An Economic Analysis of Rail Abandonment in Central and Southwestern Ohio Grain Producing Areas

by

Donald W. Larson

Michael D. Kane

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Introduction

Transporting agricultural products and farm inputs frequently presents problems to U.S. agriculture. A number of grain transportation problems became severe in the early 1970's. They include shortages of transportation equipment, bankruptcies of some railroads and near financial collapse of others, energy shortages, railline abandonment, higher transport costs and increased demand for transportation services. The uncertainty of future rail service due to rail reorganization added to the complexity of the problem in the Northeast and Midwest of the U.S.

The grain transportation problem is an important one. Interruption of transportation services may seriously disrupt the normal operations of grain producers, country elevators, processors, terminal elevators, exporters and feed manufacturers. These disruptions may cause inefficiencies and higher costs for transportation services. Higher transportation costs will result in higher consumer food prices and/or lower producer grain prices. The distribution of these increased costs between consumers and producers depends upon the price elasticities of demand and supply for the products. The more inelastic the demand curve relative to the supply curve the greater the proportion of the higher cost which consumers will pay in the form of higher food prices.

The purpose of this study is to evaluate the impact of railline abandonment on grain marketing and transportation costs in Central and Southwestern Ohio.[1/] This evaluation will include the impact on: a) total costs of transportation, storage and handling of grain, b) grain shipping patterns and transport modes, c) location of individual elevator operations and d) farm storage activities.

*The authors are Associate Professor and former Research Associate respectively, Department of Agricultural Economics and Rural Sociology, Ohio State University.
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The Problem

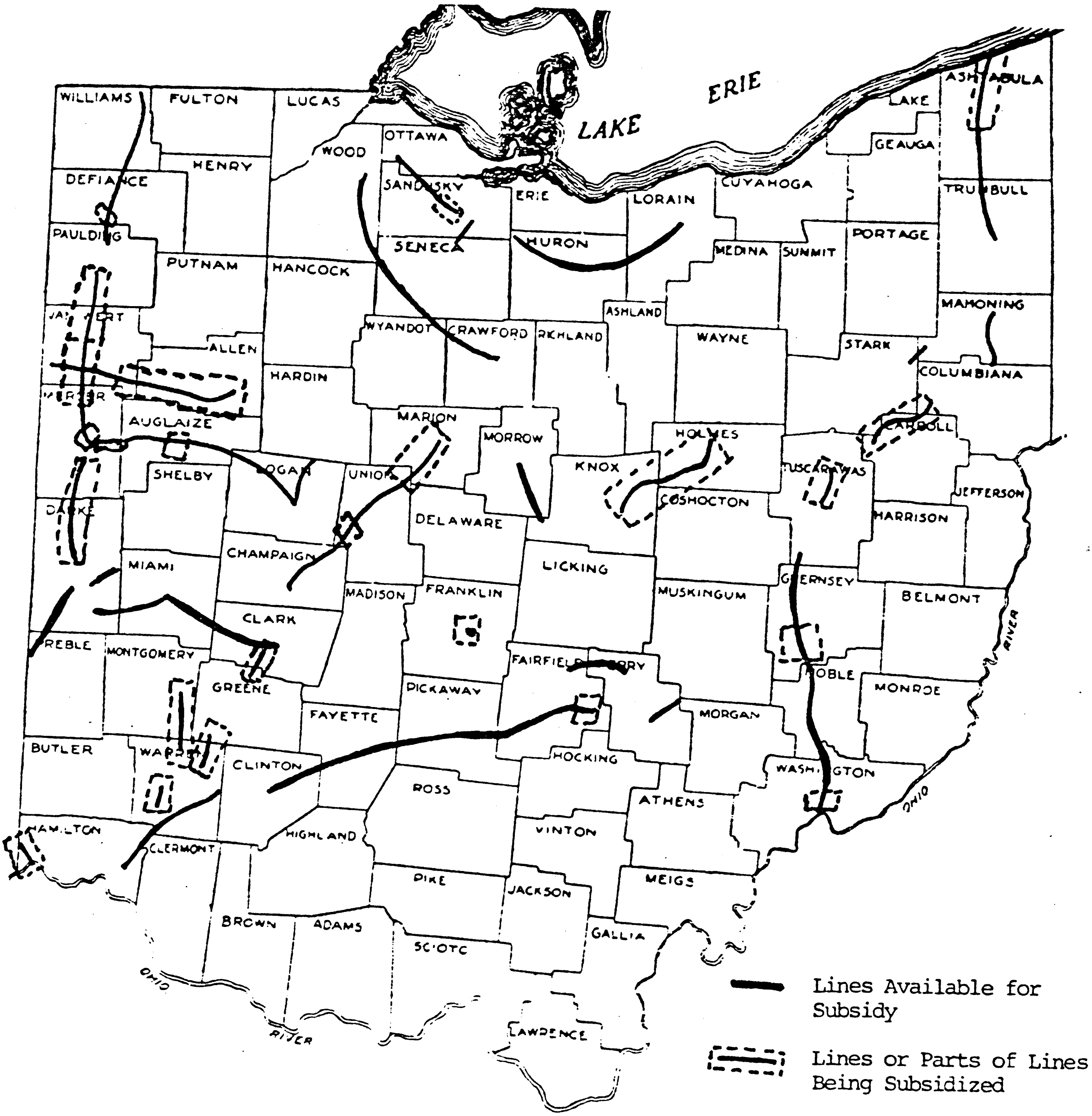
Ohio, an important surplus grain producing state, is one of 17 states in the Northeast and Midwest region in the process of railroad reorganization (Larson). Congress passed the Regional Rail Reorganization Act of 1973 (RRRA) and the Rail Revitalization and Regulatory Reform Act of 1976 (RRRRA) to provide the legal and financial means for rail reorganization. The Final System Plan of the U.S. Railway Association defines the new structure and the legal and financial terms of the reorganization. Consolidated Rail Corporation (Conrail), a profit oriented government owned and operated corporation which began operation April 1, 1976, is a major feature of the reorganization plan. Conrail assumed control over the bankrupt Penn Central and seven other railroads in the region.[2/]

But, Conrail did not assume control of all the operations of the bankrupt lines. The Final System Plan established criteria by which railline segments would be judged as financially viable or "potentially excess".[3/] Using these criteria, approximately 6,000 miles of light density tracks in the Northeast and Midwest were designated as "potentially excess". Light density tracks designated as "potentially excess" were not included in Conrail and would be abandoned unless they are absorbed and subsidized by local and/or state governments with assistance provided by the Federal Government on a matching basis from 100 percent Federal the first year to 70 percent Federal in the fifth year of the branch line subsidy program.[4/]

Ohio has approximately 7,500 miles of railroad track with about 4,200 miles owned by solvent carriers and about 2,100 operated by Conrail. Of the remaining 1,200 miles, primarily light density lines, the Final System Plan designated a total of 885.5 miles available for subsidy. A total of 225.5 miles of these lines are recommended for subsidy under the Ohio Branch Line Plan. A large percentage of the branch lines available for subsidy and those lines currently being subsidized are located in Western Ohio which is the main grain producing area of the state (See figure 1). Elevators located on these lines will have to subsidize the line in order to retain rail service or seek alternative modes of transportation if the branch line is abandoned. The elevators have five years in which to make this adjustment.

Grain is transported from Ohio elevators by three principal methods: truck, rail hopper cars and barge for those elevators located on the Ohio River. Semi-trailers are the usual form of truck transport although a few elevators use three to five hundred bushel farm trucks. Elevators may use rail in one, three, five, ten and 100 car train units depending on the availability and size of rail siding. The export elevators located in Cincinnati utilize barge transport.

Figure 1: Location of Rail Lines Available for Subsidy in Final System Plan and Lines Currently Being Subsidized, Ohio 1976



About 64 percent of all grain was shipped by rail in 1975. Rail service in this region is most important for wheat and least important for soybeans (See table 1). The increased use of unit train shipments from elevators in the region assure that rail shipments will continue to be important in the future. Although data on barge shipments were not reported by the surveyed firms, barge traffic on the Ohio River increased as grain elevators build facilities on the river.[5/]

Table 1: Relative Importance of Elevator Grain Shipments By Mode of Transportation for Central and Southwestern Ohio, 1975

	Percent Shipped By	
Grain	Truck	Rail
Corn	31	69
Soybeans	64	36
Wheat	26	74
Total Grain	36	64

Source: Kane

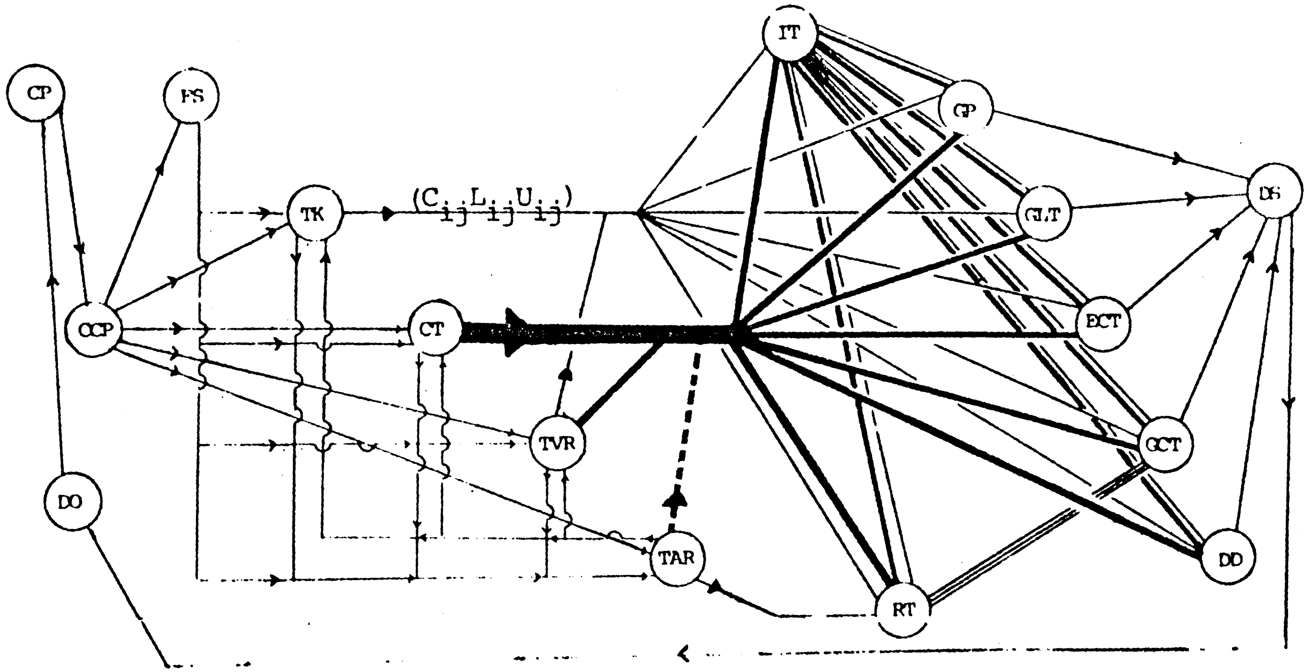
The Model

Many different analytical methods have been used to study grain transportation in recent years. The most popular technique has been some type of a linear programming model which has been used by Ladd and Lifferth, Baumel et.al., Bunker and Tyrchniewicz and Tosterud.

This study uses an alternative method formulating the problem as a constrained network flow consisting of nodes and arcs characterized by finite upper and lower bounds. The Out-of-Kilter Algorithm (OKA) is a method of solving problems of this type (Durbin). The objective is to estimate a set of flows through the arcs that minimize total costs of transportation and handling which satisfies all demands without violating the capacity limitations of the network. The OKA solution yields the flow that minimizes total cost ($\min \sum_i \sum_j C_{ij}X_{ij}$) subject to a circulation principle that what flows into a node must flow out ($\sum_j X_{ji} - \sum_j X_{ij} = 0$) and subject to the lower and upper capacities of the arcs ($X_{ij} \leq U_{ij}$ and $X_{ij} \geq L_{ij}$).[6/]

The network consists of nodes, diagrammed as circles, connected by arcs (See figure 2). Nodes are identified by an alpha-numeric code. Direction of flow on the arc (ij) is illustrated as movement from the initial lower case letter to the following lower case letter; for example, flow from node i to node

Figure 2. The Ohio Grain Rail Abandonment Model



Key

Transport Modes
- Rail
- Barge
- Truck
- Abandonment

Nodes
- DO - Dummy Origin
- CP - County Grain Production
- FS - Farm Storage
- TK - Truck Only Elevator
- CT - Country Terminal
- TVR- Truck Viable Rail
- TAR- Truck Abandon Rail
- CCP- County Corn Production

- IT - Inland Terminal
- RT - River Terminal
- GP - Grain Processor
- GLT- Great Lakes Terminal
- ECT- East Coast Terminal
- GCT- Gulf Coast Terminal
- DD - Domestic Destinations
- DS - Dummy Sink

j is designated by X_{ij}. The unidirectional flow of product on the arc is from i to j. Each arc has a specific capacity for flow. The upper capacity from node i to node j is designated as U_{ij}. The lower capacity is designated L_{ij}. The use of these capacities allows for the construction of networks with controlled flows that may describe minimum demand levels. Arcs have cost characteristics; the cost incurred to move a unit of product from node i to node j is designated by C_{ij}. A dummy origin and a dummy sink are used to assure that total supply equals total demand.

The structure of the cost-flow network for grain is formulated in Figure 2. The Ohio Grain Rail Abandonment Model (OGRAM) is a cost minimizing, multi-modal, multi-period, transhipment model which consists of 1,245 nodes connected by 10,464 arcs. Four submodels function through three time periods to satisfy the demands. The sub-models are: (1) Grain origin model, (2) County grain flow model, (3) Grain transport model, and (4) Grain destination model.

The major activities are farm storage and drying, elevator storage and drying, elevator receiving and load-out and transportation by truck, rail and barge. Rail shipping activities were further sub-divided to represent the single car, multi-car and unit train options which elevators have the option of using in Ohio. Beginning and ending farm and elevator inventories were also included in the model.

Each county (CO) is sub-divided into origins of grain shipments. To analyze the impact of rail abandonment, the methods of transport serve as the basis for classification of the elevators into grain origin nodes. The nodes represent: (1) farm storage (FS), (2) elevators using truck transport only (TK), (3) elevators using truck transport and who ship by rail in unit trains (CT), (4) elevators that utilize truck and rail service but will not suffer rail abandonment (TVR) and (5) elevators that utilize truck and rail service but are on a branch line which may be abandoned (TAR).

The network permits intra-county transfer of grain among origin nodes which would permit firms that lose rail service to transship grain to a nearby elevator. The farm storage node is included to assess the possible changes in on-farm storage due to rail abandonment.

The origin nodes may ship to intermediate nodes labelled inland or river terminals (IT, RT) which then ship to final destinations or shipments can go directly to final destinations. The final destinations for this grain are export terminal elevators on the Great Lakes, East Coast and Gulf Coast (GLT, ECT and GCT), grain processors (GP) and other domestic demand points (DD).

The network has three time periods selected to coincide with grain harvesting and shipping patterns. The first time period, June through August, covers the wheat harvest and marketing period. The second time period, September through December, covers the corn and soybean harvest and the marketing period prior to closing of the Great Lakes for shipping. The final time period, January through May, covers the balance of the marketing year.[7/]

Rail line abandonment is simulated by setting the upper limit on the rail load-out arcs equal to zero for those elevators which are located on rail lines subject to abandonment. This restricts the flow to zero and consequently no rail shipments occur from these elevators.

The Data

To obtain the basic data on grain market structure and flows for crop year 1974/75, interviews with 58 grain elevators in 31 counties of Western and Southwestern Ohio were completed in the Summer of 1976. The study area contained 17 rail lines with a total of 134 miles of track subject to abandonment or available for subsidy. These 17 rail lines varied from 2 to 35 miles in length; 18 elevators were located on these lines.

Grain storage and handling costs were obtained from secondary sources (5). Rail and truck rates were also obtained from published sources. The one, three, five, ten and 60 and 100 car unit train rates were used in the model. Not all rates were used for each elevator. The elevator shipping patterns were analyzed to determine which rate options should be used for a particular elevator type. County farm storage capacity and cost data were estimated from recent studies by Sharp and Baldwin. The transportable surplus of grain was defined as county grain production less feed use. County feed use was estimated from county livestock numbers for each major class of livestock multiplied by grain consumption rates for each class.[8/]

Results

Analysis with the OGRAM network involves a comparison of two optimal solutions: The OGRAM base solution and the OGRAM abandonment solution. The summary results are shown in Table 2. In the OGRAM base solution, aggregate total transfer costs equal slightly more than $71 million. Rail transport costs account for 36 percent of total transfer costs. The interstate grain moves by rail, mainly multi-car and unit trains. Intrastate grain moves almost entirely by truck. More than 297 million bushels of grain are handled in this system.

Table 2 Summary of Yearly Grain Flow and Costs By Activity and Elevator Type, OGRAM, 1975

Activity	Amount (000's Bu) Cost in $	Elevator Type: Truck Only Available	Truck Viable Rail	Truck Abandon Rail	Country Terminal	Inland Terminal	River Terminal	Totals All Elevators
Harvest to Elevator	Amount	35,960	52,958	17,240	31,166	19,071	—	156,395
	Cost							
Farm Storage to Elevator	Amount	11,121	12,535	6,605	16,639	9,949	—	56,849
	Cost							
Farm Drying	Amount							37,548
	Cost							4,355,568
Elevator Grain Receipts	Amount	47,831	65,493	23,845	51,398	24,677	—	213,244
	Cost	1,052,282	1,440,846	524,590	1,027,960	493,540		4,539,218
Elevator Drying	Amount							92,513
	Cost							6,013,345
Elevator Storage	Amount	15,814	69,744	5,664	14,257	31,507	1,953	138,936
	Cost	1,210,505	5,296,120	490,910	780,640	1,272,350	$130,650	9,181,175
Farm Storage	Amount							76,105
	Cost							9,995,340
Truck Load-Outs	Amount	52,030	18,813	4,495	—	—	—	75,338
	Cost	1,456,840	526,764	125,860	—	—	—	2,109,464
Rail Load-Outs	Amount	—	42,299	18,298	50,302	33,791	—	144,690
	Cost	—	1,353,568	587,264	955,738	642,029	—	3,538,599
Intrastate Truck	Amount	52,030	18,813	4,495	—	—	—	75,338
	Cost	4,092,436	1,437,601	404,098	—	—	—	5,934,135
Multi-Car Rail	Amount	—	42,299	18,298	24,215	9,719	—	94,531
	Cost	—	8,227,404	3,543,128	4,494,339	2,134,580	—	18,399,451
Unit Trains	Amount	—	—	—	26,079	24,072	—	50,152
	Cost	—	—	—	3,761,455	3,433,075	—	7,214,530
Total Cost		$7,811,063	$18,282,303	$5,675,850	$11,040,132	$7,975,574	$130,650	$71,280,825

About 240 million is demanded at final destinations and the balance, 57 million bushels, goes to ending inventory. Corn, soybeans and wheat represent 59 percent, 19 percent and 22 percent respectively of this grain flow.

The elevators which will suffer rail line abandonment handle 23.8 million bushels of grain or about 11 percent of all elevator receipts. They ship nearly 80 percent of this grain by rail and the balance of truck. These same elevators store only four percent of all grain stored in elevators. These elevators use single and multi-car rail but do not have the capability to use unit trains.

Unit train shipments from inland and country terminals account for over seven million bushels of grain. This is a substantial amount of grain but is still less than half of the 18 million bushels which moves by single and multi-car rail.

Results from the OGRAM abandonment solution indicate the total transfer costs increase less than one percent ($253,000) with rail line abandonment. This increase in total costs is not sufficient to cover the costs of upgrading and maintaining the 17 branch lines in the study area.

The grain elevators which lose rail service also lose about half of their grain receipts but they are not eliminated from the solution. The elevators losing rail service acquire new intra-state destinations which they service by truck. They ship about 4.3 million more bushels of grain to new intra-state destinations.

Country elevators with viable rail service considerably increase the volume of grain merchandized, especially those with multi-car rail capability. These elevators gain about 15 million bushels of grain due to rail line abandonment. Nearly 100 percent of this increase is from the elevators which lost rail service. The other elevator types neither gain nor lose grain to any signigicant amount from rail line abandonment.

The demand for farm storage facilities increases due to rail line abandonemnt. The elevators losing rail service store less grain; some of this decrease goes into more farm storage.

Conclusions and Implications

Rail line abandonemnt has little impact upon aggragate total costs of grain transfer in the region. However, considerable changes occur in grain flows, storage and transport throughout the region.

Elevators losing rail service show substantially reduced grain receipts and increased transport costs associated with a shift to intra-state trucking. In the short run, these elevators may chose to maintain rail service on the branch line by entering an agreement with other firms to subsidize the rail carrier with the rail service continuation subsidies available from the RRRRA of 1976. In the long run, rail service on the studied lines will likely be discontinued because the cost of upgrading, maintaining and continuing service on these rail lines exceeds the benefit for the local elevators.

The elevators losing rail service may have to add new products and services to diversify their enterprise in the future. Previous research has shown that elevators which lost rail service have remained in business by diversifying the firms.

Country elevators with viable rail service show a substantial increase in grain receipts and domestic rail shipments. Thus, rail abandonment greatly benefits those firms who have multi-car shipping capability.

Rail reorganization does not favor grain movement through unit train facilities. These facilities will ship about the same large amount of grain with or without rail line abandonment.

Rail abandonment will increase the demand for farm storage. More grains will be stored on farms and shipped longer distances to large elevators as a result of rail abandonment. The large elevators with favorable multi-car rail rates will be able to pay higher prices for grain than the elevators which lose rail service.

FOOTNOTES

1/ The grains included in this study are corn, wheat and soybeans.

2/ The other seven railroads are the Lehigh Valley, Lehigh and Hudson River, the Reading, The Central of New Jersey, The Erie Lackawanna, and the Boston and Maine. The Pennsylvania and New York Central railroads were merged in 1968 and went bankrupt in June, 1970.

3/ A financially self-sufficient line is one that: (a) is capable of generating sufficient revenue to cover approximately 90 percent of the costs incurred on the light density line itself as well as the variable costs of moving that branch line generated traffic over other lines to its destination or interchange with another rail carrier; (b) while not currently self-sustaining, can be made viable by reasonable rate adjustment (10 percent or less); or (c) while not currently self-sustaining, will be made so because of identifiable traffic growth in the near future.

4/ Ohio's position in the subsidy program is unique because a provision in the State's Constitution forbids the use of public funds to subsidize private corporations. The shippers will have the responsibility to form a legal entity, sign the agreement with the carriers and provide the matching funds.

5/ The Baldwin and Sharp study indicates that barge shipments on the Ohio River were negligible in 1970 and Ohio did not have any unit train facilities at the time.

6/ Further information on the structure and solution procedure of the algorithm may be obtained from Ford and Fulkerson (4) and Durbin (3).

7/ The network must be duplicated for each additional time period with new arcs connecting the nodes that include storage costs and capacity information.

8/ See Kane for additional information of sample design, data sources and estimation methods.

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