125</strong></td>
<td><strong>4,375</strong></td>
<td><strong>3,875</strong></td>
<td><strong>2,625</strong></td>
<td><strong>20,875</strong></td>
</tr>
<tr>
<td>B &amp; O</td>
<td><strong>3,000</strong></td>
<td><strong>5,250</strong></td>
<td><strong>6,625</strong></td>
<td><strong>8,250</strong></td>
<td><strong>6,375</strong></td>
<td><strong>29,500</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,875</strong></td>
<td><strong>11,375</strong></td>
<td><strong>11,000</strong></td>
<td><strong>12,125</strong></td>
<td><strong>9,000</strong></td>
<td><strong>50,375</strong></td>
</tr>
</tbody>
</table>
### Table 21 (continued)

<table>
<thead>
<tr>
<th>YEARS AFTER CONTROL</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Total All Payments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C &amp; O</td>
<td>$ 732,919</td>
<td>$ 639,025</td>
<td>$ 698,692</td>
<td>$ 535,954</td>
<td>$ 228,772</td>
<td>$2,835,362</td>
</tr>
<tr>
<td>B &amp; O</td>
<td>1,284,830</td>
<td>527,831</td>
<td>1,358,536</td>
<td>1,142,146</td>
<td>451,616</td>
<td>4,764,959</td>
</tr>
<tr>
<td>Total</td>
<td>$2,017,749</td>
<td>$1,166,856</td>
<td>$2,057,228</td>
<td>$1,678,100</td>
<td>$ 680,388</td>
<td>$7,600,321</td>
</tr>
</tbody>
</table>

6. Income Tax Savings

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C &amp; O</td>
<td>$ 381,118</td>
<td>$ 332,293</td>
<td>$ 363,320</td>
<td>$ 278,696</td>
<td>$ 118,961</td>
<td>$1,474,388</td>
</tr>
<tr>
<td>B &amp; O</td>
<td>668,111</td>
<td>274,472</td>
<td>706,439</td>
<td>593,916</td>
<td>234,841</td>
<td>2,477,779</td>
</tr>
<tr>
<td>Total</td>
<td>$1,049,229</td>
<td>$606,765</td>
<td>$1,069,759</td>
<td>$872,612</td>
<td>$353,802</td>
<td>$3,952,167</td>
</tr>
</tbody>
</table>

7. Net Cash Required

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C &amp; O</td>
<td>$ 968,520</td>
<td>$ 560,091</td>
<td>$ 987,469</td>
<td>$ 805,488</td>
<td>$ 326,586</td>
<td>$3,648,154</td>
</tr>
</tbody>
</table>

8. Interest at 5% on
Net Cash Required

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ 48,426</td>
<td>$ 28,005</td>
<td>$ 49,373</td>
<td>$ 40,274</td>
<td>$ 16,330</td>
<td>$182,408</td>
</tr>
</tbody>
</table>

Source: Finance Docket No. 21160, pp. 87-88.
"featherbedding" rule. The former may be defined as a working rule or practice which effects a reduction in effort per man-hour paid for, and thereby leads to a reduction in useful output per man-hour; the latter is a working rule resulting in extra compensation for no extra work, or for work not performed. 8

While there is a tremendous variety of working rules and practices that are in some way restrictive, a large number fall into relatively few categories. It would be impossible to list each rule or practice that is restrictive, but a typology may be developed that includes most rules that are highly restrictive. There will obviously be differences of opinion as to the nature and scope of any typology, but the crucial test of a typology is its usefulness in analyzing the problems under investigation.

Under the general definition of "make-work" rules, the following typology is presented:

1. **Regulating the number of men per machine or per crew.** This category would cover the various working rules and practices in numerous plants and industries which limit the number of workers on a single task or a specific machine.

2. **Stand-by crews.** This category would include those rules which require the employment of a crew regardless of the need.

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8 Except for clarification purposes, the "featherbedding" rule is not the type of work rule to which the attention herein is directed. The distinction between the two types is in accord with conventional labor economics usage. For example, see The Report of the Presidential Railroad Commission, February 26, 1962, especially pp. 1-100. The Commission was established by Executive Order 10691 in accordance with the agreement of October 17, 1960, between the Class I railroads and five operating brotherhoods.
3. **Requiring time-consuming methods of work or requiring that unnecessary work be done.** This category would include those working rules which limit or specify the procedures or type of work to be performed.

4. **Limiting daily or weekly output, or the speed of work.** Such rules place specific limits on the output of workers or limit the pace of work of employees.

5. **Requiring that work be performed by specific craft or occupation.** This category includes those rules which specify in detail the work of each craft or occupation and penalize the employer for any error in assignment.

While there are a number of rules that may fit the definitions of both make-work and featherbedding, the categories of rules or practices subsumed by the "featherbedding" definition are distinct from those under the make-work definition. The principal categories of featherbedding rules are as follows:

1. **Requiring the payment of extra compensation for no extra work.** This category includes those rules which require the payment of compensation over and above regular compensation without requiring additional work.

2. **Requiring the payment of compensation for time spent not working, or for work not performed.** This category includes those rules which require the payment of regular compensation for time not worked or work not performed.

3. **Wage guarantees.** These rules guarantee a specific minimum amount of compensation per unit of time, regardless of the amount of work performed in that time. Thus, when effective, these rules require the payment of compensation for time when work is not performed.\(^9\)

A significant number of working rules in the railroad sector would fall under one or more of the above. The fact that a rule falls

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within such a definition, however, does not automatically imply that the rule is economically or socially "undesirable." If one accepts the proposition that any rule or practice causing a deviation from the competitive norm of a misallocation of resources is ethically wrong, then a large proportion of existing working rules would deserve public condemnation. If one accepts the proposition that collective bargaining per se is not an economic or social evil, then one may easily conclude that many work rules serve a useful purpose.\(^{10}\)

Because of the strong social antipathy for any rule labeled "make-work," or "featherbedding," to categorize any working rule as a make-work rule or a featherbed rule, is a serious indictment both of the rule and of the union involved. It is, therefore, the obligation of an investigator of working rules to study the origin and development of a rule, to analyze the criticisms and defense of the rule, to examine the functioning of the rule in practice, and then to apply the criteria of the definition of a make-work or a featherbed rule to the rule under analysis. A further step, however, is also necessary. A separate and additional condition is the application of a rule of reason whereby a judgment is made, based upon all aspects of the rule, of the economic and social desirability of the particular working rule. Along with the economic

\(^{10}\) For those who accept the proposition that all the results of the collective bargaining process are economically and socially good, then all working rules serve a useful purpose. For a discussion of the efficiency implications of collective bargaining, see Dunlop, \textit{op. cit.}, especially 427-31.
effects, one must also take into account all other effects, including health and safety. Whereas honest differences of opinion as to what is reasonable will undoubtedly exist, if the opinions are based upon a totality of knowledge concerning the working rule, the differences of opinion will be at a minimum.

The technological requirements for work rules are at least as important as the industry and union structure. An almost universal characteristic is the gradual substitution of one form of technology for another. The displacement is evolutionary, wiping out the wage-rent differential of skilled groups. This type of change establishes the conditions for the imposition of the rules, as well as pointing the way toward their elimination. Thus, the type of rule of current concern arises shortly after the commercial introduction of a technology that is likely to adversely affect a relatively small, and usually skilled, group in the work force, e.g., the existence of firemen on diesel locomotives. Quite frequently work rules emerge from the carrying forward of a set of practices appropriate for one technology to another where it is alien.

The specific labor groups engaged in work rules do not allow employers to modify the job assignments of the workers. This fact, along with analysis of broader categories of inputs, implies that the elasticity of substitution for specific groups in a firm is zero or close to it.\footnote{K. J. Arrow, H. B. Chenery, B. S. Minhas, and R. M. Solow, "Capital Labor Substitution and Economic Efficiency," Review of Economics and Statistics, XLI (August, 1961), 225-50.} However, this is an empirical problem, and
one that needs examination before a definitive answer to the impact of work rules can be provided. The railroad industry is experiencing an agonizing reappraisal.\textsuperscript{12} It must compete vigorously with other forms of transportation or face the consequences of carrying a steadily declining proportion of tonnage and passengers;\textsuperscript{13} it must "modernize," reduce costs, and offer the prospective passenger the rather substantial advantages now provided by the automobile, bus, and airplane.

That the industry is cognizant of the problem is clearly evident - it is demonstrating a vigorous effort to free itself from

\textsuperscript{12} The issue of the impact of technological change and the railroads has caused the publication of a considerable number of research papers, largely related to union work rules, railway productivity, and the issue of "featherbedding." Among the more important ones, the following should be mentioned: Eli L. Oliver, Are Railroad Workers Featherbedding? Sumner Slichter, James J. Healy, and Robert Livernash, The Impact of Collective Bargaining on Management; and William Gomberg, "Work Rule Problems and Property Rights in the Job," Monthly Labor Review, LXXIV (June, 1961), 595-96.

\textsuperscript{13} Many people sense that the prevalent attitude of railroad management toward passenger profit potential is one of de-emphasis. It may well be that there exists this objective among railroad management, especially on many of the "Eastern" roads. Except for the recent provision for the "Metroliner" service on the Northeast Corridor Project by the Penn-Central, the tendency of management to emphasize freight traffic has completely obscured the willingness to operate the passenger service sector efficiently and profitably. This is a symptom of disinvestment in a losing proposition, both in terms of good will and of the physical facilities. It is an entirely rational approach on the part of management, given that passenger service is incapable of being profitable, since any action that would tend to lower passenger revenues might increase the probability of a successful abandonment.
some of the regulatory restrictions which had their origin more than eighty years ago when railroads unquestionably had a cartel control over domestic transportation. It is seeking a substantial degree of freedom to compete, to consolidate, and to merge. Mergers and consolidations may provide a more rational organization of the railroad system and thus make possible not only some reduction in costs and the attraction of business currently carried on by competing forms of transportation, but also the ease with which technological change can be contemplated.

Work rules which determine the earnings of "road" employees provide for a combination of mileage and daily or hourly rates of pay, popularly known as "dual system of wage payments." The inadequacy of straight time as a basis of pay has been demonstrated in the past by the extraordinary variety of local circumstances and conditions attaching to various "runs," that is, the types of scheduled trips which the train operators would make.

The phrase "graduated rates of pay" refers to a set of two or more wage rates for a specific job classification, varying with the size and/or complexity of the equipment worked on by an employee. The effect of these rates, especially in the rail sector, is a built-in earnings escalator, resulting from technological improvement. One may possibly argue that the graduation of wage rates is unnecessary.


Horowitz, op. cit., pp. 11-12.

Ibid., pp. 14-17.
but it is quite clear that the graduation is an objective criterion based upon the handling of larger machines or a greater number of units or cars.

"Interdivisional and interseniority district run" restrictions are one of the more aggravating rules, in the sense that efficiency is unequivocally impaired in many cases by some of these outdated division and district schema. Occasionally, for reasons of efficiency or economy, or because of relocation of industrial centers, rearrangement of runs, new construction or technological improvements, or expanding urban markets, the limits of divisions change; and in an even smaller number of cases, do seniority districts change. According to one author:

Time and technology have changed 100 miles from a full day's work to something less than a day's stint. As a result it has become, in many instances, economical and more efficient to run a through train 200 or even 300 miles without stopping for a change of engine and of crew. The apparent answer to such technological changes is interdivisional runs and interseniority district runs. Some carriers have operated interdivisional and interseniority district runs for many years, and under present rules and practices the employees of the seniority districts involved generally share either on a mileage percentage basis or by some other arrangement in the operation of such runs. The number of these runs, however, is relatively small. The seniority rights of numerous crews are affected, and the result is that on most long runs the crews have to be changed every one hundred or so miles. The New York-Chicago passenger train, for example, has to stop and change engine crews seven different times along the way. The Chicago-Denver run requires eight different engine crews, each putting in an average of about two hours.17

17 Ibid., p. 17.
Monthly mileage runs are another type of impeding rule, particularly if the supply of labor is not excessive. Velocities of carriers have increased immensely over the years, and to limit the output of an engineer on this basis is certainly not reasonable, although it is clearly an effective share-the-work method. To illustrate that this type of rule is antiquated, consider the following: "The fact of the matter is that mileage limitations established in 1913 by the so-called Chicago Agreement, have not changed at all, and mileage limitations typically found in current agreements are the same as those of 1913."\(^{18}\)

Railroads are faced by a number of state acts, commonly referred to as full-crew laws, which specify the size of train crews according to the length of the train. Unions have advocated these laws chiefly on the grounds that the employment of more men in train service is necessary for the safety of railway passengers and employees. The railroads contend that these laws do not increase the efficiency or safety of railway operations or otherwise benefit the public, and hence they do add unnecessarily to operating expenses. Much litigation concerning this issue has prevailed for a considerable time.

Constructive allowances are payments principally for special or extra work, or for 'waiting time' or other time when men are required to be on duty but are not producing transportation - in

\(^{18}\)Ibid., p. 20.
any event, outside the scope of the time or duties for which compensation is provided by the regular mileage or hourly basis. Four of the major constructive allowance payments include: 1) Deadheading — when payments must be made to an employee who must be transplanted from his normal place of duty to some other place at which his services are required; 2) 'Held away from home terminal' rule — where one receives a payment for a share of the time lost as the result of waiting for a carrier to return him to home terminals; 3) Switching rules, which require carrier operators to make extra stops or deviate from prescribed routes for various, sundry reasons; and 4) terminal delay payments.

Craft jurisdictional lines suggest another type of mitigating or adverse effect on efficiency, especially in the rail sector. Only an electrician can install a headlamp, a mechanic must be called to do any minor repairs that are mechanical, and so on. If a railroad fails to call a worker of the proper class to perform a specific job, a furloughed worker of that class may claim a day's pay for not being called upon to do the work.\(^\text{19}\)

The argument is not that the sheer existence of the rules implies inefficiency, but rather that there exist rules which possibly may indicate a source of conflict, and thereby could induce inefficiency, i.e., causing a delay or deviation in service.

to the public. A conclusion of the above analysis is that unions, by a willingness to retract their heretofore adamant positions concerning most of the preceding work rules, of which many are antiquated, can provide for a more efficient utilization of the available units by management, and this process, coupled with continuous managerial advances, sequentially would create an increased demand for labor in the rail sector - the net result being actually more jobs.

Another item to consider is the tendency of management to replace the labor factor with capital (labor-saving) equipment. The social costs of such a substitution certainly must be weighed in relation to the purely mechanical concepts of manipulating costs and profits. An underlying factor inherent in the efficiency structure involves the "caliber" of management, which in itself would involve another, separate analysis and pose many, additional questions. One could argue that work rules may impede the rate of technological development by disallowing capital-labor substitutions to occur at a rate which would take place if work rules were non-existent; or, conversely, one could argue that the litigation involved in the work-rule structure has actually generated or promoted a rate of technology far greater than that which would have occurred if there were no work rules. The solution to the dilemma presented is one of pure conjecture.

The overtone of this analysis is one of a movement toward increased efficiency in rail operations. It is into this frame-
work that the benefits of mergers can only be realized fully. Otherwise, the efficiency effects will be stymied by the structural rigidities of the work-rule mechanism.
APPENDIX C

LOCOMOTIVE MAINTENANCE POLICY PROJECT: C & O / B & O

I. Introduction:

Data have been assembled in order to evaluate several alternative locomotive maintenance policies by considering their maintenance cost functions which will serve as guidance for selecting the "optimal" policy on the general classes of C & O / B & O road freight units. An attempt is made to establish a tradeoff equation which would minimize total costs and simultaneously provide sufficient protection against unwarranted occurrences of random road failures and consequent service delays.

Apart from the function of servicing, maintenance on locomotives is practiced for essentially two reasons: (a) the need for continuous locomotive operation and (b) the diminishing of random road failures. The method or type of maintenance to prescribe presents a choice of: (a) routine maintenance, (b) whole unit or "group" maintenance, (c) piecemeal, separate or "selective" maintenance, or (d) some combination thereof. When diesels were first adopted by the B & O, the intended policy was that of preventive maintenance; however, the criteria used to establish the overhaul cycle gave the effect of over-maintenance. More recently, the B & O has not followed a preventive maintenance policy but

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1 By the author during the summer of 1967 from the following departments of the C & O / B & O Railroad Companies in Baltimore, Md., Cleveland, O., and Huntington, W. Va.: Mechanical, Electrical, Mechanical Engineering, and Research Services.

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rather one based on the number and frequency of road failures. Maintenance of road failures has also been the basis of C & O policy and virtually no attention has been given to preventive methods. But one of the fruits of the consolidation has been the recognition of the need for some type of scheduled maintenance.

The purchase of new locomotives by a railroad represents outlays for capital equipment which is designed to offer improved, faster, or cheaper service. If group maintenance is the policy of the railroad for its fleet, then the decisions to be made are: at what point in time should replacement be made - the timing; and what type of power should be used as the replacement - the selection. The necessary decisions become more complex as consideration is given to such things as increasing maintenance costs, decreasing salvage value, technological innovations, and so on. However, there are many units which do not deteriorate markedly with service but which suddenly and permanently fail after a period of use. If selective maintenance is pursued, components on the failing units can be (a) repaired or replaced upon failure, (b) repairs can be made even when the units are operating satisfactorily in order to prevent unscheduled interruptions in their operation or, finally, (c) some combination of (a) and (b) can be utilized.

Regardless of which policy the railroad selects, it is uneconomic for a railroad to prevent all road breakdowns. But a decrease in road failures associated with a certain type of maintenance policy could result in substantial cost savings,
for example, improved service and availability, increased economies of scale, fewer rescheduling problems, and so on. The magnitude of the savings depends upon the cost functions of each alternate maintenance policy. Empirical evidence on failure times and various cost factors provides the basis on which the cost functions are tabulated, but since this model cannot encompass all the complexities, the analysis had to incorporate the dictates of judgment and experience for supplementary purposes.

A. Therefore, the first type of maintenance policy to be considered would be one based upon failures alone (denote this policy by $P_1$). Clearly it is possible that this policy could be the most effective, i.e., a policy which results in the lowest total cost for the system and does not allow the rate of failures to increase uncontrollably.

The remaining types of maintenance policies will be in the preventive maintenance category and reflect varying degrees of insurance against unscheduled road failures.

B. Let $P_2$ represent a group maintenance policy based upon time alone, that is, a program will be set up such that a complete locomotive unit will be overhauled after a fixed period of time has expired. The shop load can be adjusted when additional road failures necessitate immediate repairs. No consideration is given in this type of policy to the utilization of the locomotives.

C. Let $P_3$ represent a group maintenance policy based upon use, that is, mileage irrespective of age of unit. In this case,
the complete locomotive will be overhauled after a predetermined number of miles has accumulated since the unit was delivered or since last overhauled. Empirical observations have demonstrated that the probabilities of failure for different components vary widely. This indicates that a maintenance policy based upon piecemeal or selective replacement could easily be the most opportune.

D. Let $P_4$ represent a selective maintenance policy based upon time. The difference between this policy and $P_2$ is that in the selective policy only certain components will be replaced after stated intervals of time on the premise that the major components have significantly varying life expectancies.

E. Let $P_5$ represent the selective type of policy based upon mileage. This is similar to Policy Type $P_4$ except that the criteria of determinancy is utilization and not time.

F. Denote the final type of maintenance policy under consideration is $P_6$ which represents a selective maintenance policy based upon a combination of time, mileage, and judgment. Under this policy, the suggestion would be to evaluate the performance of locomotives on the basis of effects of age, wear, handling, type of activity, and a subjective element of inspection. The details of this policy are demonstrated in Section V.

The foregoing list of six alternative maintenance policies is not exhaustive, but it does provide a sufficient range of possibilities upon which a reasonable selection can be made. With the coverage of the road locomotives by the appropriate policy, an
increased economic return manifested in reduced downtime and an increase in availability will be expected. The remaining "non-crucial" units (switchers, passenger units and mongrel road units) could be covered by routine maintenance or even the identical type of policy which applies to the road units.

II. THE POLICY ALGORITHM:

The principal feature of the analysis is that the objective function is treated in terms of real costs, that is opportunity costs including actual monetary outlays. The outlay costs reflect 1) direct fixed and variable labor - and - material expenditures and 2) indirect expenditures which cannot be directly attributed to any one factor but are actually incurred. The opportunity costs reflect the dollar value of certain missed opportunities resulting from disruption in the planned schedule. For example, the opportunity costs of a major road failure (which would result in a train delay) would include elements such as: the marginal cost of bringing out the repair crew, rescheduling costs if trains are to be rerouted, the lost production of a relief unit, the lost production of the failing unit itself, overtime crew costs on the hampered consist, qualitative impacts of shipper dissatisfaction due to significant delays, etc. Real costs are analogous in the economic analysis sense to the term "implicit" costs. They are the total costs which are "really" borne and associated with any particular policy, and they include both contract and nonexpenditure cost elements.
In terms of the failure example cited, the real costs of that situation include the cost of the replacement component, the cost of the man hours necessary for making the repair, plus all the relevant opportunity costs.

Maintenance is in itself a waiting line situation, that is, estimating the probability of a unit (or component) to fail. The ideal situation, of course, is to remove the component from the unit immediately prior to its failure. Any deviation in either direction is costly, that is, either failure costs are incurred on the one hand or, on the other, useful component life is sacrificed. The mathematical and statistical techniques developed to solve this situation fall into the realm of queueing problems. Since the evolving technology has not yet permitted universally acceptable expressions, a more simplified method is used in this study, namely, the estimation of real cost functions for alternative maintenance policies and the selection of the minimum total cost policy as the optimal one.

One of the policy alternatives is based solely on failures; the others reflect some degree of preventive maintenance. Clearly, the common objective is that of minimizing emergency or unscheduled maintenance costs, but the crux of the problem is associated with the consideration of which proper variables to include or exclude.

The interval of impact of cost estimates is one year, but the figures used in the algorithm are average monthly figures. In fact,
the figures are average real maintenance costs per unit per month for
660 C & O and 708 B & 0 units, or a total of 1,368 road freight locomo-
tives (see Table 22 for the class breakdown). The direct labor
and material costs are easily predictable on an annual or a monthly
basis. However, the early-stage cost impact of the opportunity cost
variables makes average monthly figures more meaningful than "rougher"
annual ones. Admittedly, the standard deviations are sizeable, but
comparatively speaking, monthly estimates are more workable.

ROAD FREIGHT POWER: C & O / B & O as of June 30, 1966

<table>
<thead>
<tr>
<th>CLASS</th>
<th>C &amp; O</th>
<th>B &amp; O</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-3,-7</td>
<td>21</td>
<td>344</td>
<td>365</td>
</tr>
<tr>
<td>GP-7,-9</td>
<td>542</td>
<td>223</td>
<td>765</td>
</tr>
<tr>
<td>GP-30</td>
<td>46</td>
<td>77</td>
<td>123</td>
</tr>
<tr>
<td>GP-35</td>
<td>39</td>
<td>40</td>
<td>79</td>
</tr>
<tr>
<td>SD-35</td>
<td>12</td>
<td>24</td>
<td>36</td>
</tr>
</tbody>
</table>

660 708 1,368

(TABLE 22)

This analysis identifies economically preferred combinations
of cost characteristics for current levels of output-operation. In
planning the configuration, one should know or be able to estimate
how the costs of alternative systems are sensitive as the values of
each characteristic affecting the system performance change. However,
there are limitations to this process because of the complexity and
uncertainty of the relations that usually exist between the physical
and operational characteristics of the system (namely, controlled
variables) and the alternative, competing modes (namely, uncontrolled
variables). The result is that the optimal combination of the system variables is seldom to be expected from such an analysis. Nevertheless, it is essential that all factors which would otherwise be involved in the decision underlying a system design be taken into account insofar as is feasible (See Table 23).

General estimates on the amount of revenue foregone (variables $X_3$ to $X_9$) varied from $10.00 per unit per hour to $75.00 per unit per hour, so a figure of $50.00 per locomotive per hour was selected as a representative average. In terms of a specific policy, estimates were made for the average number of hours per month that would be "lost" or foregone as a result of the respective policy for each of the variables. This figure was then multiplied by $50.00 to yield the net cost shown in each row and column position in the algorithm.

For example, consider policy $P_5$ and variable $X_7$. Approximately twenty subjective estimates from the Mechanical Department, the Power Bureau, and the Cost and Economic Research Department were obtained on this variable (rescheduling costs) from which the final result was that on the average one would expect the additional time required for rescheduling locomotives on account of random failure to be six hours for each unit per month (or 6 hrs. x $50.00 = $300) if maintenance policy ($P_5$) were being followed, viz., selective maintenance policy based on mileage alone. The rationale behind this estimate is that since the expected component life varies sharply depending upon the component, it would be necessary to
maintain a more precise degree of control over what work is being performed on the unit. This is difficult to implement and anything less than proper control would lead to chaotic shopping situations, thus increasing rescheduling problems.

The cost of $P_5X_7$ exceeds that of $P_3X_7$ (group maintenance, based on mileage) because scheduling itself is easier, although useful component life is sacrificed (which incidentally is reflected in a higher value for $P_3X_9$ than for $P_5X_9$). In terms of $P_3X_9$, the component waste factor more than offsets any potential savings in scale.

The cost estimates for columns $X_1$ and $X_2$ were determined and estimated from maintenance records supplied by the Accounting, Mechanical and Cost and Economic Research Departments. Variables $X_1$ and $X_2$ in policy $P_1$ were historical data, but all the variables on the other policies required modifications and estimates that were developed chiefly through the assistance of the locomotive maintenance officers and their staffs. Interviews were conducted with and suggestions made by several members of the following departments: Mechanical, Power Bureau, Accounting, Tariff Bureau, Marketing (General Freight), Costs and Budget Maintenance, and Planning.

III. THE MINIMUM-COST POLICY:

The total cost of $P_6$ is estimated to be $1,880.00 per unit per month which states that if a preventive maintenance policy like the point system method is adopted, the real maintenance costs of each road freight unit (C & O / B & O) will approximate $1,880.00 per
<table>
<thead>
<tr>
<th>Total Cost</th>
<th>$X_1$</th>
<th>$X_2$</th>
<th>$X_3$</th>
<th>$X_4$</th>
<th>$X_5$</th>
<th>$X_6$</th>
<th>$X_7$</th>
<th>$X_8$</th>
<th>$X_9$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_1$</td>
<td>3005</td>
<td>1050</td>
<td>800</td>
<td>-</td>
<td>400</td>
<td>275</td>
<td>200</td>
<td>200</td>
<td>30</td>
</tr>
<tr>
<td>$P_2$</td>
<td>2790</td>
<td>850</td>
<td>900</td>
<td>300</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>10</td>
<td>450</td>
</tr>
<tr>
<td>$P_3$</td>
<td>2850</td>
<td>800</td>
<td>1000</td>
<td>400</td>
<td>50</td>
<td>40</td>
<td>250</td>
<td>20</td>
<td>200</td>
</tr>
<tr>
<td>$P_4$</td>
<td>2520</td>
<td>1000</td>
<td>800</td>
<td>250</td>
<td>50</td>
<td>30</td>
<td>30</td>
<td>250</td>
<td>10</td>
</tr>
<tr>
<td>$P_5$</td>
<td>2755</td>
<td>975</td>
<td>900</td>
<td>350</td>
<td>50</td>
<td>50</td>
<td>60</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>$P_6$</td>
<td>1880</td>
<td>800</td>
<td>650</td>
<td>200</td>
<td>50</td>
<td>20</td>
<td>30</td>
<td>150</td>
<td>5</td>
</tr>
</tbody>
</table>

Where: $P_1$, $P_2$, $P_3$, $P_4$, $P_5$, and $P_6$ are the various types of maintenance policies described in Section 11.

$P_1$ - failures only - no p.m.

$P_2$ - group p.m. - based only on time

$P_3$ - group p.m. - based only on mileage

$P_4$ - selective p.m. - based only on time

$P_5$ - selective p.m. - based only on mileage

$P_6$ - selective p.m. based on time, mileage, and judgment
Table 23 (continued)

and where:  \( X_1 \) through \( X_9 \) are the cost variables

1. \( X_1 \) - direct fixed and variable labor
2. \( X_2 \) - direct fixed and variable material
3. \( X_3 \) - unavailability of locomotive due to preventive maintenance activities
4. \( X_4 \) - unavailability of locomotive due to random road failures
5. \( X_5 \) - unavailability or delays of other locomotives associated with failures of initial locomotive
6. \( X_6 \) - overtime crew costs
7. \( X_7 \) - rescheduling costs (principally administrative and supervisory)
8. \( X_8 \) - qualitative factor (degradation of service associated with failures; control; transport operation; etc.)
9. \( X_9 \) - economies of scale factor (lost savings on account of poor utilization; shop efficiency; servicing cost changes; the cost of useful components being replaced prematurely; etc.)
month. Compared with the present maintenance policy ($P_1$), the real cost savings can be calculated easily for each alternative policy, although one must be wary of the secondary effect implications, that is, variables $X_3$ to $X_9$ are averages of expected incremental costs, some of which lag in impact more than others.

The real cost differential between policy $P_1$ and policy $P_6$ is $1,125.00 which, when multiplied by the number of road freight units, would yield a sizable cost savings potential. It is also obvious that as the degrees of utilization and efficiency increase, the opportunity costs diminish and the total real costs approach the outlay costs.

The computations also tend to indicate that any kind of selective maintenance policy is preferred to a group maintenance policy, no matter what the factors are on which it is based. The apparent reason for this conclusion can be found by observing the values of $X_9$, when the group maintenance policies have several-fold higher costs than have the selective maintenance policies. Clearly, the substantial waste of useful life in some components associated with a group maintenance policy more than offsets the shop scale advantages of having a group policy by such a degree that it pays to accept fewer scale economies but little component waste with a selective maintenance policy. The algorithm also shows that no significant difference prevails over $P_1$ as between $P_2$, $P_3$, $P_4$, and $P_5$. 
In fact, the substantial reduction in component waste coupled with increased utilization of facilities results in a negative cost for $X_9$ in policy $P_6$, that is, an absolute savings of $25.00 per unit per month attributed to the variable.

A cost/effectiveness analysis provides a quantitative foundation for evaluating a system's performance in the light of both its cost burden and its aggregate effectiveness. This type of analysis identifies economically preferred combinations of alternative levels of system capability and the total resource implication at each alternative level. The integration of the tradeoff between cost and effectiveness is contained within the present analysis, subject to the constraint that all six maintenance policies are calculated under the assumption that current resource capability would be constant for the next year. In the process, only certain characteristics are treated as variables and they are varied over a specified range only. The values of the other characteristics are fixed, for example, productivity of the work force, actual man-counts, etc.

These decisions concerning which characteristics will, or will not, be varied and the values assigned to them involve implicit suboptimizations of their importance to the overall system effectiveness. If these decisions do not adequately reflect the importance of these characteristics, the need to re-examine them must be indicated in the future extension of this analysis.
IV. **THE POINT SYSTEM METHOD:**

The maintenance policy function with the minimum total real cost is $P_6$, which prescribes a selective maintenance policy based upon the combining of time, mileage, and inspection. A more relevant problem concerns the implementation of the elements associated with policy $P_6$, and the following is a sample of how it could be accomplished.

A chart is devised which assigns point values to various components of the locomotive depending upon time and use since last replacement (See Chart 1). In addition, marginal evaluations by qualified inspectors provide a final determination of whether or not it should be placed in the shop. It is not feasible to make one comprehensive chart for all classes of road freight locomotives, so it is necessary to estimate each class of locomotive separately. An example of such a charge would be as follows, where the sample class consists of GP-7 and GP-9 locomotives on both the B & O and C & O.

In the left-hand column is listed the number of points to be assigned and these vary from 1 to 20. In the sample chart, points are assigned to the following factors:

1. The age of the unit
2. The mileage of the engine since last replacement
3. The number and frequency of power assembly replacements
4. The time since last replacement of the following:
a) Main bearings  
b) Accessory drive and gear train  
c) Main generator  
d) Trucks  
e) Engine  
f) Traction motors  
g) Blowers

Point values are designated in such a way that higher points are attached to those units with higher probabilities of failure. In other words, the progressively higher the point value, the more susceptible to failure the component is becoming. A maximum point value of 20 is assigned in just three cases and represents a situation in which failure is expected to be almost immediate.

One of the limitations of the chart is that of eliminating both horizontal and vertical bias, namely, arranging the points such that not only will evaluations in and of themselves be handled but also comparative considerations be made. Therefore, periodic revisions of the points are necessary and changes in the primary components can be made accordingly.

In the present example, the maximum number of total points for the 11 areas is 178, the minimum, 11. If this charge is devised for all of the road freight locomotives and the total tabulated for each one, an array can be set up wherein units with the highest total point values would appear at the top of the array, and the units with progressively lower point values would indicate better expected levels of performance, that is, the probability of road failure is reduced. Discretion must be used by inspectors along the line as to which components need immediate replacement.
A CHART FOR IMPLEMENTING THE POINT SYSTEM METHOD TO C & O / B & O GP-7, GP-9 LOCOMOTIVES

<table>
<thead>
<tr>
<th>No. of Points to be Assigned</th>
<th>Unit Age (yrs)</th>
<th>Engine Mileage (000's)</th>
<th>PA's*</th>
<th>Main Acc Dr &amp; Gear Bearings</th>
<th>Blowers</th>
<th>Main Air Train Gens**</th>
<th>Air Comps**</th>
<th>Traction Motors</th>
<th>Trucks etc.</th>
<th>Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0-50</td>
<td>All 16</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>50-100</td>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
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<tr>
<td>3</td>
<td>3</td>
<td>100-150</td>
<td></td>
<td>3</td>
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<td>3</td>
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<tr>
<td>4</td>
<td>4</td>
<td>150-200</td>
<td>1-2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>200-250</td>
<td>None</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>250-300</td>
<td></td>
<td>5</td>
<td>6</td>
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<tr>
<td>7</td>
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<td>3-6</td>
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<td>350-400</td>
<td>7-15</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>400-450</td>
<td></td>
<td>9</td>
<td>9</td>
<td>8+</td>
<td>6+</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>450-500</td>
<td></td>
<td>9</td>
<td>9</td>
<td>6+</td>
<td></td>
<td>9</td>
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<td></td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>500-550</td>
<td></td>
<td>10+</td>
<td>8+</td>
<td></td>
<td>10+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>550-600</td>
<td></td>
<td>8+</td>
<td></td>
<td>10+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>600+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOTALS: ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )

Maximum possible - 178
Minimum possible - 11

* The number of cylinders renewed within the nearest twelve months. Careful attention must be given to the frequency and repetition of head-only changes.

** Consideration must be given for different types of repair.
Flexibility is the primary objective in the sense that the shop capacity is a function of the number of road failures and the scheduled shop load. Allowances can be made for random road failures such that no overload at the shop should take place. For example, if the number of road failures should increase sharply, it would be necessary to send into the shop a smaller number of locomotives than was scheduled since the scheduling itself can be varied. In other words, during Week one, 15 locomotives with the highest number of points can be scheduled to be sent into the shop. All 15 of these locomotives are subject to a thorough inspection by the foreman when each is flagged and again at the shop prior to repair. If six load failures occurred, only nine of the originally scheduled units would be shopped. Repairs are done not specifically on a time basis, but on priorities determined by the point evaluation. In Week two there could be fewer road failures which would allow additional scheduled units to be handled.

It is also possible in a given week that the top 15 locomotives would have point values between 170 and 150 whereas in another week the top 15 locomotives might have point values ranging from 130 to 110. In either case, no more than 15 locomotives could be sent into the shop at any one time because of our assumption on the limits of shop capacity. If the disparity between point values becomes too great, then a re-evaluation of the point assignment may be necessary.
V. CONCLUSION - RECOMMENDATIONS

Essentially, the benefits of the implementation of a selective maintenance policy for locomotives, such as P₆, would be derived in the following way:

1) A decrease in total locomotive repair expenses.
2) A decrease in unscheduled delays with resulting improvement in the quality of service, increased productivity and locomotive availability.
3) An increased efficiency in the operation of the major overhaul shop.
4) A decrease in running repair activities.
5) A guideline to supplement other departmental projects on maintenance policies.

Recommendations:

1. Test the Point System Method on either:
   a) a sample of, say thirty, locomotives each from the C & O and the B & O; or
   b) a whole class of power; or
   c) the whole fleet of 1,368 units.

2. Design a control system which would follow up on the point system to detect more feasible approaches, limitations, and so on.
APPENDIX D

A DIGRESSION ON THE PROBLEM OF AGGREGATION

In his pioneering work on the problem of aggregation, Henri Theil\(^1\) dealt with a fundamental problem, namely, the interpretation of macro-relations estimated using given aggregate data and given micro-relations. He concluded that the mathematical expectation of macro coefficient estimators will depend in general on a complicated combination of corresponding and non-corresponding micro coefficients. Since the appearance of Theil's work, little progress has been made on the troublesome issues which he raised. Those who construct both macro and large scale micro models tend to side-step these issues and are convinced that their coefficients estimates are economically meaningful. Thus, there is a major disagreement between theory and practice which must be resolved in order to know what it is that aggregate coefficient estimators (say, in production functions) estimate. This Appendix deals with the special econometric problem of aggregation, as applied to the use of the modified Cobb-Douglas type production function for the railroad industry which is generated by summing the production functions of each railroad. In this sense, the resultant industry production function is an aggregate.

It can be shown that for one class of models with random coefficients and for a certain range of specifying assumptions com-

---

\(^1\) Henri Theil, *Linear Aggregation of Economic Relations*, especially Chapter 1.
pletely analogous to some employed by Theil and others, there is no aggregation bias. However, the usual measures of precision, that is standard errors, used in macro work are probably seriously in error in many cases. The fact that no aggregation bias is found in this work does not mean that Theil's results are incorrect; they are mathematically correct but relate to models with fixed coefficients. On the other hand, the results here relate to models with random coefficients and hence the difference.

Further, the fact that there is no aggregation bias under certain conditions should not be interpreted as a blanket endorsement of aggregate work. In many instances, information which can be used to improve the precision of estimation, to test interesting hypotheses, and to measure effects which are beclouded by aggregation. Also, even with random coefficient models, there are many conditions in which aggregation bias can occur and some of these should be clear from what follows:

Theil's approach to the problem of aggregation over individuals can be summarized in the following way. Let the economic relationship for the \( n \)th economic unit, say a railroad, be given by

\[
(1) \quad y_n = x_n b_n + u_n \quad n = 1, 2, \ldots N
\]

where \( y_n \) is a Txl vector of observations on a dependent random variable, \( x_n \) is a Txk matrix of observations with rank k on k "independent" variables, \( b_n \) is a kxl vector of nonrandom coefficients, \( u_n \) is a Txl

---

2 For example, with macro data we are usually unable to make inferences about underlying distributions of economic units' characteristics.
vector of disturbance terms each with mean zero, and \( N \) is the number of economic units being considered.\(^3\)

Now introduce macro variables obtained by simple aggregation; that is

\[
(2) \quad Y = \sum_{n}^{N} Y_n ; \quad X = \sum_{n}^{N} X_n
\]

In line with practical procedures, Theil postulates the following relationship connecting the macro variables:

\[
(3) \quad Y = XB + u
\]

where \( Y \) and \( X \) are given in (2), \( B \) is a \( k \times l \) vector of non-random macro coefficients and \( u \) is a \( T \times l \) vector of macro disturbances, each with mean zero. It should be realized that the relationship in (3) does not follow mathematically from (1) but is entertained as an economically meaningful relationship, suggested perhaps by some macroeconomic theory. Then the question posed by Theil is the following one. If \( B \) is estimated in (3) by least squares using macro data, how does the mathematical expectation of the macro coefficient estimator depend on the micro coefficients, the \( B_n \) in (1)? To answer this question, the macro estimator is formed as:

\[^3\text{The essential difference between the fixed coefficients model and the random coefficients case is that in the former the assumption is made that the microcoefficients are constant, with the random part being concentrated in the additive term, while in the latter case the assumption is made that the microcoefficients follow a certain statistical distribution. If one follows the fixed coefficients model, the result is that the macroparameters are normally subject to some type of aggregation bias. See Theil, \textit{loc. cit.}}\]
(4) \[ \hat{B} = (X'X)^{-1} X'Y = (X'X)^{-1} X' \sum_{n=1}^{N} Y_n \]

Substituting from (1) and taking expectations yields:

(5) \[ \text{EB} = E (X'X)^{-1} X' \sum_{n=1}^{N} (X_n B_n + u_n) \]
\[ = \sum_{n=1}^{N} (X'X)^{-1} X'_n B_n = \sum_{n=1}^{N} P_n B_n \]

where \( P_n \equiv (X'X)^{-1} X'_n X_n \). It is clear from (5) that in general the expectation of a single element of \( B \), say marginal cost for the industry, will depend on corresponding micro coefficients, individual firm's marginal costs, and non-corresponding micro coefficients, say individual firm's input prices. This basic problem is the central point of Theil's analysis of the aggregation problem, a point which is rightly of concern to many.

At this point, we now turn to consider the model in (1) to be one in which coefficients are random. As Klein (1953) points out, this point of view may be appealing in the analysis of cross section data since it permits corresponding coefficients to be different for different individuals. In fact, as is well known, if we assume coefficients to be non-random and if they differ over individuals, then usual least square estimators will be biased. Thus, assuming coefficients to be random may be a desirable specifying assumption for a broad range of situations.

Considering \( B_n \) in (1) to be random, we are interested in estimating the mean of the \( B_n \), say \( \bar{B} \), which is given by

(6) \[ \bar{B} = \text{EB}_n \quad n = 1, 2, \ldots, N \]
Klein shows that, in a single cross section, the least squares estimator is a consistent estimator of $B$. Also, for a simple model, he derives non-linear maximum likelihood estimating equations for the means of two coefficients and other parameters. While these results are extremely interesting, their implications for the aggregation problem appear not to have been explored. To develop this point, let

$$B_n = \bar{B} + \mathbb{S}_n \quad n = 1, 2, \ldots, N$$

where $\mathbb{S}_n$ is a random vector with $E\mathbb{S}_n = 0$. Then we can rewrite equation (1) as follows:

$$Y_n = X_n (\bar{B} + \mathbb{S}_n) + U_n \quad n = 1, 2, \ldots, N$$

and on summing over $n$ we obtain

$$X^\prime Y_n = (X^\prime X_n) \bar{B} + \mathbb{S}_n \mathbb{S}_n^\prime + U_n$$

or

$$Y = X\bar{B} + \mathbb{S}_n \mathbb{S}_n^\prime + u$$

which, in contrast to (3), is the macro equation implied mathematically by the micro-relations.

---


5 The finite sample properties of these estimators appear to be unknown. Monte Carlo experiments are being performed to shed light on this issue. Also, work on Bayesian methods for analyzing this model is in progress; see Henri Theil, "Consistent Aggregation of Micromodels with Random Coefficients," Report 6816 of the Center for Mathematical Studies in Business and Economics, The University of Chicago (April, 1968).
It is almost obvious that the macro least squares estimator, 
\[ \hat{B} = (X'X)^{-1} X'Y, \]
is an unbiased estimator of \( \bar{B} \), the common mean of the 
minor-coefficient vectors -- see equation (6). That it is
\[ (10) \quad \hat{B} = (X'X)^{-1} X'Y \]
and
\[ (11) \quad \mathbb{E}[\hat{B}] = \bar{B} \]
since \( \mathbb{E}(X'X)^{-1} X'X = 0 \) and \( \mathbb{E}(X'X)^{-1} X'u = 0 \). Thus, there is 
no aggregation bias. \(^3\) Note, however, that the sampling error of the 
estimator \( \hat{B} \) in (10) is given by
\[ (12) \quad B - \hat{B} = (X'X)^{-1} X' \Sigma X \delta_n + (X'X)^{-1} X'u \]
which reflects two sources of randomness, namely, that arising from the 
\( \delta_n \) and that arising from the macro disturbance \( u \). Thus, it is indeed 
perplexing to infer what the usual standard errors, computed in macro 
work as the square roots of diagonal elements of the well known matrix 
\( (X'X)^{-1} X'Y, \) mean. Clearly, additional work on the statistics of 
this model is required in order to put inferences on a sound basis. 
However, it is the case that the macro least squares estimator, \( \hat{B} = 
(X'X)^{-1} X'Y, \) is an unbiased estimator \(^4\) of \( B, \) the mean of the micro-

\(^3\) If the elements of \( X_n \) are stochastic and if they are dis-
tributed independently of the \( \delta_n \) and \( u, \) \( B \) is still an unbiased 
estimator of \( \bar{B}. \) Of course, if the variables in \( X \) are stochastic and 
correlated with the \( \delta_n, \) the property of unbiasedness no longer 
follows. As pointed out by Z. Griliches, these considerations about 
the properties of the \( X_n \) and \( \delta_n \) are similar to, but not exactly 
the same, as Theil's "covariance condition" (ibid., p. 16).

\(^4\) It is not at all clear that this estimator is efficient or 
what its small sample properties, other than that of unbiasedness, are.
parameter vectors. Thus, for the specifying assumptions introduced above, there is no aggregation bias.

This last conclusion should not be crudely generalized to all situations. Obviously, there are situations in which the specifying assumptions used above do not apply (see footnote 3 for an example). Other examples, say involving temporal aggregation, or nonlinear aggregation, are not hard to generate. As usual, each situation has to be analyzed carefully. While this is recognized, it is thought that the analysis presented above may apply in some practical situations. 5

5 This approach was suggested to me by Professor Arnold Zellner in correspondence with him at the University of Chicago.
### APPENDIX E

**APPROVED AND PENDING UNIFICATIONS OF MAJOR CLASS I LINE-HAUL RAILROADS SINCE 1954**

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