AN ABSTRACT OF THE THESIS OF

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Title: The Impact of the Staggers Rail Act of 1980 on Pacific Northwest Wheat Transportation: A Spatial Equilibrium Analysis

Abstract approved: Michael V. Martin

This study analyzes the impact of the 1980 Staggers Rail Act (SRA) on Pacific Northwest (Oregon, Washington, Idaho and Montana) wheat transportation.

A minimum cost uncapacitated transshipment network flow model is employed to simulate the origination and destination pattern of grain flows before (1977) and after (1985) the SRA. The grain transportation flow for those two years is compared and analyzed as a basis for measuring the impact of rail deregulation. The Transportation Simplex Algorithm is used to find the optimum (minimal cost) wheat transportation flow for the two time periods. Four modes of transportation--truck, barge, rail, and ocean carriers--are used to link a sample of inland grain elevators (source), barge terminals (transshipment), PNW

ports on the Lower Columbia River and Puget Sound (transshipment), and foreign countries (sink).

The empirical results indicate that the SRA has had a significant impact on modal distribution, overall transportation costs, and rate competition. Under the assumption of perfect information and profit maximizing behavior, and considering both single car and multicar rates, two-thirds of the total PNW wheat traffic should have moved by rail in 1985. This represents a significant increase compared to 1977, when this percentage was estimated at only 46.43 percent. This increase in rail modal share has come at the expense of truck-barge shipments. The truck-barge share of wheat transportation declined from 47.53 percent in 1977 to 25.66 percent in 1985. Most of this increase in rail shipment is the result of lower shipping costs offered through multicar rates. If only single car rail rates are considered in 1985, the rail market share is only 25.66 percent; while truck-barge market share is 66.60 percent. The volume of wheat exported through the Lower Columbia River ports and Puget Sound appears not to have been affected by the SRA.

Overall wheat transportation cost decreased significantly over this time interval. In nominal terms, it cost an average of 5.32 percent less in 1985 than in 1977 to transport a metric ton of PNW wheat to the port terminals on the west coast. When adjusted for inflation, average wheat transportation cost decreased around 44 percent.

Sensitivity analysis showed that the wheat transportation market in the PNW has been very competitive since 1977 with some apparent changes in market behavior. First, railroads had a greater ability in 1985 than in 1977, to capture wheat traffic from truck-barge by lowering rates. When rail rates are reduced by one percent, rail traffic increases 7.93 percent in the 1985 model and only 2.40 percent in the 1977 model. Rail rate increases, on the other hand, lead to higher traffic losses in 1977 than in 1985. For an increase of one percent in rail rates, rail traffic decreased 10.21 percent in 1977, and only 4.76 percent in 1985.

The conclusion of this study is that there has been a significant diversion of wheat traffic from truck-barge to rail, during the period of rail deregulation. Overall transportation costs have also decreased, and the railroads ability to capture wheat traffic by reducing rates has been enhanced. It is concluded that the impact of the SRA on PNW wheat transportation is due largely to the introduction of multicar rates by the railroads serving the region.

The implications of these findings are that railroad deregulation has provided many of the benefits expected by this legislation. Shippers are favored by the SRA because they are paying lower transportation costs. Railroads have benefited, to the extent that their market share has increased. Barge companies, however, have been adversely influenced by the SRA because they have lost their modal share of wheat traffic to railroads. Shippers, while benefiting from lower rates, seems now more vulnerable to the potential for future rail rate increases.

The Impact of the Staggers Rail Act of 1980 on Pacific Northwest Wheat Transportation: A Spatial Equilibrium Analysis

by

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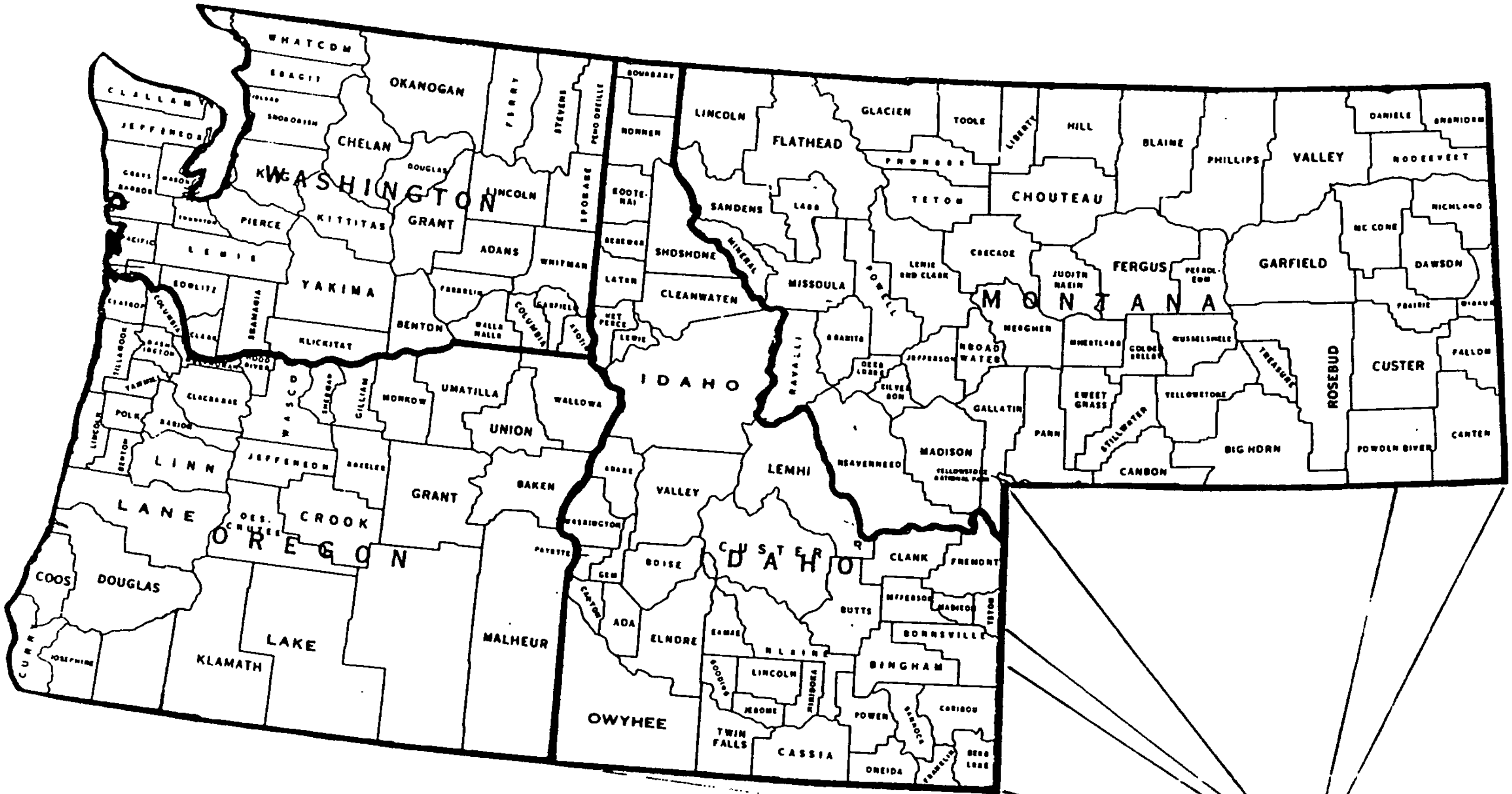
CHAPTER I

INTRODUCTION

The Pacific Northwest (PNW) consisting of the states of Oregon, Washington, Idaho and Montana (see Figure 1), is the area discussed in this project. An annual average of 18 percent of total U.S. wheat production comes from this region, accounting for about 27 percent of the total U.S. wheat exports. A remarkable characteristic of the PNW wheat production is its great dependence on export markets. Over the past 10 years an average of 83 percent of the region's total wheat production has been exported annually.

As Meyer (1984, p. 1) points out, this dependence reflects a response to the expansion of export markets in Pacific Rim countries (Japan, Korea, China, Taiwan, The Philippines, Singapore, Indonesia, etc.) in the last ten years. As a result, large quantities of wheat and feed grains have been exported through PNW ports. This high growth in Asian demand has provided the incentive for the expansion of grain handling and transporting facilities inland as well as at the ports.

The expansion of these transportation facilities has



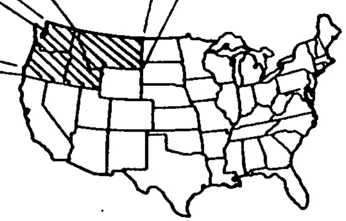


Figure 1. The Pacific Northwest: States, Counties, and Geographical Location.

influenced grain transport rates throughout the PNW since 1975. Grain volume movement by truck-barge increased steadily from 2,199,120 metric tons during the crop year 1974/1975 to 5,926,120 metric tons during the crop year 1980/1981 (see Table 1). The railroads, operating with more freedom after The Staggers Rail Act (SRA) of 1980, responded to this increase by offering shippers multicar rates, and implementing more competitive rate-making policies.

After the SRA, truck-barge has been losing grain traffic to railroads. During the crop year 1985/1986, 37.54 percent of the total wheat received at Lower Columbia River ports went by truck-barge, in contrast with the crop year 1976/1977 when this percentage was 48.94 percent (see Table 1). On the other hand, during the same period the percentage of grain moved by rail increased from 45.46 percent to 57.38 percent.

Several studies conducted in the last five years, support the contention that the Staggers Rail Act of 1980 (SRA) has been the most important factor behind this increase in railroads market share, and indirectly, it has influenced the amount of grain exported through The Lower Columbia River ports and Puget Sound as well.

Although these studies provide a good overview of the effect of the SRA in the PNW grain marketing system, they were made too early (between 1981 and 1983) to measure the full impact of the Act, or do not use a methodology

Table 1. Receipt of Wheat and Barley at Columbia River Ports by Mode of Transportation, 1974-1986 (in thousands of metric tons).

Crop Year	Rail	Barge	Truck	Total
1974/1975	6104.91	2199.12	510.02	8814.05
% of Total	69.26	24.95	5.79	100.00
1975/1976	5704.76	2816.86	617.58	9139.18
% of Total	62.42	30.82	6.76	100.00
1976/1977	3058.80	3285.17	369.23	6713.19
% of Total	45.46	48.94	5.50	100.00
1977/1978	3216.07	3564.68	570.45	7351.20
% of Total	43.75	48.49	7.76	100.00
1978/1979	4613.55	4134.84	526.83	9275.23
% of Total	49.74	44.58	5.68	100.00
1979/1980	5438.93	4612.12	648.39	10699.44
% of Total	50.83	43.11	6.06	100.00
1980/1981	6742.81	5926.12	762.93	13431.86
% of Total	50.20	44.12	5.68	100.00
1981/1982	6192.60	5583.16	726.37	12502.13
% of Total	49.53	44.66	5.81	100.00
1982/1983	5546.68	4635.14	708.99	10890.82
% of Total	50.93	42.56	6.51	100.00
1983/1984	6238.05	4777.47	469.03	11484.55
% of Total	54.32	41.69	4.08	100.00
1984/1985	5894.21	4605.82	547.66	11047.69
% of Total	53.35	41.69	4.96	100.00
1985/1986	4855.55	3176.65	430.52	8462.72
% of Total	57.38	37.54	5.08	100.00

SOURCE: Graton (Grain Transportation Consultants of the Pacific Northwest).

appropriate to quantify this effect (they are simply the analysis of some isolated figures and events). Consequently, the question of how PNW grain transportation flow has been affected by the SRA is still largely unanswered.

The present project intends to answer this question. The project focuses on the intermodal competition between railroads and truck-barge transport. It is also aimed at determining the influence, if any, of the SRA on PNW ports' share of grain exports.

This study uses an uncapacitated transshipment network flow model to simulate the PNW grain marketing flow for a year before the SRA (year 1977) and a year after the SRA (year 1985); and then compares the grain marketing flow for those two years. Based on the changes observed when making this comparison, a conclusion on the effects of the SRA is made. The Transportation Simplex Algorithm is used to find the optimal wheat transportation flow for those years.

This chapter provides a background on PNW grain marketing flow and factors influencing it (especially transportation regulation); it also outlines the problem under consideration in this study, the specific research objectives, and the procedure.

The chapter is structured as follows: the first section describes the PNW grain transportation system. The second section describes the grain transportation flow before deregulation. The third through fifth sections describe different aspects of transportation regulation relevant to the present study, especially the Staggers Rail Act of 1980. The sixth section describes the grain transportation flow after deregulation. The seventh and eigth sections define the general and specific research problem. The nineth section discusses different groups that would find this research useful. The tenth section gives the objectives of the study. The eleventh section explains the procedure. The summary and conclusions of the chapter follow in the last section

The Pacific Northwest Grain Transportation System

To understand the impact of the Staggers Rail Act of 1980 on the PNW grain marketing flow, it is important to know how different components of the transportation system fit together. The transportation system serving agriculture in the area is composed of:

1. The Columbia-Snake River Waterway System extending 465 miles to Lewiston, Idaho, has consisted of eight locks and dam pools since 1975 (see Figure 2 and Table 2). The system has 21 ports with grain storage and barge loading facilities serving inland transportation (see Figure 3 and Table 4). Grain is trucked to these inland port facilities, and sent by barge down river to The Lower Columbia ports, where deeper

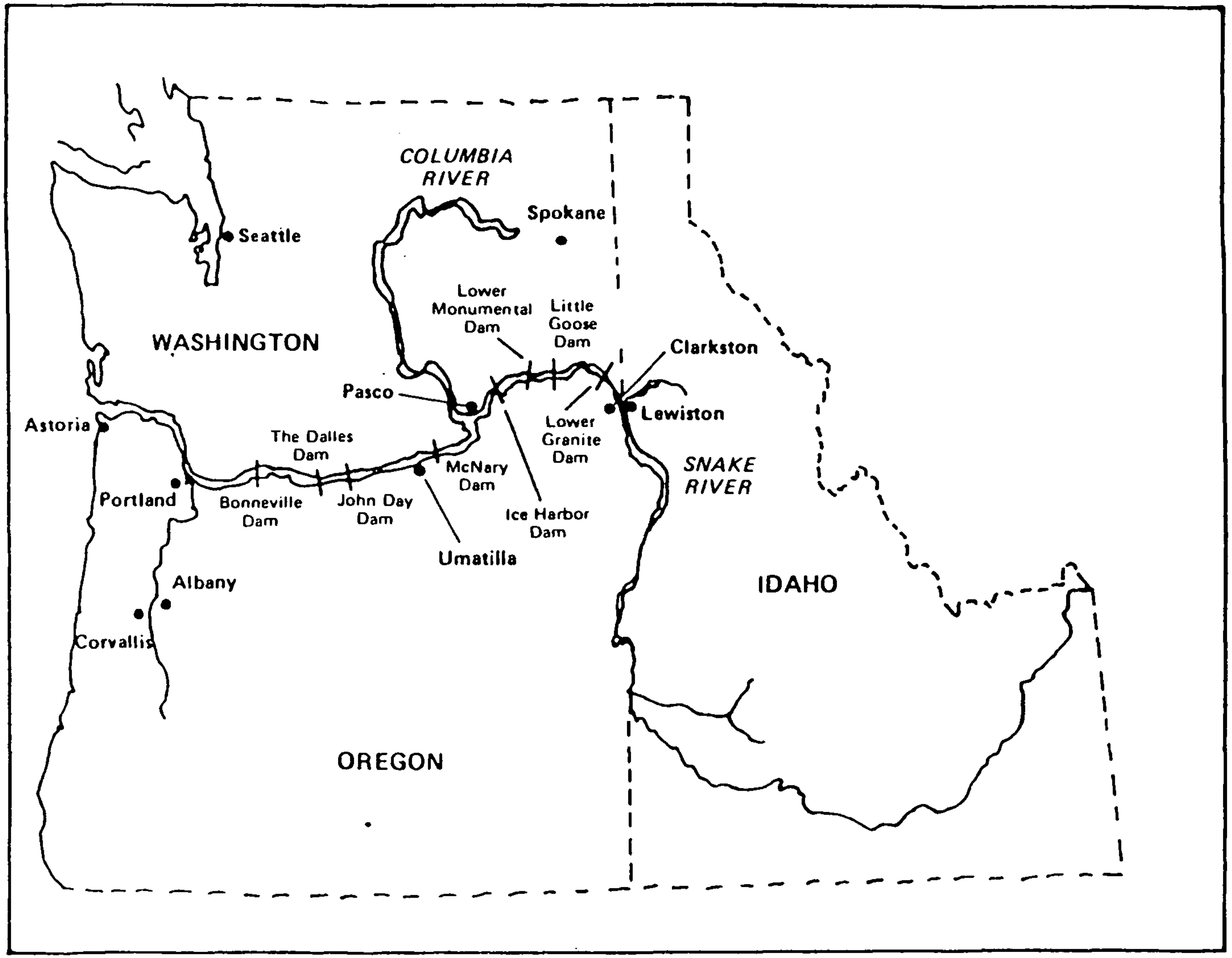


Figure 2. The Columbia/Snake River System.

Table 2. Dams and Locks on the Columbia and Snake Rivers.

	Total Lift (Ft.)	Width (Ft.)	Length (Ft.)	Pool Elev. Above Mean Sea Level (Ft.)
Columbia River				
Bonneville	84	76	500	72
The Dalles	88	85	675	160
John Day	105	86	675	265
McNary	75	86	675	340
Snake River				
Ice Harbor	100	86	675	440
Lower Monumental	100	86	675	540
Little Goose	98	86	675	638
Lower Granite	100	86	675	738

SOURCE: Bunge Corporation.

Table 3. River Barge Loading Facilities.

		Elevator Capacity (Metric Tons)
<u>Columbia River</u>		
The Dalles	Midco Elevator	40,909.05
	Cargill	5,454.54
Biggs	Mid Columbia	47,127.22
Roosevelt	Farmers Whse.	28,009.06
Arlington	Cargill	20,454.52
Port of Morrow	Sunkyong	21,818.16
Hogue Warner	Morrow County GG	44,999.96
Umatilla	Pendleton GG	98,181.72
Port Kelley	Walla Walla GG	90.136.27
Walulla	Walla Walla GG	34,227.24
Kennewick	N.P.G.G.	141,818.04
Pasco	Contingental	13,636.35
<u>Snake River</u>		
Burbank	Cargill	68,181.75
	Connell GG	18,409.07
Sheffler	Walla Walla GG	13,799.99
Windust	Louis Dreyfus	9,272.72
Lyons Ferry	Columbia County GG	76,363.56
Central Ferry	Harvest States	40,363.60
	Columbia Grain	59,999.94
Port of Garfield	Pomeroy GG	62,727.21
Almota	Almota Elevator Co.	57,272.67
	S & R Grain	9,272.72
Wilma	Stegner Grain	114,545.34
Clarkston	United Grain	15,272.71
<u>Clearwater River</u>		
Lewiston	Lewiston Grain Term.	136,363.50
	Continental Grain	19,090.89

SOURCE: Bunge Corporation.

Table 4. Pacific Northwest Grain Export Terminals.

		Elevator Capacity (Metric Tons)
Seattle	Cargill	114,545.34
Tacoma	United Grain	122,727.15
	Contingental Grain	81,818.10
Astoria	Vacant Since 4/78	27,272.70
Longview	Contingental Grain	136,363.50
Kalama	North Pacific GG	174,545.28
	Peavey	54,545.40
Vancouver	United Grain	136,363.50
Portland	Columbia Grain	117,272.61
	Cargill	199,090.71
	Bunge	40,909.05
	Louis Dreyfus	51,818.13

SOURCE: Bunge Corporation.

draft allows grain to be transferred to ocean going vessels for export.

2. A network of highways and railroads includes three railroads serving agriculture in the area. They are the Burlington Northern Company (BN), The Union Pacific (UP), and The Southern Pacific Company (SP). The BN and UP are shown in Figure 4. The four main highways serving agriculture in the PNW are I-5, I-84, I-90, and I-94 (see Figure 4).

3. PNW port areas include The Lower Columbia River (Portland, Kalama, Vancouver, and Longview) and Puget Sound (Seattle and Tacoma). The location of these ports, and their corresponding export terminal capacity are shown in Figure 3, and Table 4.

4. The PNW grain transportation modes include truck, rail, and truck-barge (truck-barge is considered here as a single mode, because the barge alternative faced by shippers involves trucking wheat to the Columbia/Snake River System for shipment).

5. Grain storage facilities include country elevators, on-farm storage, subterminal and terminal elevators.

Grain Marketing Flow in the PNW Before the Staggers Rail Act of 1980

Before the SRA, the freight market share had the fol-

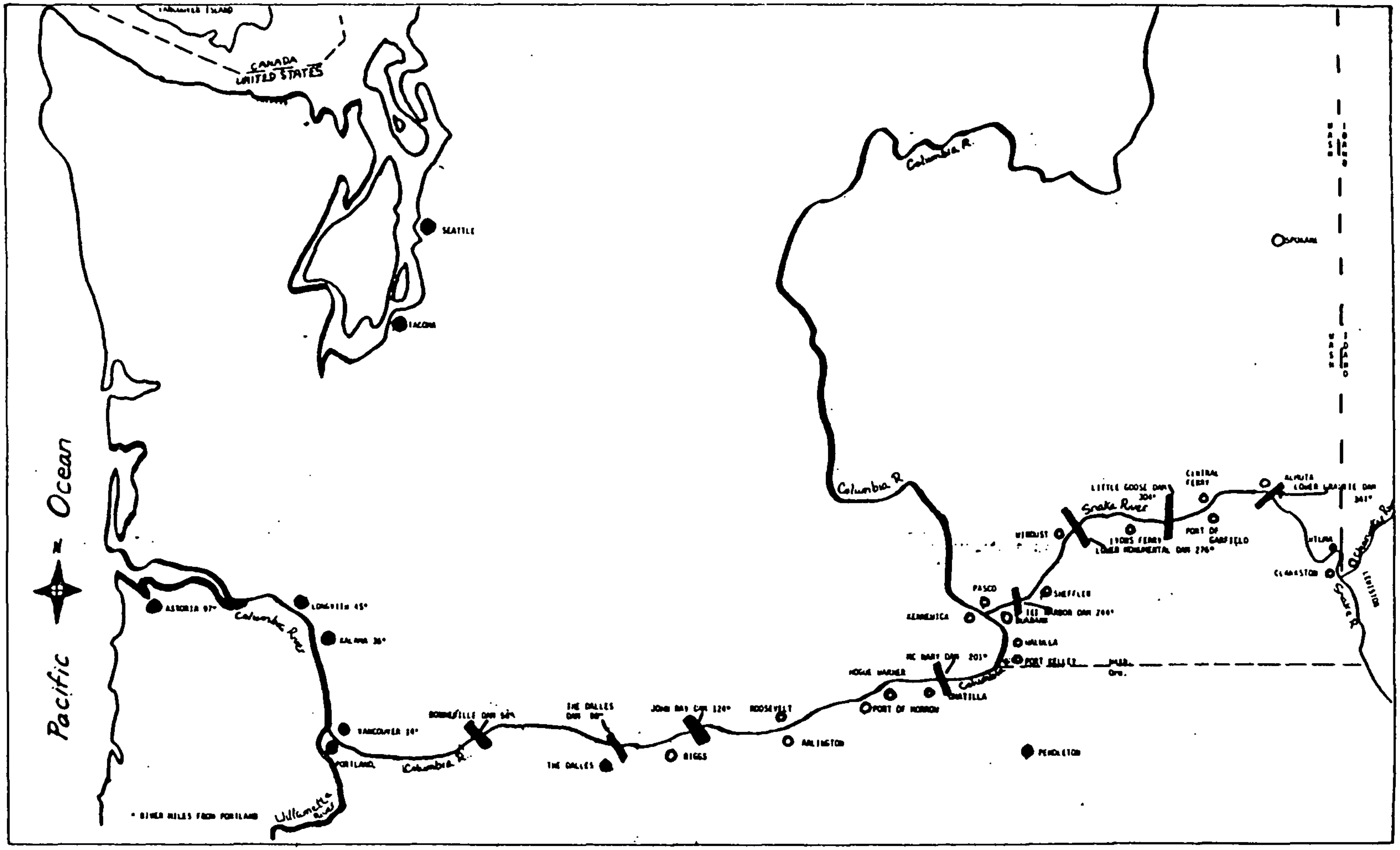


Figure 3. Pacific Northwest Grain Export Terminals and the Columbia/Snake River System (with the Location of Locks, Dams, and River Barge Loading Facilities).

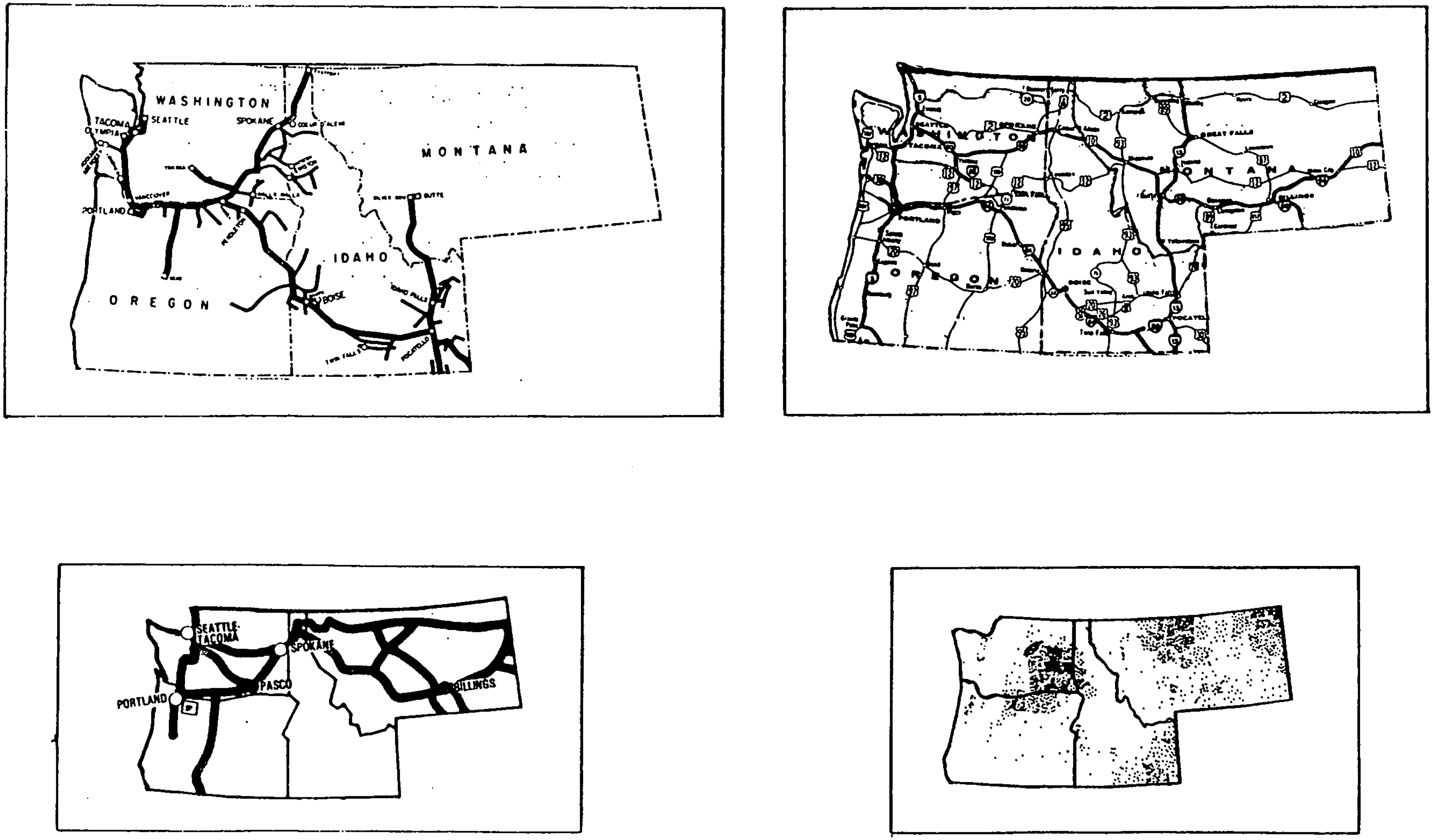


Figure 4. Location of Pacific Northwest Highways, Railroads, and Wheat Production.

lowing characteristics:

- The railroads' market share was consistently decreasing. This situation occurred mostly after the completion of the Columbia/Snake River system. Table 1 shows that the railroads market share decreased from 69.26 percent in the crop year 1974/1975, to 43.75 percent in crop year 1977/1978 although there were some significant recoveries by the end of the 1970s. On the other hand, the truck-barge market share increased from 24.95 percent to 48.94 percent during the same period.

The causes of the decrease in the railroads' grain market share were: (a) Public investment in highways and inland waterways, especially the completion of the Columbia/Snake River System in 1975; and (b) Government regulation in that unregulated barge and truck competition gave truck-barge an advantage over regulated railroads in grain traffic.

Regulation in the Transportation System

The key to this analysis is government economic regulations, which are restrictions placed upon carriers' abilities to affect transportation rates, routes and frequency of services, as well as the freedom to enter or to exit the transportation industry.

Among the transportation modes serving agriculture in the U.S., railroads were the first to be subject to economic regulation. The main reason for railroad regulation was the great importance of railroads and their tendency toward monopoly and thus economic malpractices. By the 1850s the railroad industry had developed to the point that railroads were essentially the only carrier of goods, regardless of distance traveled. Therefore, they faced very little competition from other modes of transportation.

Between 1830 and about 1870 there was a strong mutual friendship between the people and the railroads (Milner, 1970). People wanted rail service and they provided capital to help build lines. As railroads grew, industry grew, but so did abuses. By the 1870s, animosities were arising over conflicts of interest; railroads emphasized profits, and shippers wanted low cost transportation. Railroads were accused of several economic malpractices which Harper (1982, pp. 457-459) enumerates as follows:

- The charging of unjust high prices. Since railroads had monopoly positions in many markets, the management was free to charge whatever price it wished (monopoly pricing).

- Geographic Price Discrimination. Railroads charged lower prices and paid more attention to service where intermodal and intra-modal competition existed.

- Fluctuating prices. Rates fluctuated so much in some cases that it was difficult for the user to plan for transportation costs in advance. When two or more railroads competed for the same traffic, competition led to rate wars.

Malpractice and other problems associated with railroads caused organizations, individuals representing shippers groups, and the general public to urge Congress to act. As a result, Congress passed the Interstate Commerce Act of 1887, and created the Interstate Commerce Commission (ICC) to rule upon it, and oversee railroads ratemaking and operation.

The transportation environment has changed since 1887 when Congress passed the Interstate Commerce Act. With the emergence of trucks. barges, pipelines and air transportation as new transportation modes, the transportation industry became a competitive one. Railroads were facing competition from these alternative modes, especially from trucks and barges. In this competitive environment, regulation of railroads and other competing modes (trucks, barges and airlines were also regulated by the U.S. Government, but for different reasons than railroads) were found to produce social costs and were also blamed for the deteriorating financial situation of several railroads. (This topic is explained more extensively in the third section of Chapter II.)

Since the mid-1970s, there has been a tendency to reduce regulation in the U.S. transportation industry; especially railroads regulation. The philosophy now is to relax transportation regulation as much as possible and to allow competition between and within modes.

A number of bills were introduced in Congress to relax transportation regulation; especially the Railroad Revitalization and Regulatory Reform Act of 1976 (4R Act of 1976), and The Staggers Rail Act of 1980. These Acts relaxed many regulatory restrictions on railroads. The Motor Carrier Act of 1980 initiated regulatory reform in the trucking industry; and the Airline Act of 1980 deregulated airlines.

The Staggers Rail Act of 1980

This Act was the most dramatic change in federal policy toward railroads since the Interstate Commerce Act of 1887. The Act assumed that less regulation and more reliance on the marketplace would help assure a better rail system and its more efficient use, which should result in saved energy and reduced inflation.

The most important provisions of the Staggers Rail Act of 1980 influencing PNW grain marketing flow are: (a) the allowing of more rate-making freedom and (b) the legalization of rail contract with shippers.

The Act allows more rate-making freedom by amending the 4R Act to state that, except where a railroad had "market dominance" it would be free to set rates as it choses. A carrier has market dominance if the ratio of revenue to variable costs for a given commodity is above a specific value (160 percent in 1980, to rise to between 170 percent and 180 percent by 1985, by increments of five percent points a year). The Act also sets a rate floor (variable costs) and allows a zone of rate flexibility around an existing "base" rate for those carriers not deemed to be earning an adequate return.

Contract rates are specifically legalized in the Act. All contracts must be filed with the ICC. Grounds for shippers' complaints against a contract are severely restricted. Once approved, the ICC cannot require a carrier to violate the contract. Contract enforcement is restricted to the court.

In conclusion, the Staggers Rail Act of 1980 (SRA) encouraged contract rates, and gave railroads more freedom to set rates.

Deregulation of Other Competing Modes

Interstate truck and barge transportation of grain within the PNW has always been virtually exempt from ICC economic regulation. Therefore, the major impact of transport deregulation on grain movement in the region can be attributed to railroad deregulation; specifically the SRA.

Grain Marketing Flow in the PNW After the Staggers Rail Act of 1980

Since the passing of the SRA, truck-barge has been losing grain freight market share to railroads. Table 1 shows that the rail market share rose from 50.20 percent in the crop year 1980/1981 to 57.38 percent in the crop year 1985/1986; while during the same period, the truck barge market share dropped from 44.12 percent to 37.54 percent.

This increase in railroads market share must have been the result of the offering of multicar rates, multiple origin-multicar rates and contract rates by railroad companies; which all represents significant rate reductions in relation to the traditional single car rates.

According to Cornelius (1983, p. 2) these rate reductions have caused competition between truck-barge and railroads to be more active for grain shippers 50 to 100 miles inland from the Columbia/Snake River System.

There is the concern among small shippers that rail contracts tend to favor large volume shippers, because larger shippers can guarantee larger volume in return for favorable rates and service. In addition, small and medium-size shippers complain they are at disadvantage vis-a-vis large-size shippers in negotiating contract rates because information about transportation costs is not fully available. Another concern regarding contract rates relates to grain shipments where the receiver pays the freight charges, and later, invoices the shipper for freight costs. There have been cases in which shippers complain that receivers engage in rail contracts, but charge them tariff transportation costs. Contract rates are on the average 10 percent to 25 percent lower than tariff rates (Cecil Brennam of "GRATRON", interview of July 18, 1986). This means the saving, associated with rail contracts, is passed to receivers.

Another impact of transportation rate changes was upon the grain holding system in the PNW (Cornelius, 1983, p. 2). Favorable rates available to large volume shippers have encouraged the construction of larger grain shipping facilities, such as subterminal elevators with multicar loading facilities. This is a significant change from the previous "country elevator" concept which characterized shipments from interior elevators over the past 100 years.

The Problem

Because of deregulation (henceforth I will refer to the relaxation of railroads regulation as deregulation), railroads now have more ability to compete with other modes of transportation in the PNW; especially the truck-barge combination.

This new ability to compete may have caused railroads increase of grain freight market share at the expense of truck-barge market share and could have the following consequences:

1. A decrease in the use of the Columbia/Snake River System as the main method of grain transportation in the PNW, and consequently, a decrease in the amount of grain exported via lower Columbia River (C.R.) ports.

2. An increase in the use of railroads, which could have diverted some of C.R. export grain to the Puget Sound (P.S.). Grain export shipments by rail are available to either C.R. ports or P.S.; while barge shipments are only available to C.R. ports. Increases in railroad grain export shipments to P.S. account for a great deal of the increase in railroad grain export shipments to PNW ports. Table 5 shows that P.S. share of export wheat registered a continuing decrease until crop year 1980/1981, when it was at its lowest level (.44 percent). After the SRA, however, the percentage of grain exported through Puget Sound has been increasing; although during the crop year 1985/86 P.S. still only accounted for 3.08 percent of shipments.

A diversion of grain export flow to P.S. could cause excess capacity on lower Columbia River port facilities;

Table 5. Pacific Northwest Wheat Exports by Port Area, 1972-1986 (in thousands of metric tons).

Crop Year	Columbia River	Port Share %	Puget Sound	Port Share %	Total
1972/73	5763.63	75.29	1891.32	24.71	7654.94
1973/74	6223.11	76.57	1903.89	23.43	8127.00
1974/75	6691.73	83.39	1333.24	16.61	8024.97
1975/76	6440.86	72.75	2412.14	27.25	8853.00
1976/77	6072.06	79.46	1569.55	20.54	7641.61
1977/78	6605.10	85.62	1109.50	14.38	7714.60
1978/79	8626.34	91.19	833.78	8.81	9460.12
1979/80	9741.04	96.22	382.84	3.78	10123.88
1980/81	11681.54	99.56	51.76	.44	11733.30
1981/82	10801.20	95.62	494.94	4.38	11296.14
1982/83	10157.38	89.46	1196.94	10.54	11354.32
1983/84	9845.60	93.54	679.49	6.46	10525.09
1984/85	8970.32	92.24	754.69	7.76	9725.01
1985/86	7456.08	96.92	236.83	3.08	7692.91

SOURCE: Grain Market News. (U.S.D.A.). Several issues.

while P.S. might not be able to handle an unexpected increase in the amount of export grain. There is no evidence that this is the case; U.S.D.A data for the last two years shows that on the average, both C.R. and P.S. has been using only 50 percent of their export elevator capacity due to the actual low demand for export grain. But this scenario could become a reality if there were an increase in the demand for export grain.

Other consequences of changes in modal share induced by deregulation could be:

1. Impact on port development. The planning and construction of new port installations are based on projections of the grain flow via Columbia/Snake River System, which may or may not increase in the future.

2. Impact on the future of the Columbia/Snake River System. Profits would decrease if facilities were not used at optimal capacity.

Railroad deregulation may have been the most important variable influencing grain transportation modal share in the PNW. Although there is evidence that intermodal competition has increased, and barge volume on the Columbia/Snake system has been declining since 1982 (see Table 1 for evidence); the impact of railroad deregulation is still not clear (for example, the decline in barge volume could have been due to the decline in grain export those years).

Components of the PNW grain transportation system are undoubtedly affected by these changes in modal share, and further adjustment to the current circumstances will continue to occur.

The potential impacts of deregulation justify research on how deregulation has affected the economics of grain transportation in the PNW.

The Specific Problem

Specifically the problem deals with the need for information regarding the effect of the Staggers Rail Act of 1980 on the wheat marketing flow from farms to PNW ports. With this information, the different components of the PNW grain marketing system may be able to adapt appropriate to the effects of deregulation.

This study is centered on the competition between railroads and truck/barge and is limited to four states: Oregon, Washington, Montana and Idaho.

Of special interest here is the impact of the SRA on the market share of those two modes (rail and truck/barge); and its indirect impact on port share. More specifically, this research is focused on answering the following questions: "Is the Staggers Rail Act responsible for the changes in modal share and port share, experienced by the PNW in the last five years?; and if that is the case, to what extent?.

Groups Who Would Find This Research Useful

Grain elevator owners: this research provides relevant information about changes in the system so that they can adjust if necessary.

Planners and policy makers: this study could influence development of ports in the PNW.

Interstate Commerce Commission (ICC): this study provides information about how the transportation system in the PNW is adapting to deregulation; and hence could influence future decisions in this area.

Grain producers: this research provides information regarding shipping pattern flows for their export grain to PNW ports.

Truck, barge, and railroads companies: the information provided by this research influences these companies decisions and strategies in the future.

The Study Objectives

The main objective of the present study is to provide different groups, individuals and organizations involved in the handling and transportation of grain in the PNW, with information regarding what has been the impact of the

Staggers Rail Act of 1980 on the PNW grain marketing flow from the different supply areas to the coast. Specifically, the objective is to construct a wheat transportation model for the PNW before and after the SRA, and through the comparison of these two models to:

1. Measure the effect of the Staggers Rail Act of 1980 on grain transportation modal share in the PNW.

2. Measure the effect of the SRA on the wheat transportation cost from farm to PNW ports.

3. Determine the impact of the SRA on the amount of wheat received by different PNW port area.

4. Measure the effect of the SRA on the sensitivity of rail demand to changes in rail rates.

The Procedure

According to informed observers, deregulation, especially rate deregulation would increase intermodal competition and hence lead to a more efficient allocation of traffic between competing modes. Since commodities will be carried more cheaply by the more efficient carriers (those with lower costs); overall transportation rates will decrease, and modal share will increase for the more efficient carriers. Consequently, we may speculate that deregulation will increase modal competition, influence modal transportation share, and cause rates to decline in the PNW. In addition, the volume of grain exported through the Lower Columbia River ports and Puget Sound could be affected as well (as previously explained).

From these likely impacts of deregulation, we can conclude that in order to measure the effect of the SRA on the PNW grain transportation system we must find out how modal share, modal competition, port share, and overall transportation rates have been affected by the Act.

Accordingly, the present study formulates the following hypothesis:

HYPOTHESIS A. "The Staggers Rail Act of 1980 is not the factor responsible for the increase in the railroads grain transportation modal share at the expense of the truck-barge share".

HYPOTHESIS B. "The Staggers Rail Act of 1980 did not caused a diversion of the flow of export grain from CR ports to PS".

In order to test these hypotheses a transshipment model is used to simulate PNW wheat transportation flow (a detailed description of this model is given in Chapter III). Through this model the grain transportation flow for a year before and a year after the passing of the SRA are determined and compared.

Years 1977 and 1985 are the ones chosen. Nineteen seventy-seven is chosen because information is available for that year. Also, 1977 is a representative year of the time period 1975-1980 (which is the time period between the completion of the Columbia/Snake River System and the passing of the SRA). Choosing this year, allows for more complete system adjustments to the influence of the 4R Act of 1976, and the improvement in the waterway system. The uncapacitated transshipment model for year 1977 is denominated Model A.1.

The year 1985 has the advantage that it is the most recent year during which, we can study the impact of the SRA, and hence eliminate to a great extent the bias from less than full adjustment to the effects of the SRA.

For each of the two years the model determines the following variables:

1. Grain transportation modal share for rail and truck-barge.

2. Port area share.

3. Average per unit cost of transporting a metric ton of wheat to PNW ports from interior elevators.

"Most experts agree that the SRA encouraged the introduction of multiple rail cars in the PNW in the year 1981. Therefore, multiple car rates should be considered as a consequences of the SRA, rather than an independent factor affecting PNW wheat transportation. Multiple rail cars are in a real sense a technological innovation. They represent a significant saving cost compared to the traditional single car. In order to make sure that for year 1985 the effect measured is not simply that of multiple car rates, two separate models are constructed for that year. These models are called Model B.1 and Model B.2. Model B.1 contains both single and multiple car rates, and represents the actual conditions in the area. Model B.2 uses only single car rates, and represents how the wheat marketing flow would be in 1985 without the introduction of multiple car rates.

Hypothesis "A" is rejected if the 1985 models find:

1. An increase in railroad market share in relation to 1977. Accordingly, the percentage of wheat that goes by rail and truck-barge is compared for the two years under consideration.

2. An overall decrease in grain transportation rates in 1985 in relation to 1977. This is found by comparing the average cost of transporting a metric ton of wheat from supply areas to PNW ports for both years. The average per unit cost is calculated by dividing the total cost of transportation (cost of transporting the whole PNW export wheat production to ports) by the total PNW wheat export production.

3. An increase in competitiveness in the wheat transpor-

tation market. This is found by a sensitivity analysis made for years 1977 and 1985, and comparing elasticities.

Hypothesis "B" is accepted if Model B.1 finds a significant increase in Puget Sound's port share and a significant decrease in the lower CR port share.

Finally, it is important to note that contract rates are not explicitly included in the models. As mentioned before, rail contracts were legalized by the SRA. Since rail contracts are confidential agreements between shippers and carriers, information about the rates that apply for these contracts and the amount of wheat that moves under these agreements is not available. Given this limitation, the variable contract rate is not included in the grain transportation models used in this study. However, considerations are made about to which extent contract rates could be influencing PNW grain marketing flow, when analyzing the final results.

Chapter Summary and Conclusions

This project is aimed at determining the impact of the Staggers Rail Act of 1980 on the wheat marketing flow to ports of the PNW.

Since the most important provisions of the SRA are the allowing of more ratemaking freedom for railroads and the legalization of contract rates; intermodal competition (specifically competition between truck-barge and railroads) is treated as the most important aspect affected by the Act in the region. It is also found that the percentage of wheat exported through the two port area of the region (Lower Columbia River and Puget Sound) could have been affected by the act as well.

Given this judgment, it is a conclusion of this Chapter that the effect of the SRA on PNW grain marketing flow, should be measured by determining how modal share, port share, rail demand sensitivity, and overall transportation rates have been affected by the Act.

To accomplish this objective, the study uses three network models (Models A.1, B.1 and B.2) to determine and compare the PNW grain flow before and after the passing of the Staggers Rail Act of 1980. A representative year before and after the SRA is chosen, and the following variables are calculated and compared for both of them: truck-barge and railroad modal share, port share, average cost of transporting a metric ton of wheat from supply areas to ports, and rate sensitivity of the demand for rail. The transportation simplex algorithm is used to find the optimal wheat transportation flow for these models.

The next chapter provides a literature review and the theoretical and historical background that support the conclusions of the present chapter.

CHAPTER II

THE BACKGROUND AND THE THEORY

This study of the impact of the Staggers Rail Act of 1980 (SRA) on PNW grain transportation is based on economic theory which enables us to explain and analyze the behavior of the grain transportation market under regulatory constraints.

A very important step in gaining insight is to understand the economic principles involved and the different economic models developed to explain the structure and behavior of the transportation market (forces governing supply and demand). Using these principles, economic models may be used to explain and predict the effect of a specific factor or variable (government economic regulation in this case) on the transportation market.

That is why this chapter gives a brief explanation of the theoretical framework of the present study. This chapter begins by showing the different elements influencing the transportation market through the study of demand and supply of transportation service. This analysis is made in the first two sections by using a spatial price equilibrium model. Differences in transportation costs between modes is also discussed in the second section. The second and final step is to develop, in the third section, a brief discussion about transportation regulation and its effects on the U.S. transportation industry.

Spatial Price Equilibrium and the Demand for Transportation Service

Grain transportation is a service, not a commodity; thus, the demand for wheat transportation may be said to be derived from the demand for wheat in its final markets (which is a primary, rather than derived, demand).

The demand for PNW wheat transportation can be determined by analyzing spatial price relationships, which are determined largely by transfer costs between regions provided competitive conditions prevail. Transfer costs, which include loading or handling as well as transportation charges, are high in relation to the farm value of agricultural commodities. Hence, farm prices differ depending on whether the production area is near or far from the principal market areas.

The principles which underline price differences between regions (assuming a competitive market structure including homogeneous commodities, perfect knowledge, and no barriers inhibiting trade) can be summarized as follows (Tomek and Robinson, 1981, p. 150):

1. Price differences between any two regions (or markets) that engage in trade with each other will be greater than or equal to transfer costs.

2. Price differences between any two regions (or markets) that do not engage in trade with each other

will be less than or equal to transfer costs.

Price differences between regions can not exceed transfer costs because any time the price is greater than transfer cost, traders will seek profits by arbitrating wheat from one region to the other. Arbitrage will continue until it is no longer profitable to ship commodities between markets; that is, until the price difference between them no longer exceeds transfer costs.

For some agricultural commodities, forces of demand and supply are brought together in central markets. In this case, the precise structure of prices are easily determined, since the farm price in each surplus area will differ by the cost of transporting the commodity to the central market.Observed price differences between regions within the U.S. for wheat are consistent with this pattern.

While the general structure of prices in the absence of trade barriers, such as tariffs, conforms to what would be expected based on transfer costs, there are important exceptions. Differences may exceed transfer costs, even for extended periods because of:

1. Incomplete or inaccurate information

2. Preference on the part of the buyers for produce grown in a particular area

3. An institutional or legal barrier to the movement of the commodity between regions

4. Temporary factors, such as a shortage of railroad cars, elevator space, or barge transportation also can lead to price differences between regions that at times exceed transfer costs (Tomek and Robinson).

Geographical price relationships, analyzed by using spatial price equilibrium models, can be used to determine the demand for transportation service. Through spatial price equilibrium models, the optimum or least cost trading pattern is determined given supply and demand functions within a region. Such functions are shown for a potential wheat surplus region (The Pacific Northwest), and a potential wheat deficit region (Pacific Rim Countries) in the left and right side of Figure 5. In the absence of trade, demand and supply would equate at a price P_1 in the Pacific Northwest (PNW) and P_2 in Pacific Rim Countries (PRC). At a price above P_1 in the PNW, some amount of wheat would become available for shipment to another area. Imports would be required to satisfy demands in PRC if the price were below P_2.

From these diagrams we construct excess supply and demand curves as shown in the upper-middle part of Figure 5 (details on the construction of these curves can be found in Tomek and Robinson, and Bressler and King). If no transfer costs exist between these regions, a total of

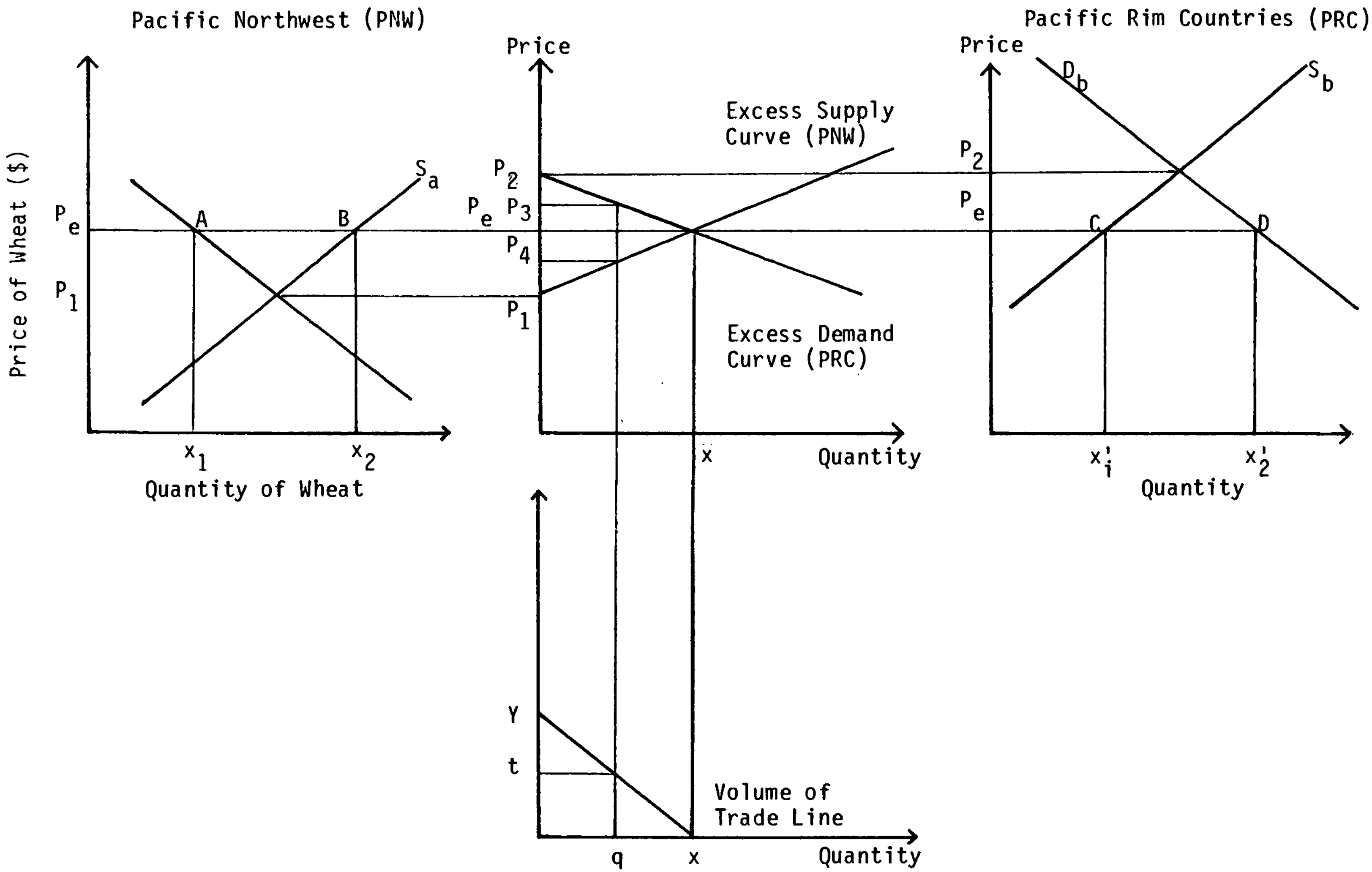


Figure 5. Two Region Spatial Equilibrum Models for Pacific Northwest Wheat.

X units of wheat would be shipped from the PNW to PRC (AB = CD = $X = X_2 - X_1 = X_2' - X_1'$) when they engage in trade. The price in both regions would then be the same (P_e), because of arbitrage.

The volume traded between these two regions declines with the introduction of transfer costs. No trade would occur if it costs more than Y (where $Y = P_2 - P_1$) to transfer a unit of wheat from the PNW to PRC. In that case, demand and supply would be equated within each region and the price difference (Y), would be less than transfer costs.

The "volume of trade" line, showed in the lower part of Figure 5 as the diagonal YX, illustrates the effects of changes on transfer costs on the amount of wheat shipped between these two regions. No trade would occur if transfer costs equal to or exceed Y and the amount of wheat traded will be maximum (X) when transfer costs equal zero. At a given transfer cost (t), the total amount of wheat that would be exported from the PNW to PRC would be "q" (see lower part of Figure 5). The effect of introducing a transfer cost (t) is to reduce the price from P_2 to P_3 in PRC and to raise the price from P_1 to P_4 in the PNW.

The "volume of trade line," represented in Figure 5 by the diagonal YX, also represents the demand for wheat transportation service. This line shows the quantity of wheat that would be traded at a given transportation cost, and hence the amount of wheat that would demand transportation at a given transportation cost.

From the previous analysis we can conclude that the demand for wheat transportation service will depend on (1) the regional demand and supply curves of wheat, and (2) the cost of wheat transportation.

Modal Cost Characteristics and the Supply of Wheat Transportation

The price of transportation, given as "t" in Figure 5 in the first section, is determined by the intersection of the demand and supply curve of wheat transportation service.

As the traditional supply function, the supply function of a transportation firm shows the quantity of transportation service that will be offered to the market at different prices and mirrors the cost of generating various quantities of the service. The market supply of transportation is then derived from the horizontal summation of all the firms in the industry.

If we group transportation firms by mode of transportation, the supply of transportation would be equal to the horizontal summation of the supply of the different modes of transportation. In the PNW we would say that the supply of wheat transportation is the horizontal summation of the supply of truck, truck-barge, and rail transportation.

Within modes, the supply curve of a transportation firm is derived from its cost curves, and is identical to the portion of its marginal cost curve above the average variable cost curve. The marginal cost curve represents the slope of the total cost curve of the firm at different levels of output; while the average variable cost and average total cost curves represent the value of variable cost and total cost respectively divided by the corresponding level of output.

Assuming perfect competition, a given transportation firm is then likely to be at optimum rate of operation at the level of output at which unit costs are minimized. At such a point, marginal cost equals total average cost.

Firms within a particular transportation mode, have special cost curve characteristics that make them different from firms within other transportation modes. As in all industry, the supply curve of the individual firms are not identical to each other. Nor are they identical within the same transportation mode. Supply curves differ because of factors such as plant size, technology, entrepeneurship, etc. Cost curves within transportation modes have particular characteristics that differentiate them from cost curves within other modes. Rail and barge transportation are generally lower cost than truck transportation on longer hauls. Figure 6 shows this cost relationship for truck and rail. Cost curves of trucks reflect a low intercept value because of low fixed costs and low terminal costs but a relatively steep increase in

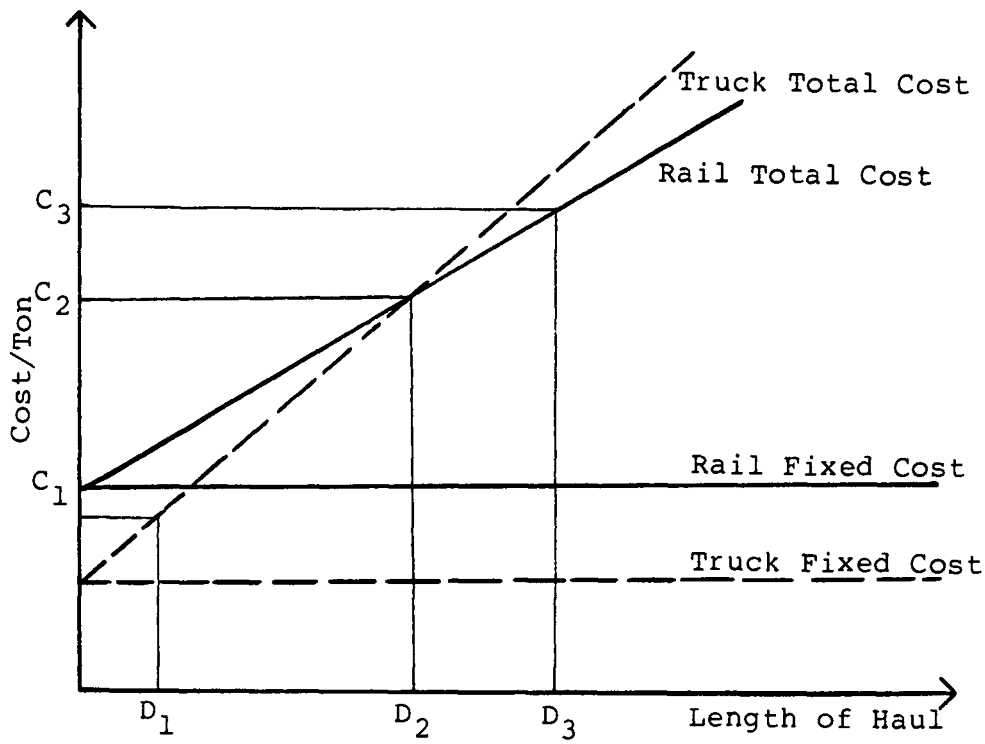


Figure 6. Cost-Distance Relationships for Grain Transportation by Rail and Truck.

costs as length of haul increases. On the other hand, railroads present a higher intercept cost and a lower cost progression as length of haul increases. This relationship suggest a cost minimizing use of truck on short hauls (D_1) and railroads or barges on longer hauls (D_3). The length of the haul associated with (D_2) varies significantly depending upon specific traffic conditions. For large trucks the intersection point (D_2) frequently occurs between 250 and 300 miles (Cramer and Heid, 1983).

Barges have a cost pattern over differing lengths of haul that is similar to railroads. Although line-haul cost are lower, in many cases, port (terminal) costs are higher than for rail.

The availability of a waterway along a specific route of a highway suggests the possibility of the combination of the particular economic advantage of trucks and barges. A farm or grain elevator with access to a waterway system through a highway may be most economically served by a truck that delivers the grain, not directly to the market, but to a river terminal, where the grain is then sent to the market by barge. This is the so-called truck-barge combination, which takes advantage of the cost minimizing use of trucks for short hauls and the low cost of barge in longer hauls.

The truck-barge combination has proved to be a successful competitor with railroads in the transportation of wheat within the PNW. The main effect of the combination of barge and truck in the PNW has been the dominance of truck-barge within 100 miles of the Columbia/Snake River System. As one moves away from the River, railroads become more competitive.

Up to this point we have studied the different factors influencing the grain transportation market of the PNW. However we have made several assumptions. One of then is that there is no government intervention in the transportation market. We must now relax this assumption because the present study deals with the effect of government regulation in the transportation market. This assumption is relaxed in the third section.

Transportation Regulation

In the first two sections the transportation market was assumed to be perfectly competitive and without any kind of government intervention. But, in reality, the transportation industry, because of particular characteristics that will be explained later in this section, is subject to government intervention, specifically economic regulation. In this section, the assumption of competitive market is relaxed, and the regulated transportation market is studied and discussed.

The main purpose of this section is to provide a background on transportation regulation, and to study the potential effect of regulation and deregulation on PNW grain transportation.

The section examines regulatory policies in the transportation industry. Existing theories of regulation are examined and used to explain regulation of the different transportation modes relevant to grain transportation: railroads, motor carriers, and barges. Then, the effect of regulation and the potential consequences of deregulation are discussed.

Accordingly, the first subsection gives a brief introduction to the topic. The second subsection reviews and analyzes the principal theories of economic regulation. The third subsection explains the evolution of the regulatory policies of the U.S. and provides a historical review of transportation regulation. The fourth subsection discusses the economic consequences of regulation, and suggests what was expected from deregulation. The fifth subsection analyzes preliminary evidence of the impact of transportation deregulation in some sectors of the economy. Finally, the sixth subsection provides a summary and presents the general conclusions of the section.

Theories of Economic Regulation

Two main theories of economic regulation have been proposed in order to explain the pattern of government intervention in the market. These are the "Public Interest" and the "Interest Group" or "Capture" theories of regulation. Political scientists and economists have proposed several versions of each of these theories in their search for the best theory of economic regulation. There is no general concensus regarding which theory gives the single best explanation of economic regulation. The purpose of this subsection is to provide a brief exposition and critique of the "Public Interest" and "Interest Group" theories of regulation. With this analysis, we may be able to explain, later in second subsection the behavior and trends of economic regulatory policies in the transportation industry of the U.S. (especially railroad, motor carrier, and inland waterways industries).

According to Posner (1974) The Public Interest Theory of regulation relies on the following two assumptions:

1. Economic markets are extremely fragile and operate very inefficiently (or inadequately) if left alone.

2. Government regulation is virtually costless.

According to this theory, behind each scheme of regulation is a market imperfection, which supplies a complete justification for regulation, assumed to operate effectively and without cost.

Hence, the public interest regulator will intervene in the transportation market if externalities, scale economies, or indivisibilities cause a natural monopoly.

There have been many criticisms of the Public Interest theory. Theoretical and empirical research conducted by economists in the past 25 years has shown that economic regulation is not positively correlated with monopolistic industries that generate substantial external costs or benefits, nor is it costless. The Public Interest Theory cannot explain why economic regulation is found in some industries where regulation has been adopted for reasons other than scale economies, externalities or indivisibilities. Critics of the Public Interest Theory also argue that this theory contains no mechanism by which a perception of public interest is translated into legislative action.

The Capture theory of economic regulation (or capture theory) does not address public interest at all, but describes a process by which interest groups seek to promote their (private) interests. Regulation is perceived as a potential resource to particular individuals or groups and is viewed as a product whose allocation is governed by laws of supply and demand so that regulation is demanded by economic groups and supplied by the state. Furthermore, the allocation of regulation requires the intervention of the political process.

There exists a number of case studies of trucking, airlines, railroads, and other industries that support the Capture Theory explanation of regulation; however, economic theory has not been refined to the point where it enables us to predict specific industries in which regulation will be found.

In conclusion, economists and political scientists are not satisfied in their search for the best theory of regulation. It appears that neither the Public Interest Theory nor the Interest Group Theory is able to explain satisfactorily the behavior of economic regulators. Although there have been case studies of several industries that support both theories, they still require refinement and need empirical verification before any of them can be accepted as a general theory of regulation.

A Historical Review of Economic Regulation of the U.S. Transportation Industry

Government has intervened in the transportation sector of many different economies, often to a greater extent than government has intervened in other activities. Most authors agree that the reason for this phenomenon is the importance of transportation to the economy and the society. Our society, based on the division of labor, cannot function without transportation. Therefore, governments cannot be neutral with respect to transportation and intervene in this sector when they consider some interests to be neglected. The two most important kinds of government intervention in transportation are promotion of transportation and economic regulation of transportation. Economic regulation is only one of the several kinds of government regulations that apply to transportation; in fact, regulation of transportation includes a variety of matters such as labor legislation, licensing and zoning laws, environmental regulation, and safety regulation.

Harper (1982) defines government economic regulation of transportation as the regulation of the business of transportation, which includes control over entry into business of for-hire transportation, control over exit from the business, regulation of rates and fares, regulation of carrier service, regulation of accounting practices, regulation of financial matters including security issues, control of mergers and consolidations, and the filling of numerous reports covering the activities of the regulated carrier.

This subsection provides a brief review of the history of the government economic regulation of transportation in the U.S. The relationship between the theories of economic regulation and the behavior of transportation regulators in the U.S. is also considered. The subsection emphasizes the period of time after the mid-1970s, when there was a radical change in regulatory policies in the U.S. transportation industry.

As mentioned in Chapter I, Federal regulation of transportation in the U.S. started in the 1880s when Congress passed the Interstate Commerce Act of 1887 to oversee railroads rate-making and operation, and created the Interestate Commerce Commission (ICC) to rule upon the law.

Trucks, barges, and airlines were also subject to economic regulation. The Motor Carrier Act of 1935 gave the ICC control of truck rates and entry into the industry. While the Transportation Act of 1940 brought certain barge transportation under the control of the ICC regulation. However, all motor carriers of agricultural commodities were exempt from regulation, as were water carriers of bulk commodities.

It can be argued that railroad regulation had its roots in the Public Interest Theory. By the 1880s, the railroad industry exhibited the typical characteristic that made it a good candidate for public-interest oriented regulation: natural monopoly. As Milner (1970) points out, the railroad industry is more monopolistic than it is competitive. Entry is difficult because a great capital outlay is required, the physical plant cannot be moved easily to satisfy shifting geographic demand, and only one or two railroads usually serve particular locations. In addition, intermodal competition practically did not exist at this time. Thus, railroads were in the position to control prices. Because of this situation, the public interest was neglected, and the market was inefficient. This is the typical situation in which, according to the Public Interest Theory, economic regulation is warranted. Then, from this point of view, economic regulation is justified by the need to protect not only the public interest (in special shippers), but also to protect the economy, since transportation is a very important part of it.

Regulation then was oriented toward the promotion of economic efficiency.

On the other hand, the Interest Group Theory also has its merits. Railroad regulation was the product of certain groups. Not only shippers (granger and farmer organizations especially), but railroads. According to Friedlaender (1969), railroads supported regulation to formalize the existing rate structure and to end the instability created by frequent rate wars. That shipper organizations, and, to some extent, railroads, acknowledged the benefits they could get from railroads regulation, and took advantage of this opportunity suggests support for the Interest Group Theory.

Since the mid-1970s there have been radical changes in transportation regulatory policy in the U.S. The philosophy of the period has been to relax transportation regulation as much as possible and to allow competition between and within modes.

Farris (1983) mentions three events as the main causes of this change in regulatory policies. First, studies which attempted to quantify the costs of misallocation of traffic due to regulatory restraints, showed that in fact, regulation had led to misallocation. Second, the deterioriating financial situation of railroads. Finally, temporary shortages of petroleum due to the Arab Oil boycott in 1973 called attention to the fact that regulatory constraints were making airlines and many trucks waste this scarce resource (backhaul restrictions for example).

A number of bills were introduced into Congress to deregulate transportation. Especially the Railroad Revitalization and Regulatory Reform Act (4R Act) of 1976, and the Staggers Rail Act of 1980. These acts relaxed many of railroads regulatory restrictions. The Motor Carrier Act of 1980 initiated regulatory reform in the trucking industry. The Air Cargo Deregulation of 1977 and the Airline Deregulation Act of 1980 deregulated airlines.

The Railroad Revitalization and Regulatory Reform Act of 1976 was the first attempt to deregulate railroads. As the title implies, this Act had two aims: providing government subsidies and reforming regulation. The portion of the Act dealing with regulatory reform was geared to giving railroads more commercial freedom in several directions, including rates, merges, and abandonments.

For rates, the Act established that no rate above variable costs should be considered unreasonable unless someone contesting it could prove otherwise. Second, it stated that the ICC should seek out the type of traffic in which rail transportation had no monopoly power and totally eliminate regulation in it. Third, the ICC was instructed to take the financial health of the railroad industry into consideration (this was intended to imply that any firm not earning a compensatory return on investment should be allowed to raise rates). Fourth, for areas in which a railroad firm was found not to have "market dominance," it was to be free to move its rates up or down within a seven percent "zone of reasonableness" with no regulatory approval.

The Act shortened the time period within which the ICC must deal with a merger application and directed the secretary of transportation to facilitate mergers. It also established the principle that a railroad cannot be forced to provide service on which it looses money. Subsidization of several improfitable railroads was also provided by the Act

The Staggers Rail Act of 1980 was the most dramatic change in federal policy toward railroads since the Intereststate Commerce Act of 1887. In some ways it was an even more dramatic change than that law, because while the 1887 Act codified principles already existing in common law, the Staggers Act completely reversed earlier policies.

The Staggers Act is based on the premise (stated in the first subsection) that while the railroad industry once constituted a monopoly requiring ICC regulation, this was no longer so. Most transportation is competitive and much ICC regulation has had an adverse effect on economic efficiency, as well as forcing the industry to accept a return on investment far below the level adequate to maintain financial viability and finance future growth.

The Act asumes that less regulation and more reliance on the marketplace will help assure a better rail system and more efficient use of it, which should save energy and reduce inflation.

The Act's goals (the third section) include assisting the industry in its rehabilitation under private ownership, reforming federal regulatory policy to achieve an efficient, economical, and stable system, and providing the regulation necessary to balance the needs of carriers, shippers, and the public.

The Act intends to attain these goals by reducing common carrier obligations to provide either unprofitable services or profitable services at unprofitable prices. In other words, the Act sharply reduces the carrier's obligation to cross-subsidize money-losing service, allowing them instead to restructure rates and services to realize a profit or to discontinue the service if that is impossible.

Regulation is preserved only to prevent prices from rising to monopoly levels for commodities of captive shippers and to prevent rates from falling to truly cutthroat levels.

Possibly the most fought-over provision of the Staggers Act was that pertaining to maximum rates. The Act amended the 4R Act to state that, except where a railroad had "market dominance," it would be free to set rates as it chooses.

A carrier has market dominance if the ratio of revenue to variable costs for a given commodity is above a specific ratio (160 percent in 1980, to rise between 170 percent and 180 percent by 1985, by increments of five percent points a year).

The Act also allows a carrier to raise rates in two other circumstances. Carriers not deemed to be earning an adequate return are allowed a zone of rate flexibility around existing "base" rates, which could, depending on the current level of rates, allow the carrier to raise rates to as much as 190 percent of variable cost.

To account for inflation the ICC must specify a railroad cost index as a basis for automatic quarterly rate increases. The Act also sets a rate floor (variable costs).

Furthermore, the Staggers Act gives the Commission the option of exempting rail transport of certain commodities groups from regulation altogether. This is permitted when intermodal competition is so strong that regulation is unnecessary to assure economical prices.

Contract rate agreements are specifically legalized. As the name indicates, contract rate agreements are contracts between shippers and railroads. The railroad agrees to provide service for a given price. The customer agrees to give the railroad a certain amount of traffic during a specific time.

Service under contract shall be separate and distinct from common carriage by rail. Once approved, the ICC cannot require a carrier to violate the contract. Contract enforcement is restricted to the courts.

Rail abandonments were liberalized in the SRA further than in the 4R Act, in two ways (Keeler, 1983). First, it set a time limit on the length of abandonment (255 days from the day of applications). Second, the Act specifies that abandonment is justified, based on meaningful economic criteria (since the Act clearly indicates that a railroad's cost should include an opportunity cost of capital as a return of investment). The Act also facilitates mergers by accelerating the proceedings.

The Motor Carrier Act of 1980 contained a new rule for rate making for most trucking companies, similar to that in the 4R Act of 1976 for railroads (Harper, 1982). The regulatory goals of the Motor Carrier Act of 1980, according to Farris (1983), were: to provide a variety of quality and price options; to meet the changing market demand, to achieve the most productive use of equipment and energy resources; to enable efficient and well-managed carriers to earn adequate profits, attract capital, and maintain fair wages while maintaining service to small communities and small shippers; to maintain sound, safe, and competitive privately owned motor carriers; and to promote intermodal competition.

The Motor Carrier Act of 1980 (MCA) changed entry regulations to make it easier for new carriers to get into trucking. Operating restrictions were removed within 180 days of the passage of the MCA, and a zone of rate freedom was instituted.

Deregulation (from now, I will refer to the relaxation of regulation as deregulation) in the railroad industry could be explained by the Public Interest Theory on the grounds that railroad regulatory reform was simply the way in which regulatory policy chose to adapt to the change in the transportation industry to protect the public interest. Railroads no longer held a monopoly position and, hence, regulation was not justified. Some degree of railroad deregulation could support this point of view. Regulation was kept in those routes where railroads have market dominance, and eliminated where railroads have no monopoly power. Public Interest regulators could then explain that regulation could not be completely eliminated from the industry because, in some situations, monopolistic conditions persist.

A public-oriented or interest welfare regulator would justify railroad deregulation based on these arguments. He would argue that greater reliance on the forces of competition and less reliance on the restraints of regulation is the best way to ensure services and rates in the best interest of the public.

The Interest Group Theory could explain railroad deregulation as the adjustment of supply for regulation to the change (decrease) in the demand for regulation. In other words, as in all markets, the supply for regulation equalled the demand for regulation in order to be in equilibrium.

Economic Consequences of Regulation and Expectations about Deregulation in the Transportation Industry

Among the factors that brought deregulation of the transportation industry into being was the series of studies, conducted mainly by economists, which show that there were social costs associated with regulation.

Most economists seem to agree that regulation of transportation leads to high social costs. Friedlaender (1969) classifies these costs as static and dynamic. Static costs are those produced by the misallocation of traffic resulting from the continuance of value-of-service pricing. When using value-of-service pricing, carriers are prevented from pricing their service on the basis of costs; therefore, some carriers with higher costs moved much freight that could have been carried by carriers with lower costs. Friedlaender explains that since railroads and trucks could not compete for high density traffic by cutting rates (an area in which railroads have the advantage); a considerable amount of high density traffic went by truck that could in fact have gone more cheaply by rail. Because of this lack of rate competition, rates were higher than they should have been in a competitive situation. Friedlaender (1968) estimated the cost to be around $500 million per year (1968 dollars).

Dynamic costs are those generated by excess capacity in the transportation industry. The term "excess capacity" in this case implies redundant factors of production. Friedlaender explains that the insistence of the notion of common carrier encouraged the regulated carriers to maintain sufficient capacity to meet the needs of all shippers that might want to utilize them. But when technological change, and many other factors, created an excess capacity in the industry, the ICC policies toward abandonments did not allow the transportation industry to eliminate capacity freely. Friedlaender estimated the costs of excess capacity to be around $2 billion (1968 dollars)

Basically, most economists agreed that deregulation, based on relaxing rate regulations and common carrier obligations, would create benefits far in excess of costs. Specifically, deregulation would lead to a more efficient allocation of traffic between competing modes and more efficient utilization of transportation capacity (Friedlaender, 1969). Johnson and Harper (1976) have argued that the railroad industry would be the prime beneficiary of deregulation, particularly with deregulation of rates. They also argue that overall transportation rates would decline with deregulation (this argument was also supported by most economists). Friedlaender pointed out that trucking firms would be particularly hard hit since rates would tend to fall to the variable costs of the most efficient trucking firms. Although water carriers would probably enjoy an eventual long-run competitive advantage over railroads, the intermediate consequences of rate competition between rail and water carriers would probably be an extended period of intensive rate competition, excessive investment, and reduced profitability for both modes. Harper and Johnson argue that while the transportation industry as a whole would become more competitive and rates would be reduced, the overall effect of deregulation would not be seriously detrimental to any mode of transportation. Deregulation would then, according to Harper and Johnson, result in more innovative carrier management in terms of rate and services

Thus, most economists believe that regulation led to social costs, composed of the misallocation of traffic due to rate distortions and excess capacity due to ICC policies. Deregulation, oriented toward relaxing rate regulations and common carrier obligations, would lead to an overall decrease in rates in the industry, a more efficient allocation of traffic and better utilization of the industry capacity, through the increase in competition.

Evidence of the Impact of Deregulation on the Transportation Industry

This subsection analyzes studies conducted in the past five years and dealing with the effects of deregulation in the U.S. transportation industry. The main objective is to determine if the benefits from deregulation are those that were expected. Most studies deal with the impact of either the Stagger Rail Act of 1980 or the Motor Carrier Act of 1980 on U.S. grain transportation.

Overall, the studies agree that it may be too early to judge the effectiveness of deregulation in the transportation industry. Transportation rates have decreased, there have been a good deal of innovations, intermodal and intramodal competition has increased, services have improved, the profitability of railroads has improved, and abandonments have increased. Some studies also show that there have been problems with deregulation.

Keeler (1983) analyzed time series data for the years 1980-1982 and concluded that railroad's profitability increased significantly during this period. He argued that regulatory reform played an important role in this increase. Keeler also analyzed time series data from 1946 to 1981 and concluded that there were few abandonments during 1979, 1980, and 1981. Overall, Keeler found that rail rates decreased in 1980. He also found some evidence of destructive competition between railroads.

Pustay (1983) analyzed the impact of the Motor Carrier Act of 1980 in the truck industry. He concluded that the motor carrier regulatory reform has developed in much the fashion that its supporters had anticipated. According to Pustay, reliance on market competition forces rather than regulation to allocate resources has increased entry into the industry, enhanced price competition, and improved service, including that to small communities.

Klindworth, Boreson, Badcock, and Chow (1985), using analysis of price spreads, studied the impact of rail deregulation on marketing of Kansas wheat. They concluded that although the rate of abandonment has increased since the passage of the Staggers Rail Act of 1980, there is still no evidence of a change in the rate of abandonments in the past four years that can be immediately identified with the Staggers Act. They also concluded that although the increase in rail tariff rates was relatively uniform from 1977 through 1980, rates have decreased in unequal amounts among areas and between shipping points since 1980.

Casavant (1985) surveyed the impact of the Staggers Rail Act of 1980 on U.S. agriculture. He examined 33 studies relating to regulation of grain transportation and completed in the last five years by academic researchers mainly from Land Grant Universities. He concluded that there have been many benefits arising from the innovations that have occurred since 1980 as a consequence of the Staggers Rail Act. According to Casavant's analysis, real rates and costs have gone down and the efficiency of movement for the railroad has increased but not without some dissatisfaction and concerns to some shippers. A continuing concern, according to Casavant, is the extent to which rail rates will increase or change as the demand for transportation services increases during a strong recovery of the economy. Shippers feel that intermodal competition for the rail system may not be as effective in a time of strong market demand. Another concern of shippers, mentioned by Casavant, is that the ICC has abandoned its intended role and is proceeding blindly toward total deregulation and elimination of the common carrier concept.

Cornelius (1984) analyzed the impact of transportation deregulation on the transportation of grain in the Pacific Northwest (PNW), which includes the states of Washington, Oregon, Idaho, and Montana. He concludes that although the impact of deregulation of railroads and motor carriers has not solved all the problems in grain movement in the PNW, there are some indications that the economic efficiency of grain transportation is being improved. In another study he discussed the effects of transportation deregulation on the competition among grain carriers in the PNW (1984). In the past four years competition between railroads and truck-barge has become more active for grain shippers 50 to 100 miles inland from the Columbia-Snake System.

These studies support the idea that, in general, deregulation is providing the benefits it was expected to. However, some imperfections exist, and it is still too early to determine the real impact of regulatory reform on the U.S. transportation industry.

Section Summary and Conclusions

In this section we have reviewed the evolution of regulatory policy in the transportation industry of the U.S. We have studied the forces that move it and its economic causes and consequences. We may now see that transportation is a very important activity in society and that is why governments intervene in this industry. The question of whether this intervention is best explained by the Interest Group Theory or the Public Interest Theory is still definitely unanswered.

The evolution of transportation regulatory policy in the U.S. has been simply a response to the evolution of the structure of the transportation system. Economic regulation of transportation was initiated to solve the economic problems produced by the monopoly power of railroads; and it worked well as long as railroads were the only carrier of goods in the U.S. regardless of the distance traveled. But market structure changed; new transportation modes emerged, and transportation turned out to be a competitive industry; the new modes also required government regulation but for different reasons than railroads. As a result regulation did not correspond, in the desired way, to the competitiveness of the market. Consequently, the financial situation of many railroads deteriorated and regulation was found to distort the transportation market by producing misallocation of traffic and making rates higher than they would be in a free competitive market. Regulation was also found to produce excess capacity in the industry and some other inefficiencies.

In order to amend these inefficiencies from regulation, regulatory policies changed radically. The new philosophy is to relax regulation and to trust that the force of competition will work in the best interest of the public and the industry. A series of acts were passed in order to relax regulation. The Staggers Rail Act of 1980 and the Motor Carrier Act of 1980 relaxed regulation in the railroads and motor carrier industry, respectively.

Most studies conducted in the past five years show that although it may be too early to make a conclusion about the impact of deregulation in the transportation industry, transportation rates have, on the whole, gone down. Also, services have improved, competition has increased, and the profitability of railroads has increased. In other words, deregulation seems to be providing the benefits it was expected to.

Chapter Summary and Conclusions

The present chapter has given a brief review of the main characteristics of the transportation market. Based on the principle that price differences between any two regions that trade with each other will just equal transfer cost, a spatial price equilibrium model was used to derive the demand for transportation service. Later, the supply of transportation and the cost characteristics of the different modes of transportation was discussed. Then, transportation regulation was introduced into the transportation market, and a theoretical background for regulation as well as the effects of regulation and deregulation in the transportation industry were discussed.

It is a conclusion of the present chapter that, the demand for grain transportation is determined by the demand and supply of wheat and the cost of transportation service (assuming a purely competitive market). The price of transportation service is determined by the intersection of the transportation demand and supply curve. The supply of transportation is the horizontal summation of the supply of the different transportation modes.

The modal supply is the horizontal summation of the supply of the firms within the mode. Supply curves of the firms are derived from their cost curves which vary among modes. It is this difference that make trucks dominate in short hauls, while barge and rail dominated in long hauls.

The combination of truck advantage in short hauls and barge advantage (over railroads) in long hauls makes the truck-barge a strong competitor for railroads 100 to 200 miles from river systems.

Another conclusion of the chapter is that regulation of transportation rates impeded transportation modes from competing efficiently, and hence grain was not shipped by the more efficient carriers. Consequently, relaxation of regulation would allow more competition between modes and a more efficient modal freight distribution.

CHAPTER III

THE METHODOLOGY

In Chapter II the supply of and demand for wheat transportation was studied, and the influence of regulation and deregulation in the transportation market were also analyzed. Chapter I discussed the particular case of PNW wheat transportation and the potential effects of deregulation. The conclusions were that: (1) regulation distorted the transportation market, and impeded an efficient allocation of wheat traffic between the different competing transportation modes; (2) deregulation would likely increase modal competition (especially between truck/barge and railroads) and lead to a more efficient allocation of wheat traffic between modes; and (3) because of increased competition, truck/barge would lose wheat traffic to rail, wheat shipments to the lower Columbia River ports would probably decrease, and the Puget Sound area would probably experience an increase in wheat shipments.

These probably consequences lead to the formulation of the hypotheses that deregulation has caused a diversion of wheat traffic: to railroads away from truck/barge, and to Puget Sound away from lower Columbia River ports. Another hypothesis was that overall transportation costs decreased because of the SRA.

To verify these hypotheses, the following variables were defined: port share, modal share, average transportation cost, and rate sensitivity. These variables are calculated and compared for year 1977 (before the SRA) and 1985 (after the SRA).

The procedure followed to calculated these variables involves two main steps. First a network model to represent the PNW wheat transportation flow was constructed. Second, a linear programming algorithm was used to determine the optimum (minimal cost) wheat transportation flow; and hence find the values of the variables mentioned in the previous paragraph.

This chapter describes the methodology followed to construct the network model, and the algorithm used. The chapter also provides a discussion of the data required to solve the model.

The first section describes how the methodology was chosen. The second section gives a brief review of networks. The third section explains the construction of the network model for PNW grain transportation. The fourth section describes very briefly the algorithm used. The fifth section describes the type of data required and how it was obtained. Finally, the summary and conclusions of the chapter follow in the last section.

Methodological Background

The present study is in a real sense a transportation demand analysis. It requires the study of the PNW grain modal transportation demand in order to accomplish its objectives. This analysis of transportation demand involves two important steps. The first step is to study the alternative methodologies available. The second step is to choose one of these methodologies. This section describes the procedure.

Several methodologies have been used to analyze the demand for transportation in general and by mode (Wilson 1984. These include optimization models, models of modal choice, ad hoc specified and econometrically estimated demand functions, and derived demand models.

The first type of transportation demand analysis, the optimization models, incorporate the interactions of commodity supply and demand conditions with transportation rates as well as constraints inherent in the system. Transportation and transshipment models are the most widely used models of this type, they employ a variety of mathematical programming techniques such as network and linear programming.

The second type of transportation demand analysis is estimation of modal choice behavioral functions. These are cross-sectional models of quantitative choice that have been used to generate own and cross-mode price elasticities, partly as a means of avoiding the long-recognized lack of time series data on potentially important non-rate variables. Linear logit models have been the most widely used models of this type. Oum (1979) points out that these models impose several rigid a priori restrictions on estimated prameters and a structure of technology which is fixed and inconsistent with reality. Consequently, it may not be appropriate for use in the case of transportation demand study. Oum recommends more flexible forms of logit models such as translog, generalized Leontief, and generalized quadratic functions.

A third type of demand analysis is specification of behavioral equations using ad hoc conceptual reasoning. These are characterized by regression models of shipments as a function of exogenous variables which are introduced without rigorous specification. Ad hoc models are typically useful for forecasting but suffer in several respects in the analysis of price responsiveness of demand.

Estimation of derived demand models provides the fourth methodology for analyzing modal demand for transportation. Assuming a dual relationship between production and cost functions of shippers' distribution activities, and flexible forms for the cost function, modal factor shares can be derived. The duality approach used to analyze intermodal competition in transportation is attractive because its functional specification is consistent with neoclassical economic relationships.

The above description of the methodologies to analyze transportation demand suggests that each of them present particular advantages and limitations, depending on the purpose and characteristics of the particular case where they are applied. There cannot be a strong argument against them in general. Consequently, the criterium for choosing one of these methodologies will depend on the particular case considered. To choose the methodology for the study of the Pacific Northwest (PNW) grain modal transportation demand, the criterions were: the objectives of the study, the simplicity of the model, data availability, and past experiences with this methodology in other PNW grain transportation studies.

In the particular case of PNW grain modal transportation demand, the calculation of the variables modal share, port share, total transportation cost, and elasticities, are the specific objectives. Among the four methodologies under consideration, optimization models, especially the transshipment model is the one most appropriate, for the following reasons:

1. The transshipment model adapts perfectly to PNW grain transportation demand analysis because of its network flow structure. This characteristic of the transshipment model simplifies greatly the study, in a very illustrative way.

2. Transshipment models allow shipments of good to go by any sequence of points rather than just from surplus regions to deficit regions. Consequently, the modal share for all transportation modes can be calculated

simulatenously, the sensitivity analysis can be made, and the volume of shipment that passes through a specific transshipment point can be calculated.

3. Since this is an optimization model, the total transportation cost can be obtained from the value of the objective function.

4. The only data required is transportation rates, and quantities supplied and demanded of the commodities considered at a specific time.

5. This methodology has been used extensively in grain transportation studies in the PNW and all over the U.S. and has proved to be very successful.

The remaining three methodologies have disadvantage compared to optimization models (in this particular case) in that most of them require time series data. The unavailability of time series data on rates for exempt motor carriers is one of the main problems which impede transportation modal demand analysis in the grain industry. This problem could be overcome by using cross-sectional data. Because most such studies use regression analysis, they may present some problems related to multicollinearity when cross-sectional data is used. In addition these models require a somewhat greater amount of data than optimization models.

Another disadvantage of nonoptimization models in this case is that they do not allow the calculation of the great number of variables/values that are easily obtained with optimization models.

Accordingly, the transsshipment model was the methodology chosen for the analysis of PNW grain modal transportation demand in this study. As was mentioned previously, these models are characterized by a network flow structure which is described in the following section.

Characteristics of Network Flow Models

The transportation of goods has been one of the systems in which network flow models have been applied extensively and successfully. These models can be displayed in two dimensional drawings, greatly simplifying the analysis of a specific problem. The PNW wheat transportation flow presents the typical network structure. Therefore, it can be represented very accurately by a network flow model.

Several studies, dealing with PNW grain transportation, have used this methodology. Among these studies we can mention Lubis, Casavant and Thayer, and Mehringer. As Kennington and Helgason (1980, p. 2) point out, a network is composed of two types of entities: arcs and nodes. The arcs may be viewed as unidirectional means of commodity transport. The nodes may be interpreted as locations and terminals connected by the arcs and served by whatever physical means of transport are associated with the arc. The structure of a network can be displayed by means of a labeled drawing in which nodes are represented by circles and arcs are represented by line segments connecting (incident on) two nodes. An arrowhead on the line segment indicates the arc direction. Figure 7 is an example of a network having nine arcs and seven nodes.

We may denote the "ith" node by "i", and the "jth" arc by "j"; so that, for any given network flow model having "I" nodes and "J" arcs, i = 1, 2, ...I; and j = 1, 2, ...J. We may also introduce the decision variable "X_j", as the amount of flow through arc "j", and the J-component vector of all flows as "X". The unit cost for flow through arc "j" is denoted by "C_j", and the corresponding J-component of the costs by "C". The arc capacity for flow through arc "j" is given by "U_j" with corresponding J-component vector U. The requirement at node "i" is denoted by "r_i" with corresponding I-component vector r. If $r_i > 0$, then node "i" is said to be a supply point with supply equal to r_i. If $r_i < 0$, then node "i" is said to be a demand point with demand equal to $[r_i]$. Nodes having $r_i = 0$ are called transshipment points. Mathematically, the minimal cost network flow problem may be stated as follows:

$$\text{Min} \quad CX \tag{1}$$

$$\text{s. t.} \quad AX = r \tag{2}$$

$$0 <= X <= U \tag{3}$$

Where "A" is a node-arc incidence matrix defined as

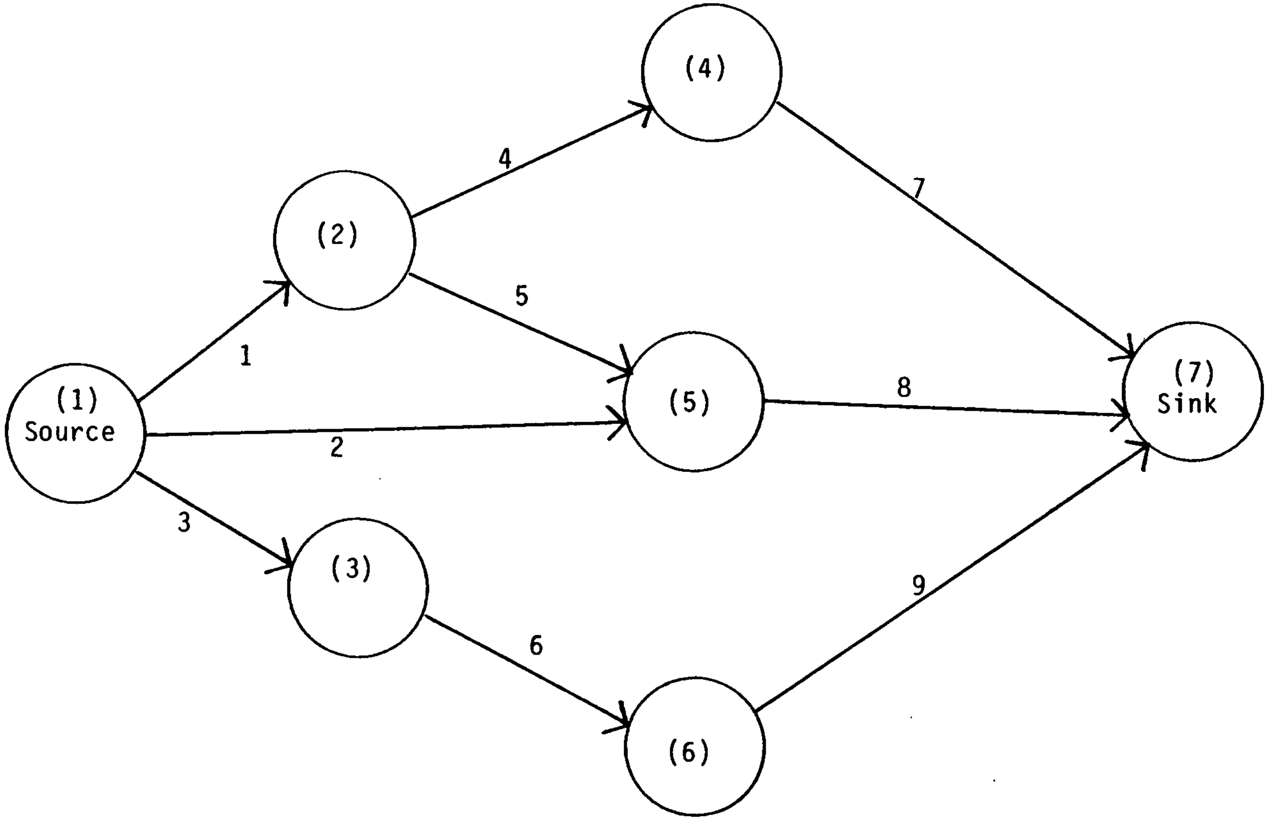


Figure 7. An Example of Network.

follows: A_{ij} = +1 if arc "j" is directed away from node "i". A_{ij} = -1 if arc "j" is directed toward node "i". The abbreviation s.t. means "Subject to".

Many special cases of this problem can be studied. However, I will describe only the "Uncapacitated Transshipment Problem" (UTP), because this is the one that fulfills the requirements of the present study. The UTP is a special kind of network problem in which $U_j = \infty$ for all "j". This means that arcs have infinite capacity.

The Network Flow Model for the PNW

To construct a network flow model for the PNW we first have to consider the different components involved in grain transportation. These components are the transportation system, and the different activities and shipping alternatives.

The main activity of the PNW network flow is to transport wheat from the farm to PNW ports, then from ports to foreign countries.

The transportation system available for wheat in the region is composed of a network of highways and railroads, and the Columbia/Snake River system. The transportation modes are: truck, truck-barge, and rail transportation. The grain handling facilities are represented by country elevators, inland terminal elevators and river terminals. PNW ports are divided in two port areas: (a) Lower Columbia River (CR), which includes the ports of Kalama, Longview, Vancouver and Portland; and (b) Puget Sound (PS), which includes the ports of Seattle and Tacoma.

The following are the alternatives available for the transportation of wheat from farm to the coast within the PNW: (a) From farm to country elevators, inland terminal elevator, river terminal, or directly to PS or CR. All these options by truck; (b) from country elevators to a river terminal by truck, to CR or PS by rail or truck, or to a inland terminal elevator by truck; (c) from inland terminal elevators to a river terminal by truck, or directly to either CR or PS by rail or truck; (d) from river terminals to CR by barge; and (e) from CR or PS to foreign countries by ocean going vessels.

The diagram of Figure 8 represents these alternatives more clearly. This diagram itself is a network model, where farms, grain elevators, ports, and foreign countries represent the nodes, and the different transportation alternatives: railroads, highways, river, and the ocean, represent arcs.

In spite of its simplicity, the network model of Figure 8 would require a great amount of data and computational work if it were used to calculate the PNW wheat marketing flow. For example, it would be almost impossible to calculate the transportation charges from every farm within the PNW to ports. Therefore, several assumptions will be made to simplify the model, and make the calculations possible.

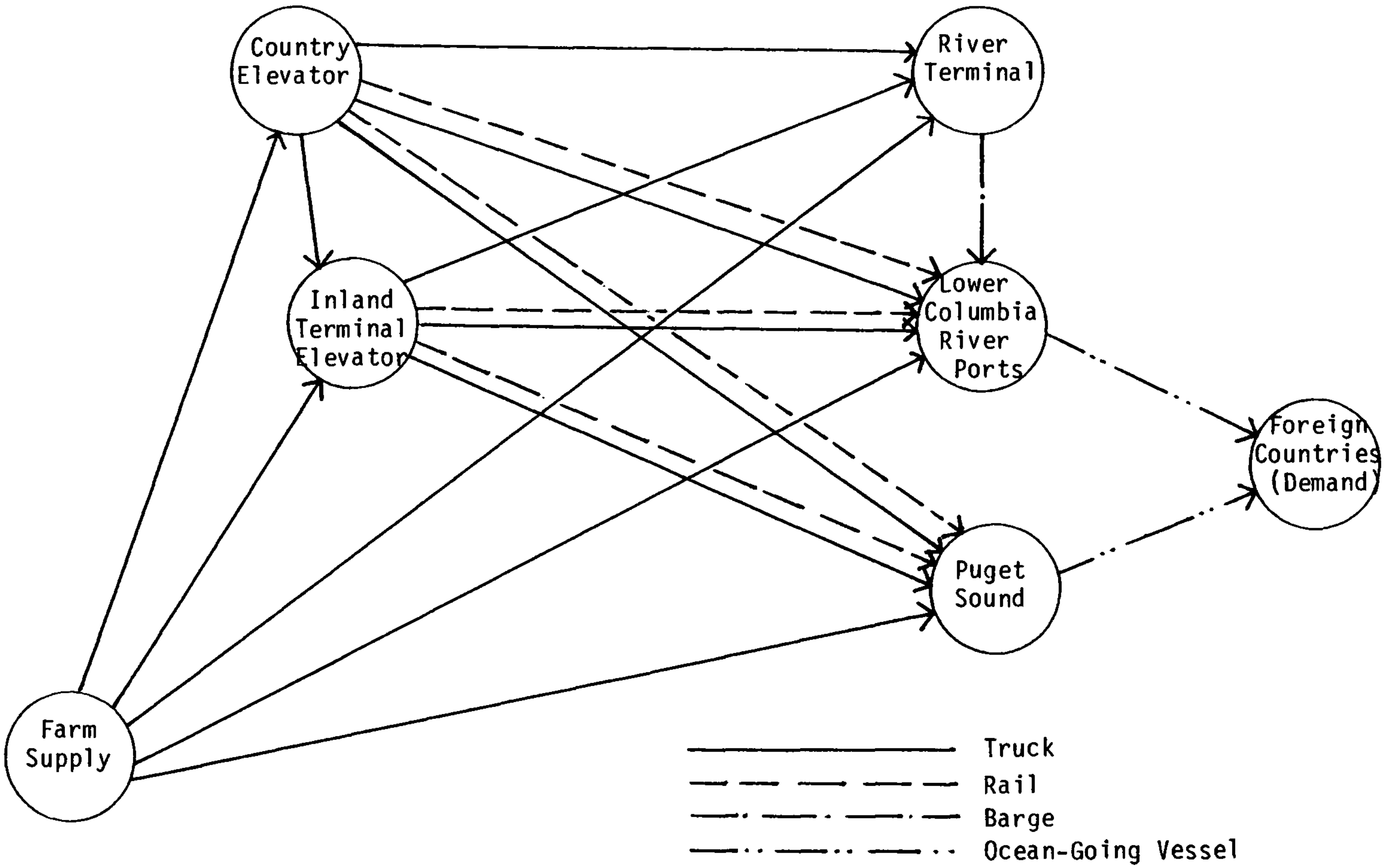


Figure 8. Pacific Northwest Grain Marketing Flow.

The assumptions made are:

1. The PNW is divided into supply areas. Generally, a supply area is represented by a single county, or several counties, depending on its wheat production. For year 1977 a total of 80 supply areas were delimited; while for year 1985 this number was 78. Figures 9 and 10 and Appendix 1 show the different supply areas.

2. It is assumed that the wheat production within a supply area is concentrated in a supply point. A supply point is represented by a country elevator, or an inland terminal elevator the supply points for 1977 and 1985 are shown in Figures 11 and 12, respectively. Whenever it was possible, terminal grain elevators were chosen instead of country elevators. Terminal elevators are preferred because they have available the unit train shipping option, which country elevators do not.

3. It was also assumed that the following are the only alternatives available for PNW wheat shippers: (a) From country elevators (supply point) to a river terminal by truck, to a inland terminal elevator (supply point) by truck, or to either PS or CR by truck or rail; (b) From inland terminal elevators (supply point) to a river terminal by truck, or

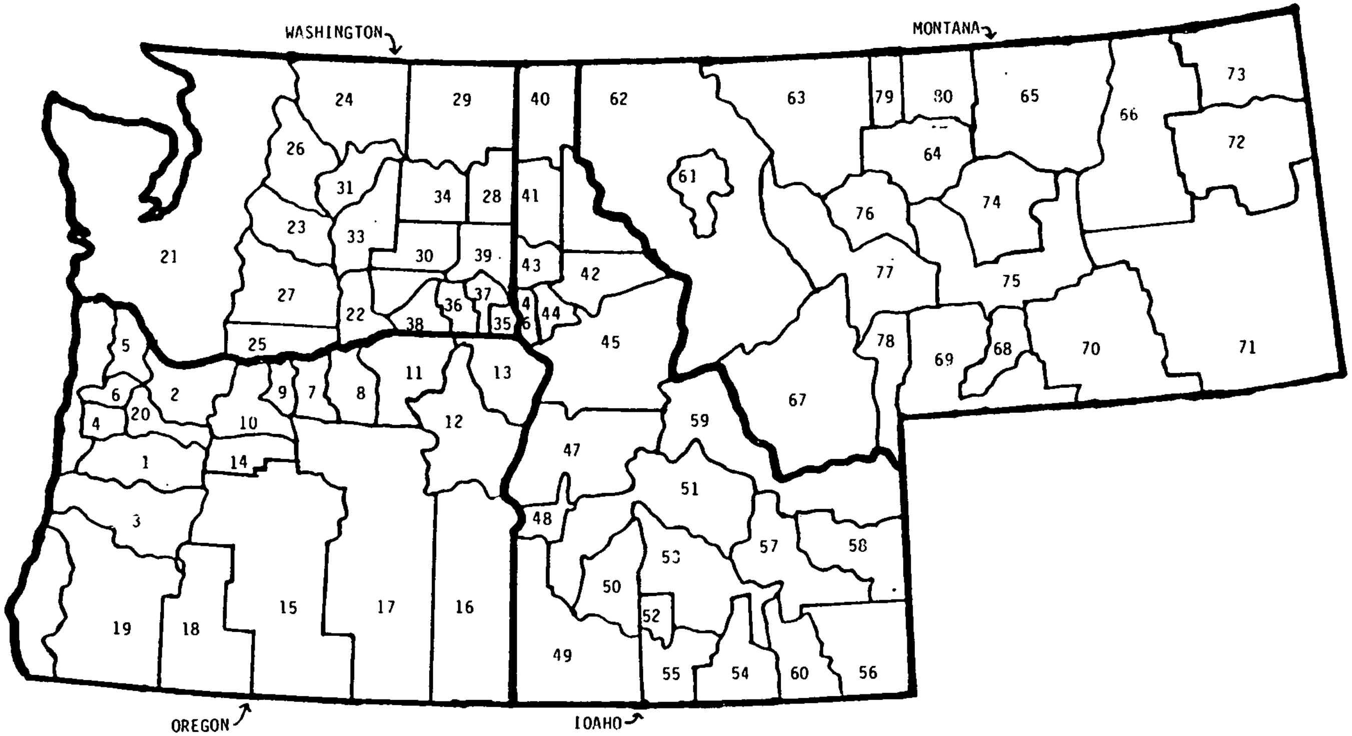


Figure 9. Pacific Northwest Supply Areas: Year 1977.

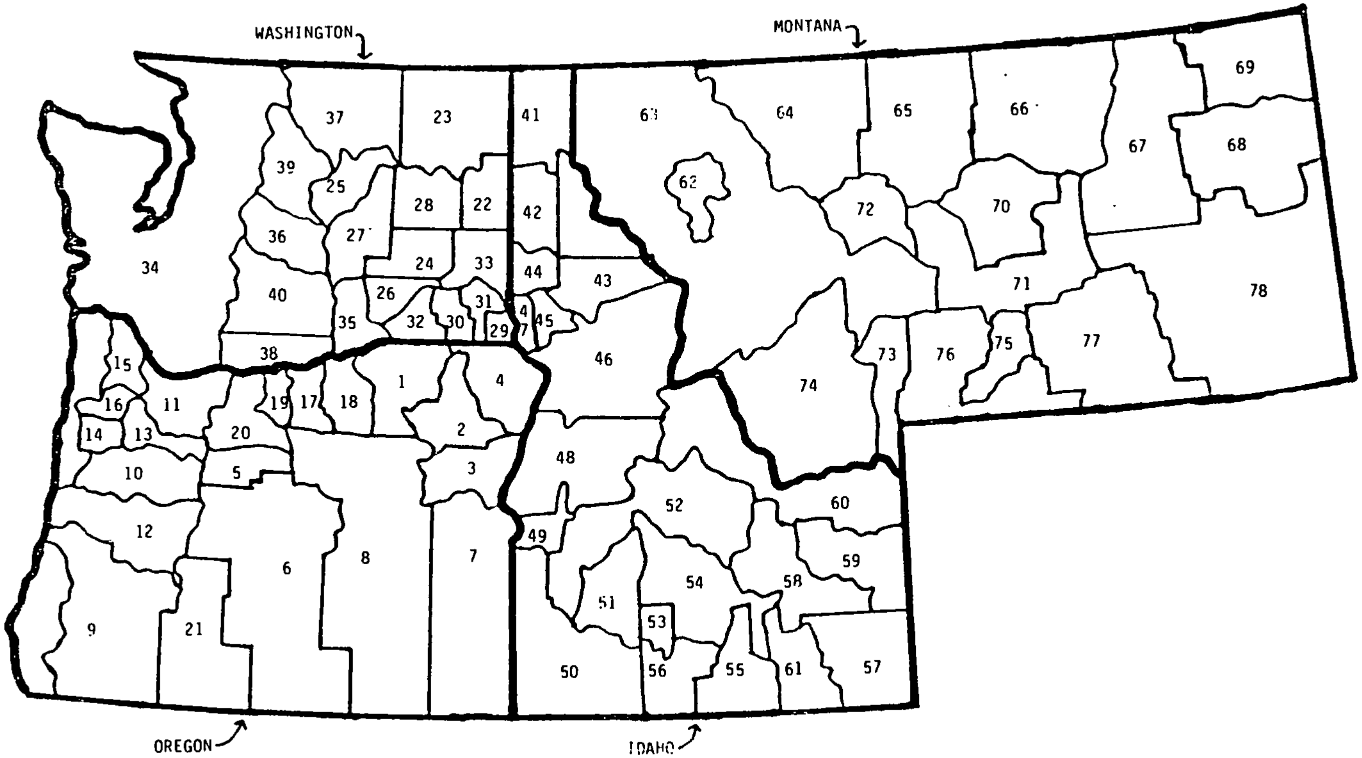


Figure 10. Pacific Northwest Supply Areas: Year 1985.

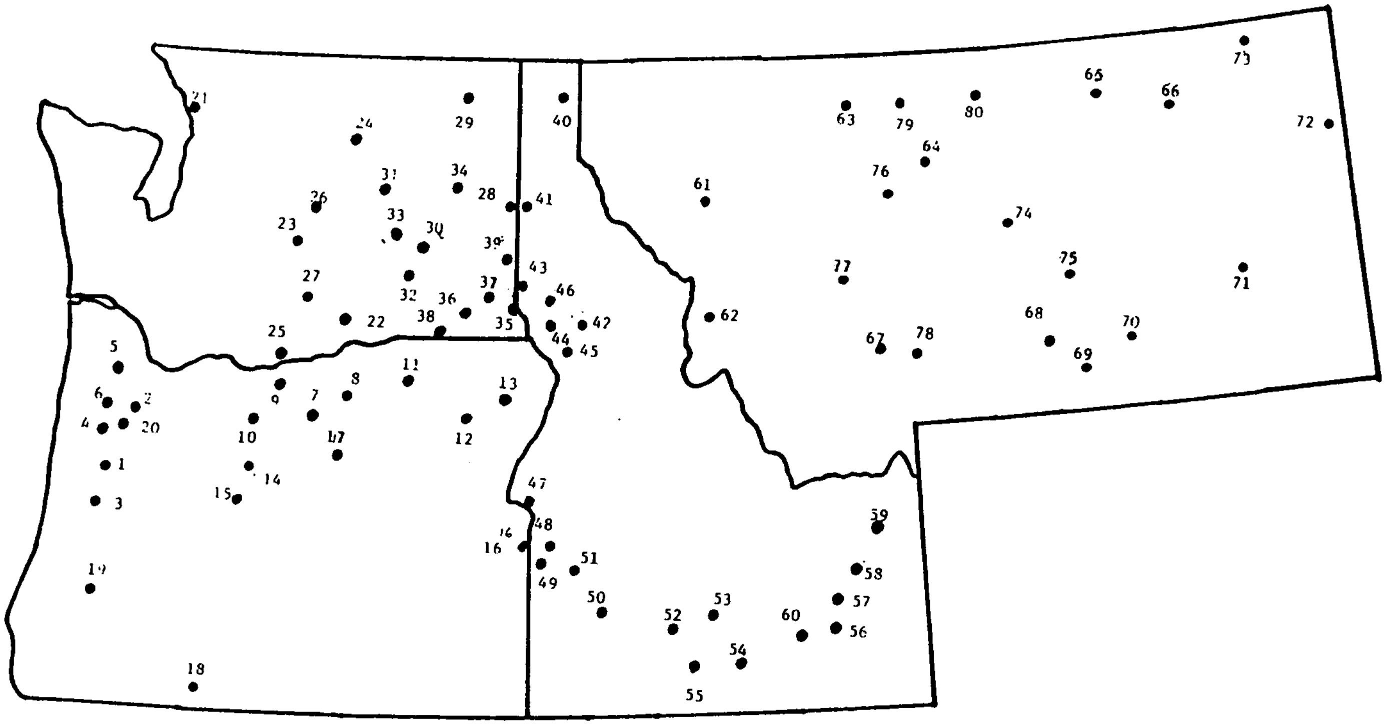


Figure 11. Pacific Northwest Supply Points: 1977.

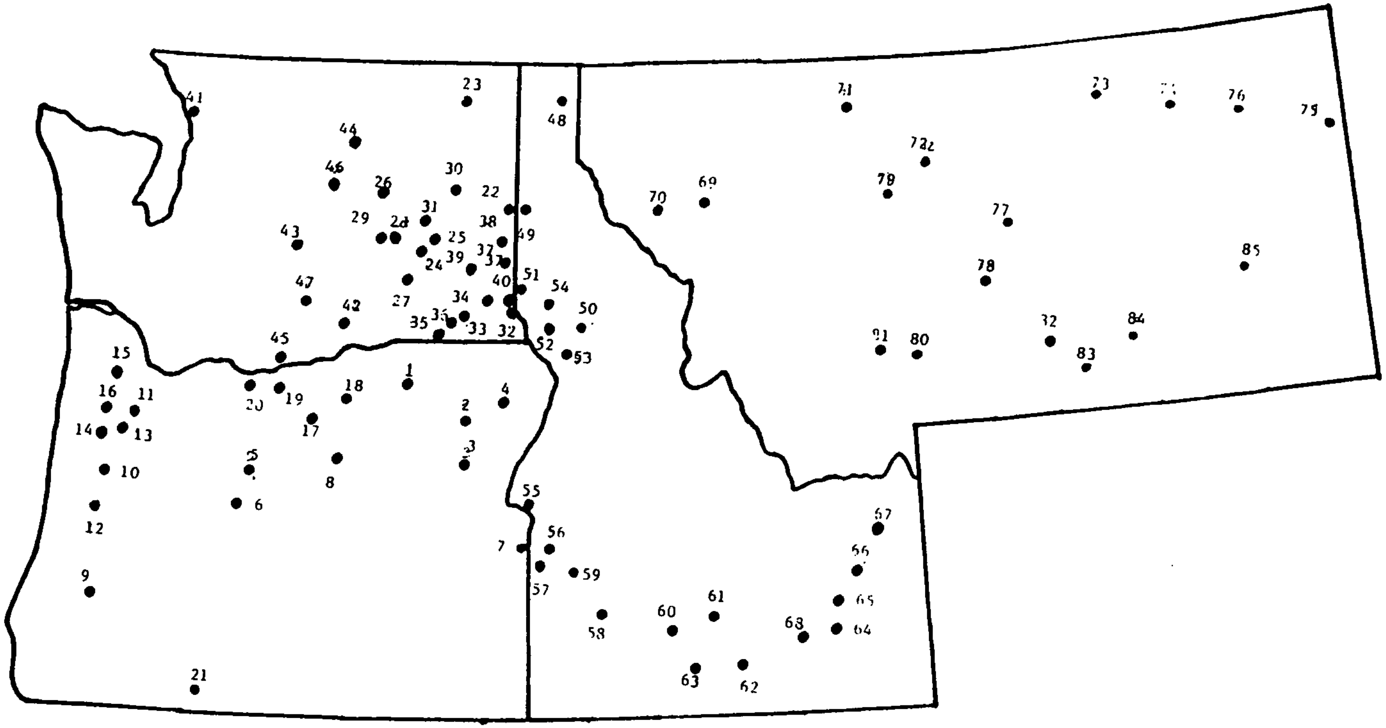


Figure 12. Pacific Northwest Supply Points: 1985.

directly to either PS or CR by truck or rail; (c) From river terminals to CR by barge; and (d) From CR or PS to foreign countries by ocean going vessels.

Figure 12a shows this simplified version of PNW wheat transportation model. For the purpose of finding the optimal solution for this model, the following assumptions were made:

1. All participants are profit maximizers, and have perfect information.

2. The PNW wheat supply regions, the foreign demand locations, the transport modes with their shipments and constraints on routes are known. Similarly, the quantity of wheat produced, and wheat exported from supply points to ports, and from ports to foreign demands are known.

3. The network model uses an annual time period.

4. For year 1985, wheat shipments by rail from inland terminal elevators depend on the number of rail cars they fill. Since year 1981, rail shipments from Montana could be made by 52, 26 and single car. Shipments have to meet the required capacity in order to ship by a given train size. The weight of a given rail shipment has to be at least 4,624 metric tons, 2,312 metric tons, and 81 metric tons in order

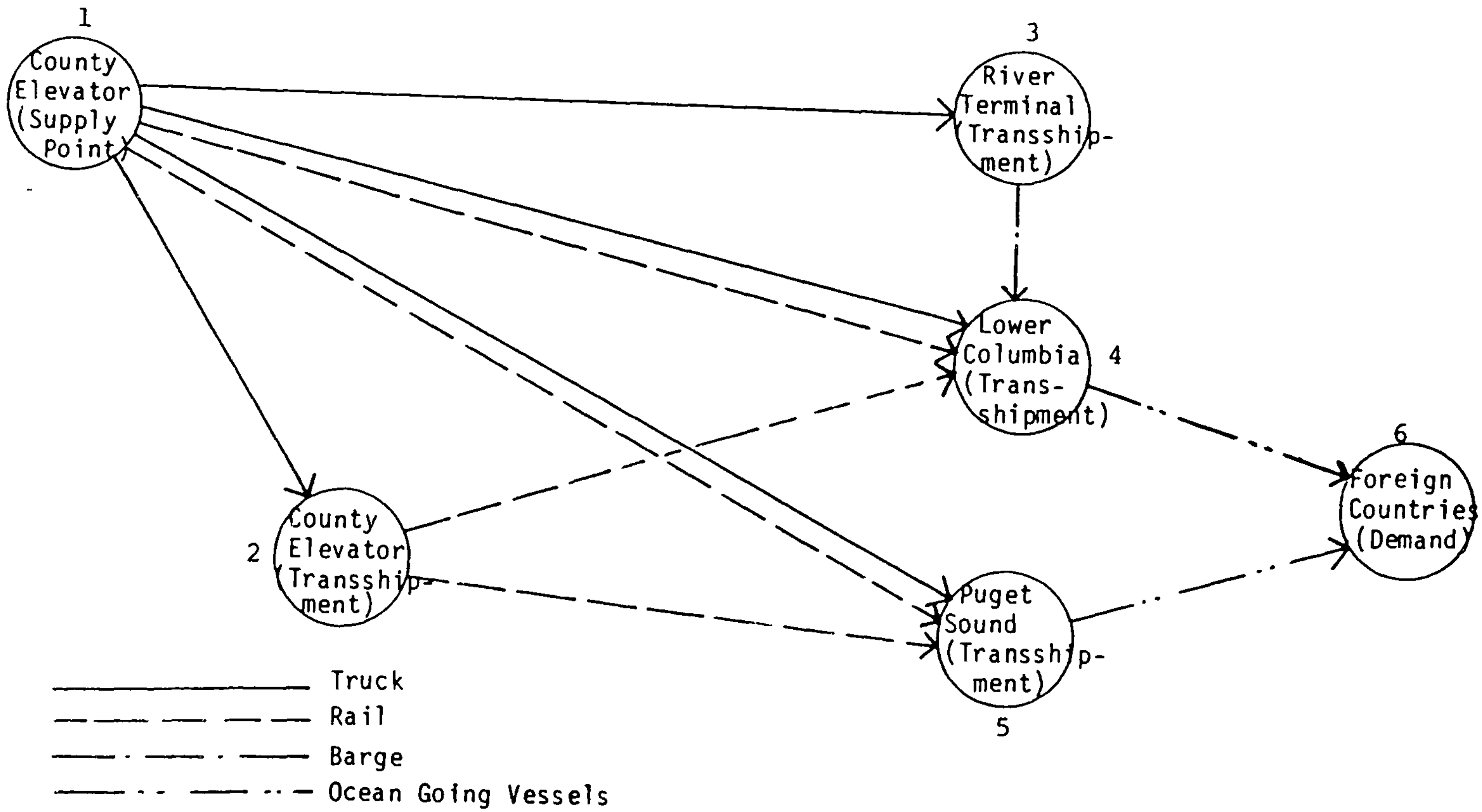


Figure 12a. Pacific Northwest Grain Transportation: Final Model.

to use 52, 26, and single car respectively. For the states of Oregon, Idaho, and Washington the rail options are 25, 3, and single car with a respective capacity requirement of 2,155 metric tons, 258 metric tons, and 86 metric tons. Whether a given rail shipment is made by 52, 26, 3 or single car depends (in this study) on the average monthly shipment an elevator made. As an example, an elevator whose average monthly shipments is greater than or equal to 2,312 metric tons, but less than 4,624 metric tons will ship using 26 rail cars. This distinction is necessary to avoid all wheat shipment being carried by multicar in the model solution.

5. It is also assumed that there is no shortage of storage capacity at the ports, river and inland elevators; as well as no shortages of transportation services. Thus, arcs in the model have infinite capacity, and nodes have no capacity constraints.

Since there is not wheat demand and supply associated with them, river terminals and ports are treated as transshipment points. Also, inland terminal elevators sometimes are treated as transshipment point. This happens when a small country elevator, which lacks the unit rail car facility, transfers wheat to a inland terminal elevator where unit rail cars are available.

The model for year 1977 includes 80 supply areas with their corresponding supply point see (Figure 9 and Appendix I), two inland terminal elevators acting as transshipment points, 15 river terminals, and PNW ports at PS and CR.

The model for year 1985 includes 78 supply areas with 86 supply points. In areas with high wheat production and very close to the Columbia/Snake River system, a stronger competition between truck-barge and railroads might be expected. In this case, it was necessary to choose more than one supply point for each supply area in order to capture more accurately, the effects of modal competition at different distances from the river. The model for year 1985 also includes two inland terminal elevators acting as transshipment points, 16 river terminals, and the PNW ports at CR and PS.

The uncapacitated transshipment problem for the PNW was formulated as follows:

Minimize Total transportation Cost = C

$$\begin{aligned} C = & \sum_{m}\sum_{p} T_{mp}X_{mp} + \sum_{f}\sum_{p} H_{fp}J_{fp} + \sum_{m}\sum_{k} B_{mk}Y_{mk} + \\ & \sum_{k}\sum_{p} I_{kp}Z_{kp} + \sum_{m}\sum_{p} R_{mp}W_{mp} + \sum_{m}\sum_{f} L_{mf} + \\ & \sum_{p}\sum_{q} O_{pq}V_{pq} \end{aligned} \tag{4}$$

Subject to

$$\sum_{p}\sum_{q} V_{pq} = \sum_{m} S_m \tag{5}$$

$$\sum_{p}\sum_{q} V_{pq} = \sum_{q} D_q \tag{6}$$

$$\sum_{m}\sum_{k} Y_{mk} = \sum_{k}\sum_{p} Z_{kp} \tag{7}$$

$$\sum_{m}\sum_{f} L_{mf} = \sum_{f}\sum_{p} J_{fp} \tag{8}$$

Where

$$\sum_{m}\sum_{f} V_{mf} = \sum_{m}\sum_{p} X_{mp} + \sum_{m}\sum_{p} W_{mp} + \sum_{k}\sum_{p} Z_{kp} + \sum_{f}\sum_{p} J_{fp} \quad . \tag{9}$$

and all variables >= 0.

Equation (4) minimizes total transportation cost from supply regions to final destination; Equation (5) insures that total shipment from origin to destination is less than or equal to total PNW wheat supply; Equation (6) insures that total shipment from origin to destination is less than or equal to import to foreign regions; Equation (7) insures that truck shipments to barge terminals are equal to barge shipments to ports; Equation (8) Insures that truck shipments to elevators used as transshipment points are equal to rail shipments from these elevators to ports.

The variables are defined as follow:

F_f = $f^{\underline{th}}$ inland terminal elevator used as transshipment point; Where f = 1,2,.....F; F = 3 for year 1977 and 2 for 1985.

M_m = $m^{\underline{th}}$ supply point; where m = 1,2,....M; M is equal to 80 for year 1977, and 88 for year 1985.

K_k = $k^{\underline{th}}$ Barge Terminal; where k = 1,2,....K. For 1977 K = 15. For 1985 k = 16.

P_p = $p^{\underline{th}}$ port area; where p = 1, 2.

Q_q = $q^{\underline{th}}$ final demand country; where q = 1 and represents the summation of the demand of all countries importing wheat from the PNW.

S_m = supply of the $m^{\underline{th}}$ supply point.

T_{mp} = per unit cost of shipping wheat from the $m^{\underline{th}}$ supply point to the $p^{\underline{th}}$ port area by truck.

B_{mk} = per unit cost of shipping wheat from the $m^{\underline{th}}$ supply point to the $k^{\underline{th}}$ barge terminal by truck.

I_{kp} = per unit cost of shipping wheat from the $k^{\underline{th}}$ barge terminal to the $p^{\underline{th}}$ port area by barge.

R_{mp} = per unit cost of shipping wheat from the $m^{\underline{th}}$ supply point to the $p^{\underline{th}}$ port by rail.

O_{pq} = per unit cost of shipping wheat from the $p^{\underline{th}}$ port area to the $q^{\underline{th}}$ importing country.

H_{fp} = per unit cost of shipping wheat from the $f^{\underline{th}}$ inland terminal elevator used as transshipment point to the $p^{\underline{th}}$ port area by rail.

L_{mf} = per unit cost of shipping wheat from the $m^{\underline{th}}$ supply point to the $f^{\underline{th}}$ inland terminal elevator used as transshipment point by truck.

D_q = demand at the qth importing country.

E_p = port share constraint for the $p^{\underline{th}}$ port area.

X_{mp}, Y_{mk}, Z_{kp}, W_{mp}, J_{fp}, A_{mf}, and V_p are wheat shipments and follow the same definition of cost.

The Algorithm

The uncapacitated transshipment problem formulated in the previous section was fitted into the format of a transportation problem and solved using the transportation simplex algorithm.

The reformulation is made in Table 6; where:

C_{kn} = cost of shipping wheat from the $k^{\underline{th}}$ transshipment point to the $n^{\underline{th}}$ foreign country (k = 1, 2, ..., k, and n = 1, 2, ..., N).

T_{mk} = cost of shipping wheat from the $m^{\underline{th}}$ supply point to the $k^{\underline{th}}$ transshipment point (m = 1, 2, ..., M).

G_{kk} = cost of shipping wheat from the $k^{\underline{th}}$ transshipment point to the kth transshipment point.

D_n = demand at the $n^{\underline{th}}$ foreign country.

S_m = supply of the $m^{\underline{th}}$ supply point.

Table 6. The Transportation Problem for the Pacific Northwest.

			TO							
		FOREIGN COUNTRY				TRANSSHIPMENT POINT				SUPPLY
		1	2	..	N	1	2	....	K	
FROM SUPPLY POINT	1	0	0	..	0	T_{11}	T_{12}	....	T_{1k}	S_1
	2	0	0	..	0	T_{21}	T_{22}	....	T_{2k}	S_2
	.	.	.	..	.	.	.	....	.	.
	.	.	.	..	.	.	.	....	.	.
	M	0	0	..	0	T_{m1}	T_{m2}	....	T_{mk}	S_m
FROM TRANS-SHIP-MENT POINT	1	C_{11}	C_{12}	..	C_{1n}	0	G_{12}	....	G_{1k}	0
	2	C_{21}	C_{22}	..	C_{2n}	G_{21}	0	....	G_{2k}	0
	.	.	.	..	.	.	.	....	.	.
	.	.	.	..	.	.	.	....	.	.
	.	.	.	..	.	.	.	....	.	.
	K	C_{k1}	C_{k2}	..	C_{kn}	G_{k1}	G_{k2}	....	0	0
DEMAND		D_1	D_2	..	D_n	0	0	....	0	

In this form, the transshipment problem can be viewed as a transportation problem. The transportation simplex method can then be applied to find an optimal solution.

The transportation simplex method (TSM) is a special version of the traditional linear programming simplex method. Through the TSM, the simplex method was modified to exploit the special structure of the transportation problem shown in Table 6. In general, the TSM substitutes the simplex tableau with the transportation simplex tableau, which is more efficient and convenient.

The transportation simplex tableau reduces significantly the number of row and columns. For a transportation problem of "m" sources and "n" destinations, the simplex tableau would have (m + n + 1) rows and (m + 1)(n + 1) columns, while the transportation simplex tableau would have only "m" rows and "n" columns.

Basically, the transportation simplex algorithm includes the following steps:

1. Initialization step; construct an initial basic feasible solution, and specify a stopping rule.

2. Iterative step; first, determine the entering basic variable; second, determine the leaving basic variable; third, determine the new basic feasible solution; and fourth, until stopping rule criteria is met.

3. Stopping rule; determine whether this solution is optimal. If so, stop; otherwise go to iterative step.

For the purpose of this study, the procedure of the transportation simplex algorithm need not be detailed more extensively here. A detailed explanation can be found in Hillier and Lieberman, Kaplan, Lawler, and Shapiro.

Date Requirement and Discussion

The data needed by the uncapacitated transshipment problem of the present study are: transportation costs, quantity of wheat supplied by the different supply points, and the quantity of wheat demanded by foreign countries. All data are based on calendar year.

Data on PNW wheat production by county for calendar years 1977 and 1985 was provided by the U.S. Department of Agriculture. Not all the PNW annual wheat production is exported. During year 1977 and 1985, 83.93 percent and 95.29 percent of the annual wheat production was exported respectively. It was assumed, in this study, that each supply point exported the same percentages of its production. For example, for year 1977 the supply of the mth supply point is equal to 83.93 percent of its wheat production. This assumption is justified by available data which shows that in fact this is nearly the case.

Data on transportation costs can be classified according to the mode of transportation available for PNW wheat: truck, barge and rail transportation. Transportation rates are used in this study as transportation costs. Transportation rates can be expected to reflect transportation costs given that the PNW grain transportation market is competitive.

Grain moving by truck within the PNW is not subject to federal economic regulation. Therefore, truck rates for wheat are not published. This means that information about truck rates is not available; specially for year 1977. Given this limitation, transportation costs for truck were calculated based on a worksheet developed by Gosgriff and McDonald, and assuming that 50 percent of the trips have backhaul. A detailed explanation of this procedure, and an illustrative example, is given in Appendix II.

For year 1985 truck transportation rates were used. Rates were collected through a telephone survey made in July 1986. The use of rates as transportation costs is justified by the fact that truck transportation is a highly competitive industry, and hence rates reflect transportation costs.

Grain moving by rail is subject to federal economic regulation. Therefore, rail rates are published and available in tariff form. There are three railroad companies which transport grain in the PNW. These companies are: the Burlington Northern Railroad (BN), the Union Pacific (UP), and the Southern Pacific Railroad (SP).

Rail rates for year 1985 were quoted from BN tariff BN-4022E and UP tariff UP-4035-B. Rail rates for year 1977 were provided by GRATRON, and crosschecked with rates quoted from Minneapolis Grain Exchange Transportation Department.

Barge rates for year 1977 were quoted from Tidewater Barge Lines INC. Rate Schedule No. 3. Rates include a river transfer charge in addition to a base rate. For year 1985, rates were quoted from Tidewater Barge Lines Inc. Rate Schedule No. 3-A, and crosschecked with rates from Knappton Corporation Tariff G-1. Rates for year 1985 include a fuel tax surcharge and a river transfer charge in addition to the base rate.

Chapter Summary and Conclusions

In this chapter I have shown how the PNW grain marketing flow was determined. The procedure can be summarized as follows:

1. A network flow model was constructed to represent the PNW wheat transportation flow. The model involves the different transportation alternatives facing PNW wheat shippers and their costs. The uncapacitated transshipment model was found to be the most appropriate for the purpose of this study.

2. Supply areas were delimited, and several assumptions were made to simplify the model.

3. The model was fitted into a transportation problem format, such that the minimal transportation cost can be found by using the transportation simplex algorithm.

4. Transportation rates were used as transportation costs and collected from truck, barge and railroad companies. For year 1977 truck rates were not available, hence, costs were used.

Up to this point I have given a detailed description of the present project, including the general procedure, the theory and background, and the methodology. We may now present and analyze the results. The presentation and analysis of the results is made in Chapter IV.

CHAPTER IV

THE EMPIRICAL RESULTS

The purpose of this chapter is to present and discuss the results of this project. Specifically, the chapter presents the values of the parameters addressed in Chapter I. These values will determine whether or not the two hypothesis formulated previously will be accepted.

The results are presented in six sections. The first section presents the solutions, and discusses the validation of the models used. The second and third sections discuss the impact of the Stagger Rail Act of 1980 (SRA) on modal share and port share respectively. The fourth section analyzes the impact of the SRA on overall transportation costs. The fifth section discusses the sensitivity of the demand for rail transportation to changes in rail rates, before and after the SRA. Finally, in the last section, a summary and conclusion of the chapter follow.

Model Validation

As Hillier and Lieberman (1980, p. 775) point out:

> "The typical simulation model consist of a high number of elements, rules, and logical linkages. Therefore, even when the individual components have been carefully tested, numerous approximations can still accumulate into gross distortions in the output of the overall model. Consequently, after writing and debugging the computer program it is important to test the validity of the model for

> reasonably predicting the aggregate behavior of the system being simulated. When some form of the real system has already been in operation, its performance data should be compared with the corresponding data from the model."

Following these recommendations, I present and discuss in this section the results obtained from applying the transportation simplex method to PNW wheat transportation model. Results are presented for models A.1, B.1, and B.2.

Models A.1 and B.1 represent the PNW wheat marketing flow for years 1977 and 1985 respectively (a year before and a year after the SRA). Model B.1 considers the different unit train sizes available in the PNW (52, 26, 25, 3 and single car) as a single mode. To do so, the annual supply of each supply point is divided by 12. This calculation gives the average monthly shipment of a given supply point. As explained in the third section of Chapter III, a given supply point will ship its wheat by a given unit train size, if its average monthly shipment meets the capacity required by that unit train size.

The above distinction was made in order to avoid a solution where all wheat shipments go at the multicar rate. Multicar car rates are cheaper the larger the size of the train. If we do not make the distinction mentioned previously, the model would always choose the cheaper multicar car rate available. We know that this does not actually happen. In reality shipments are not always made by the largest train size. Some areas within the PNW do not even have this option available. Also, the largest unit train size may not be available at the specific time a given shipment is scheduled.

Model B.2 also represents the wheat marketing flow for year 1985. As opposed to model B.1, model B.2 assumes that the multicar rate option is not available in the PNW after the SRA. In other words, model B.2 represents the hypothetical situation in which single car rate is the only rail option available for the PNW.

Model A.1 Results and Comparison With the Real Wheat Movement

Table 7 presents the results of model A.1 and the real wheat movement to PNW ports in 1977. In general the model predicts quite well the total wheat shipments to ports by mode (see part 4 of Table 7). The discrepancies begin with the quantity of wheat received at the ports (port share). Part 3 of Table 7 shows that, the model A.1 predicts 99.26 percent of all wheat going to the Lower Columbia ports. In actuality, wheat movement to the Lower Columbia ports was 81.69 percent of all shipments.

The difference in wheat movement to ports predicted by model A.1 and reality leads to the further discrepancies displayed in part 1 of Table 7. Real shipments (in percentage) to the Lower Columbia ports by modes were quite different from those predicted by model A.1. As

Table 7. Comparison of Model A.1 and Real What Movement to PNW Ports (Year 1977)

	Model A.1 Wheat Shipments (*)	%	Real Wheat Movement in 1977 (*)	%
(1) Shipments to Columbia River Ports (CR) by Mode:				
Truck-Barge	3355.70	47.88	3134.03	54.34
Rail	3262.40	46.55	2005.34	34.77
Truck	390.40	5.57	630.38	10.93
TOTAL	7008.10	100.00	5767.45	100.00
(2) Shipments to Puget Sound (PS) by Mode:				
Rail	15.70	30.19	1271.00	98.32
Truck	36.30	69.81	21.72	1.68
TOTAL	52.00	100.00	1292.72	100.00
(3) Total Shipments to PNW Ports (CR + PS)				
Columbia River	7008.10	99.26	5767.45	81.69
Puget Sound	52.00	0.74	1292.72	18.31
TOTAL	7060.10	100.00	7060.17	100.00
(4) Total Shipments to PNW Ports by Mode:				
Truck-Barge	3355.70	47.53	3184.14	45.10
Rail	3278.10	46.43	3218.73	45.59
Truck	426.70	6.04	657.30	9.31
Total	7060.10	100.00	7060.17	100.00

* Thousands of metric tons.

Table 7 shows, 54.34 percent and 34.77 percent of the total real shipment to the Lower Columbia ports, moved by truck-barge and rail respectively. These figures contrast with the results of model A.1, which predicts that 47.88 percent and 46.55 percent of total wheat shipment to the Lower Columbia ports would move by truck-barge and rail respectively.

However, results are not so different if we consider volume of wheat movement instead of percentages. Wheat shipments by truck-barge to CR were 3,355,700 metric tons according to model A.1. Real wheat shipments by truck barge were 3,134,030 metric tons.

Rail shipments to CR were 3,262,400 metric tons, according to model A.1. This is a significant difference from the real rail movement, which was 2,005,340 metric tons. It is important to note that if a port constraint were imposed, real modal share results would be equal to the modal share predicted by model A.1. This constraint would be such that the port share predicted by Model A.1 would be forced to be equal the real port share in 1977. Such a constraint would divert about 11 percent of total wheat shipment from CR to PS.

The small differences between predicted and actual wheat movement by mode could be attributed to the assumptions of the model: perfect information and profit maximizing behavior. It could, also, be attributed to the simplicity of the model, which assumes only 80 supply areas, no shortage of transportation service and no capacity constraint at the grain elevators.

In any case, we can conclude that model A.1. performs well, predicting satisfactorily the amount of wheat shipped to PNW ports by mode. On the other hand the model does not predict satisfactorily the amount of wheat that moves to the ports. The explanation of this phenomenom will be given in subsection entitled "Discussion of Port Share Discrepancies."

Model B.1 Results and Comparison With the Real Wheat Movement

As in model A.1, model B.1 port share predictions do not coincide with the reality. According to model B.1, 99.75 percent of all wheat should have moved to the Lower Columbia ports in 1985 (see part 3 of Table 8). In contrast, the real wheat movement to the Lower Columbia ports was 96.23 percent of that year's total. This difference will be explained in subsection entitled "The Impact of the Staggers Rail Act of 1980 on Port Share."

Modal share results also differ for year 1985. Model B.1 indicates that 66.60 percent and 25.66 percent should have moved by rail and truck-barge respectively in 1985 (see part 4 of Table 8); while the real amount that moved by truck-barge and rail during this year was 40.83 percent and 54.50 percent, respectively.

Again, we should not expect the results of the model

Table 8. Comparison of the Model B.1 and Real Wheat Movement to PNW Ports (Year 1985).

	Model III Wheat Shipments (*)	%	Real Wheat Shipments (*)	%
(1) Shipments to Columbia River Ports (CR) by Mode:				
Truck-Barge	2039.56	25.72	3246.00	42.43
Rail	5295.03	66.77	4024.79	52.61
Truck	595.31	7.57	379.45	4.96
TOTAL	7929.80	100.00	7650.24	100.00
(2) Shipments to Puget Sound (PS) by Mode:				
Rail	0.00	0.00	299.71	100.00
Truck	20.15	100.00	0.00	0.00
TOTAL	20.15	100.00	299.71	100.00
(3) Total Shipments to PNW Ports (CR and PS)				
Columbia River	7929.80	99.75	7650.24	96.23
Puget Sound	20.15	0.25	299.71	3.77
TOTAL	7949.95	100.00	7949.95	100.00
(4) Total Shipments to PNW Ports (CR + PS) by Mode:				
Truck-Barge	2039.56	25.66	3246.00	40.83
Rail	5295.03	66.60	4324.50	54.40
Truck	615.46	7.74	379.45	4.77
Total	7949.95	100.00	7949.95	100.00

* Thousands of metric tons.

B.1 to exactly describe the reality. As mentioned earlier for model A.1, model B.1 assumes that individuals have perfect information about the most economic transportation choices available. This implies that individuals always choose the transportation alternatives that perfectly minimize their costs. This is not the case in real life. Shippers do not have this perfect knowledge; and even when this information exists, they may not act as profit maximizers. This may be true when shippers belong to a particular shipping group or organization and hence are tied legally to chose a shipping pattern that does not minimize their transportation costs.

Another explanation is that the model only take into consideration 78 supply areas, neglecting shipping alternatives that could change the outcome of the model.

Discussion of Port Share Discrepancies

The differences between the values of port share predicted by the models A.1 and B.1, and the real wheat movement to ports, could be attributively to the following factors:

1. The models A.1 and B.1 assume that there are 80 and 78 supply areas respectively in the PNW. This assumption gives the models a great degree of simplicity; however, it neglects some low wheat production areas close to PS. For these areas, wheat

export via Puget Sound may be more convenient than via Lower Columbia River Ports.

2. Rail rates from a given point within the PNW to PS or the Lower Columbia ports are the same. This means there is not cost advantage associated with shipping to either one of these port areas. Therefore shippers must be indifferent when given the choice of sending their grain to PS or CR.

   This equality in rail rates to PNW port areas (also called rate parity) is the main cause of port share discrepancies in this study. If shippers are indifferent about which port area to ship to; the models will reflect this. Hence, the results of the models will show that all shipments are made to one port. The choice of which port this will be, depends on which one the model picks up first.

   It is likely that there would be less discrepancies in port share if instead of rail tariff rates, rail costs had been used. Rail cost depends, among other factors, on mileage. There are studies conducted on PNW grain transportation showing that there is, in fact, a cost advantage associated with shipping wheat to a specific port area.

   Koo and Dinka (1979), evaluated the feasibility of the alternative multiple-car shipment sizes for moving Montana grain to the west coast in 1977. They estimated variable costs of shipping wheat by 50, 25, 10, and single rail car from 14 selected Montana origins, to Portland, OR and Seattle, WA. They found that rail costs to Portland were slightly higher than those to Seattle, because of mileage differences.

The 14 Montana origins selected by Koo and Drinka, were a representative sample of Montana shipping points. They were spatially distributed according to the density of wheat production. In addition, 83 percent of total Montana wheat moved by rail in 1977 (a quantity equivalent to 32 percent of total PNW wheat production for that year). Therefore, we might conclude that PS should have received at least this amount of wheat because of the costs advantage mentioned before. We know that this was not the case.

The above considerations suggest that even when the cost advantage is present, the minimum cost port is not chosen because shippers are paying rail tariff rates, which do not reflex exact costs.

3. This study does not consider other commodities, like corn, which competes with wheat for the same elevator space at the ports. Table 9 shows that corn exports from PNW ports have increased steadily from zero (0)

Table 9. Pacific Northwest Corn Exports by Port Area (in thousands of metric tons).

Year	Columbia River	Port Share %	Puget Sound	Port Share %	Total
1977	0.00	0.00	0.00	0.00	0.00
1978	2.98	1.71	170.93	98.29	173.91
1979	0.00	0.00	4340.95	100.00	4340.95
1980	0.00	0.00	6861.16	100.00	6861.16
1981	6.76	0.13	5156.52	99.87	5163.28
1982	160.74	11.12	1284.76	88.88	1445.50
1983	957.99	21.34	3531.37	78.66	4489.36
1984	5005.16	51.33	4745.78	48.67	9750.94
1985	4104.38	59.51	2792.67	40.49	6897.05

SOURCES: Merchants Exchange 100. Foreign Import and Export Statistics. Monthly Issues.

GRATON (Grain Transportation Consultants of the Pacific Northwest).

in 1977 to 9,750,940 metric tons in 1984. Initially, PS captured, practically, all this traffic until 1981, when it started to share PNW corn exports with CR (see Table 9). By 1985, the Lower Columbia ports (CR) had captured 59.51 percent of PNW corn exports, up from 0.00 percent in 1980. In contrast, PS share of corn export has been decreasing from 100.00 percent in 1980 to only 40.49 percent in 1985.

These changes in corn port share, seem to be related to wheat port share. By first looking back at Table 5 in Chapter I and then make comparisons with Table 9, we can see that there appears to be an inverse relationship between corn and wheat export from CR (the same can be said for PS). In other words, the more corn exported from a given port area, the less the amount of wheat exported through that port area.

The explanation for this inverse relationship between corn port share and wheat port share appears to be that these commodities compete for the same elevator space at the ports. On the other hand, they do not compete for the same transportation means. Corn exported through PNW ports comes from origin points in the middle west, and moves by 72 rail car units, an option not available for PNW wheat shippers.

4. This study does not consider charges at the ports

(such as handling charges and other fees) that could influence the choice of a particular port area. Receiving charges at the ports are the same (this possibility was checked through a telephone survey to port elevators). However, the existence of other fees charged to ocean vessels was not checked.

There is the possibility that a port charge to ocean vessels in the form of tax exists. If this is the case, this maritime tax could be different in the two port areas under consideration.

If this maritime tax is based in a port cost recovery, it would be expected that it is the sum of two cost components. The first component would be an initial fixed charge, aimed to recover the fixed costs of the port. The second component would be a variable charge, which will depend on the quantity of wheat that is handled. This second charge would be aimed at recovering the variable cost of the port (cost of operation).

The particular characteristics and components of this maritime tax are shown in Figure 13 for PS and CR. Note in Figure 13 that the initial fixed charge for CR (C_2), is greater than the initial fixed charge for PS (C_1). The reason for this is that CR has greater fixed costs than PS. As the name indicates, the

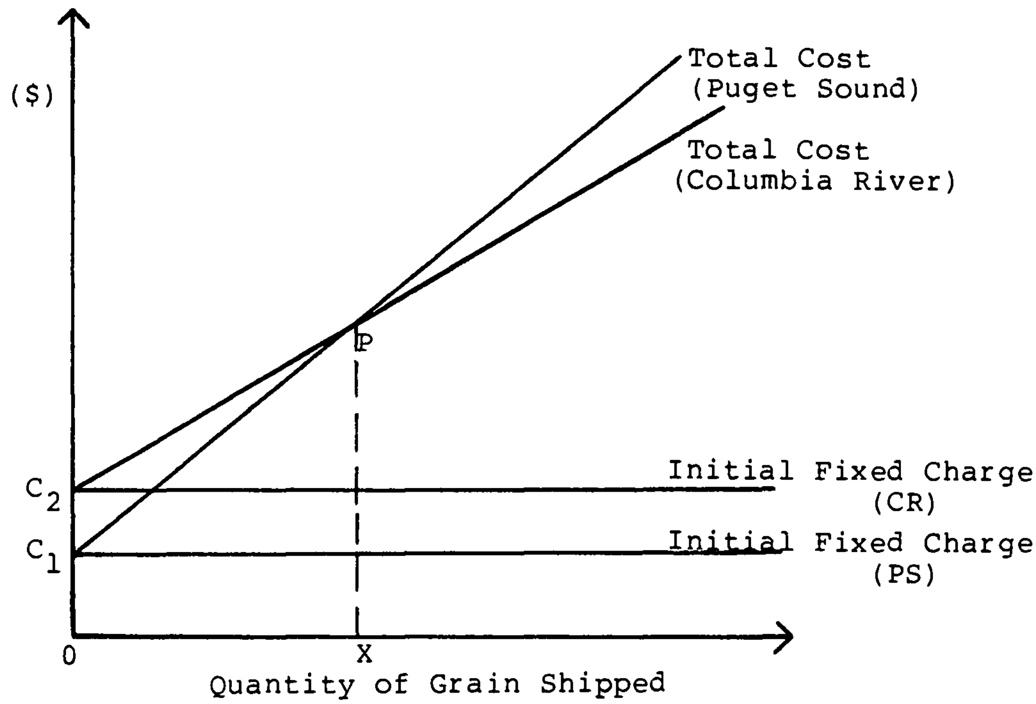


Figure 13. Possible Curve Characteristic for a Maritime Tax at Puget Sound and Columbia River.

Lower Columbia ports are river ports. PS ports on the other hand are maritime ports. Consequently, CR ports not only required a greater investment in port installations, but also the dredging of the Columbia River in order to keep the depth required for ocean vessels. It is this difference that makes fixed cost at CR higher than at PS.

Figure 13 also shows that variable charges for PS increases faster than the variable charge for CR. This is because operation costs are lower for PS ports than for Lower Columbia ports.

The above considerations imply that the total cost curves for both port areas (the summation of fixed and variable charge) intercept at point P (see Figure 13). This point (P) is a break even point with a quantity of wheat (X) associated with it. If the quantity of wheat shipped is equal to "X", shippers will be indifferent between shipping by rail to either PS or CR because transportation rates plus port charges are the same. If the quantity is greater than "X" it will be more economicly to ship to CR. On the other hand, at quantities less than "X", PS would have the advantage.

5. This study does not consider temporary shortages of port elevator capacity. Occasionally, grain can be

diverted from one port area to the other because of temporary or unexpected shortage of elevator capacity. This possibility was confirmed by Kent Casavant who is the author of several studies related to PNW grain transportation. According to Casavant, a significant quantity of wheat was diverted from Cargill grain elevators at Portland to Cargill grain elevators at Seattle in 1977. Cargill is a company that operates 21.22 percent and 50 percent of the total grain elevator capacity at CR and PS respectively. Grain was diverted because of technical problems with the elevators at Portland.

This shortage of elevator capacity suggest that the real port share in 1977 does not reflects completely a cost advantage in shipping to a specific port area. Hence we may speculate that real port share for PS was greater than it should have been for that year.

The Impact of the Staggers Rail Act of 1980 on Pacific Northwest Wheat Movement by Mode

The solutions of model A.1 and B.1 show that a greater percentage of wheat should be moving by rail in 1985 than was in 1977. This result supports the hypothesis that the SRA caused a diversion of traffic from truck-barge to railroads.

Table 7 shows that for 1977 the model A.1 predicts a modal share of 47.53 percent and 46.43 percent for truck-barge and rail respectively. For year 1985, Table 8 shows that these figures are 25.66 percent and 66.60 percent for truck-barge and rail respectively.

Assuming that these two models predicts accurately the optimal conditions under which the system could function, it is obvious that railroads should be able in 1985 to capture 20.17 percent of total wheat traffic from truck-barge. In other words, if shippers had perfect information, and always acted as profit maximizers, 66.60 percent of all wheat would have moved by rail in 1985. Again, this figure contrast with the corresponding 1977's percentage, which is 46.43 percent.

This increase in railroads market share was the result of the increase of railroads competitiveness in high production wheat growing areas, close to the Columbia/Snake River transportation system. Traditionally, truck-barge transportation has had the advantage in these areas. Figure 14 shows PNW supply areas where modal shifts occurred between 1977 and 1985. This information was obtained by comparing the results of model A.1 and B.A. The change in transportation mode is taken here as an indicator of competition between truck-barge and railroads. Changes other than from truck-barge to rail or from rail to truck-barge were not considered.

As Figure 14 shows, changes in mode of transportation occurred in southeastern Washington, Northeastern Oregon,

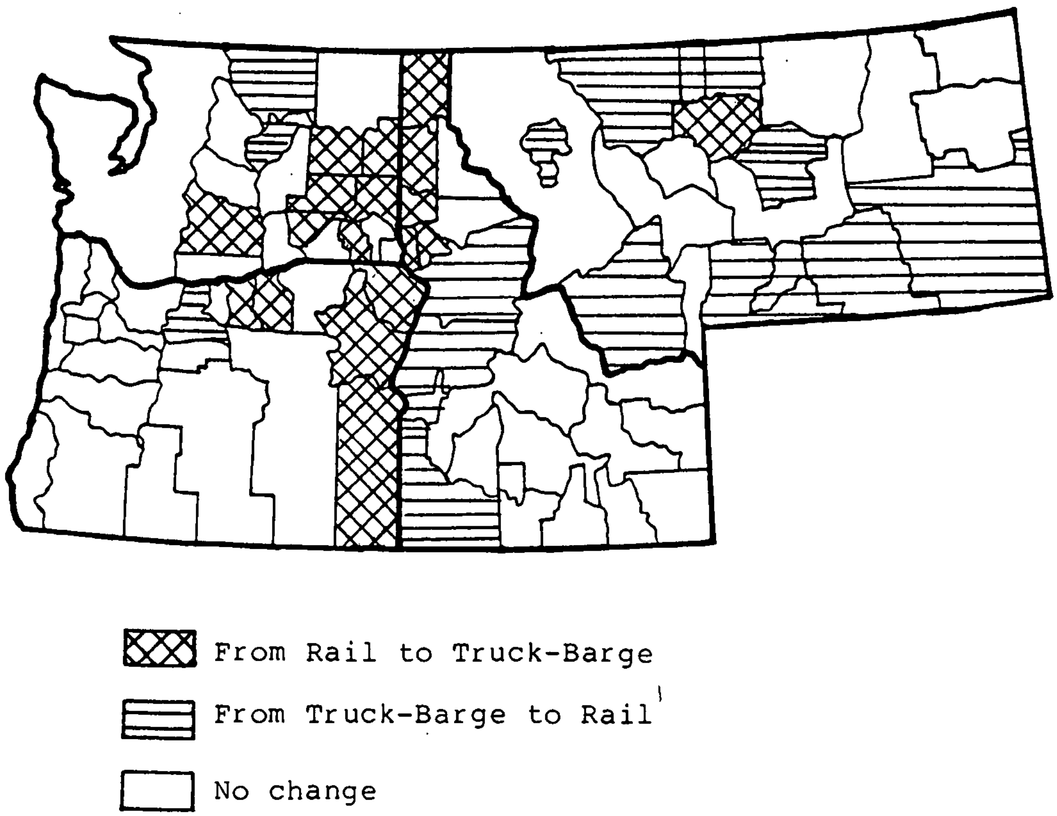


Figure 14. Grain Transportation Modal Shifts in the Pacific Northwest Periods (1977-1985).

and Northern Idaho. These areas are located near the Columbia/Snake River system. There was also evidence of changes in transportation mode all over the southern and north-central part of Montana. This suggests that competition was centered in these areas.

The changes in transportation mode that occurred near the river were mostly from truck-barge to rail. On the other hand, changes in transportation mode experienced by supply areas in Montana were mostly from rail to truck-barge. This observation suggests that railroads were able to capture wheat traffic in those areas where traditionally truck-barge shipments of wheat predominate. Meanwhile, truck-barge captured wheat traffic from railraods in Montana. From these findings it can be concluded that competition between these two modes has been very intense since 1977.

The location of supply areas where modal shifts occurred explains the increase of rail modal share at the expense of truck-barge. Railroads gained traffic in high production wheat growing areas, while truck-barge gained traffic in areas with comparatively low production. Therefore, the volume of wheat traffic that rail lost to truck-barge was small in comparison to the volume of traffic that truck-barge lost to rail.

Model B.2 results are exactly the opposite of model B.1. As mentioned before, model B.2 represents a hypothetical situation. This model assumes that single car rate is the only rail option available for PNW wheat shippers in 1985. On the other hand model B.1 considers 52, 26, 25, 3, and single car as well.

As Table 9 shows, model B.2 predicts a modal share of 66.60 percent and 20.37 percent for truck-barge and rail respectively. Comparing this result with model B.1 we can see that the rail market share falls from 66.6 percent (model B.1 results) to 20.371 (Model B.2 results), when unit trains are not included in the calculations for year 1985. This result suggest that unit train car account for a great deal of the impact of the SRA on PNW wheat transportation.

Before making a final conclusion on modal share, it is important to mention an important result of the SRA: contract rate. As mentioned before information about contract rates is not available. However, it is estimated that contract rates are 10 percent to 25 percent lower than tariff rates. Also, a considerable amount of wheat is now moving under these contracts. Consequently, we might expect the rail market share, given by model B.1, to be even higher if contract rates had been included. This consideration suggests that model B.1 might be underestimating the impact of the SRA on PNW wheat transportation.

In conclusion, the results indicate that in fact the SRA caused a diversion of wheat traffic from truck-barge to railroads. This effect was due mainly to the introduction of unit train car. This diversion of truck-barge wheat traffic to rail was due to the consequence of greater competition in high production wheat growing areas where truck-barge has traditionally had the advantage. Further, this impact would be more remarkable, if contract rates had been included in the calculations. These conclusions rely on the assumption of the models, which are, perfect information and profit maximizing behavior.

The Impact of the Staggers Rail Act of 1980 on Port Share

The comparison of port share results for year 1977 (model A.1) and year 1985 (model B.1) shows that there is not a significant change in wheat movement to PNW ports that could be associated with the Staggers Rail Act of 1980 (SRA). According to model A.1 the port share of the Lower Columbia River ports should have been 99.26 percent in 1977. For year 1985 model B.1 shows that this figure should have been 99.75 percent. This result suggests that there is virtually no change in port share for the period considered. Consequently, it may be concluded that the SRA is not affecting wheat shipments to ports in the Pacific Northwest.

The Impact of the Staggers Rail Act of 1980 on Rate Sensitivity of Rail Traffic Share

This section analyzes how responsive the rail modal share was to changes in rail rates. The analysis was made for year 1977 (before the SRA) and year 1985 (after the SRA). Model A.1 was the base model for 1977, while model B.1 was the base model for 1985. The purpose was to determine to what extent the SRA has affected the rate sensitivity of rail modal share. The own price elasticity of the demand for rail transportation (percent change in rail traffic divided by the percent change of rail rate) was taken as an indicator. It was assumed that only rail rates would change. In other words, truck and barge rates remain constant throughout the analysis. Therefore, all impacts are evaluated in the context of "all other things being equal".

It was also assumed that truck-barge and rail are perfect substitutes; so that, if rail traffic decreases (increases), truck-barge traffic increases (decreases) in the same magnitude. This assumption is justified by the fact that the modal share for the other alternative mode (truck) have remained almost constant during the last ten years (see Table 1).

The results are presented in Table 10. Overall the results indicate that rail modal share was highly elastic for both years. This indicates that a greater than pro-

Table 10. Rate Sensitivity of Rail Traffic Share in the Pacific Northwest.

Year 1977

% Change in Rail Rates (1)	Market Share %	Change in Market Share	% Change in Wheat Traffic (2)	Own Price Elasticity (2):(1)
+10	20.72	-25.71	-55.39	5.54
+ 5	41.40	- 5.03	-10.82	2.16
+ 1	41.69	- 4.74	-10.21	10.21
0	46.43	----	----	----
- 1	47.55	+ 1.12	2.40	2.40
- 5	54.00	+ 7.57	16.31	3.26
-10	56.58	+10.15	22.01	2.21

****

Year 1985

% Change in Rail Rates (1)	Market Share %	Change in Market Share	% Change in Quantity Demanded (2)	Own Price Elasticity (2):(1)
+10	59.70	- 6.9	-10.37	1.04
+ 5	63.00	- 3.6	- 5.45	1.08
+ 1	63.43	- 3.17	- 4.76	4.76
0	66.60	----	----	----
- 1	71.89	5.29	7.93	7.93
- 5	76.89	10.29	15.44	3.09
-10	78.31	11.71	17.57	1.76

portional change in rail modal share accompanied a change in rail rate. Elasticities were generally higher for small changes in rail rates.

In particular, Table 10 shows that, when rates are increased, for year 1977, elasticities are higher than when rates are reduced. For example, an increase of one percent in rail rates causes a decrease of 10.21 percent of rail traffic. On the other hand, a decrease of one percent in rail rates increases rail traffic by only 2.40 percent. This result suggests that, for year 1977, railroads potentially could have captured wheat traffic from truck-barge by reducing rates. On the other hand, increases in rail rates would have led to substantial losses in wheat traffic.

These sensitivity analysis results for year 1977 are similar to those obtained by Logsdon, Casavant, Mittelhammer and Roger (1982). These autors studied the demand for truck-barge transportation of PNW wheat by using an econometric model and 1977 data. Their analysis divided the PNW in two separated areas. The first area included the states of Oregon, Washington, and northern Idaho. The second area grouped southern Idaho and the state of Montana together.

Because of this division, the results of Logsdon, Casavant, Mittelhammer, and Rogers are not numericaly comparable with the results of this study. However they concluded that, overall rail modal share was highly elastic for that year. They also found a potential increase in rail market share through rail rate reductions. Potentially, substantial rail traffic losses, when rail rates are increased, were also found.

The sensitivity analysis for year 1985 showed results similar to those for year 1977. Overall, the rail modal share was highly elastic in relation to rail rates. Elasticities were higher the smaller the change in rail rates. However, there are some differences between elasticities in the two years. First, for year 1985, the rail modal share showed a greater response when rail rates were reduced than when rail rates were increased. Tables 10 and 11 show that when rail rates were reduced by one percent, the rail modal share increased in 7.93 percent. On the other hand for a rate increase of one percent there was a reduction of 4.76 percent in modal share.

The above results imply that railroad could have potentially captured a great deal of wheat traffic by having reduced rates in 1985. This possibility of capturing wheat traffic was greater in 1985 than in 1977. Second, results also indicate that more wheat traffic would have been lost to truck-barge in 1977 than in 1985, had rail rates been increased.

The above considerations suggest that after the SRA, the railroad's possibilities of capturing wheat traffic by reducing rail rates is greater than before the SRA. Also, the railroad's potential to loose wheat traffic when

Table 11. Response of Rail Wheat Traffic to Changes in Rail Rate.

Change in Rail Rate	% Change in Rail Wheat Traffic	
	1977	1985
-1%	+ 2.40	+ 7.93
+1%	-10.21	- 4.76

rail rates are increased seems greater before than after the SRA. In general, the wheat transportation market is shown to be highly competitive both, before and after the SRA. These conclusions are based on the assumption of "all other things being equal."

Before starting the next section it is important to discuss some characteristics of the PNW demand for wheat transportation by rail, that can be derived from the sensitivity analysis.

The different responses of rail market share to rail rate increases than to rail rate reductions suggest that the Pacific Northwest (PNW) rail transportation demand has the characteristics of a kinked demand. This type of demand curve is often used to explain the behavior of the oligopolist. As the name indicates, the kinked demand curve has a kink which divides the curve into two different sections. The upper section has a higher price elasticity than the lower part. This characteristic reflects the behavior of the oligopolist, who expects that the competitors will match any price cut, but will not follow him if he increases his price.

The sensitivity analysis shows that for 1977 the PNW grain rail transportation demand is consistent with this pattern. For that year, elasticities are higher for price increases than for price reductions. For year 1985, results also show that there is a kink in the demand for rail transportation of wheat in the PNW (Table 10).

However, year 1985 differs from 1977 in that elasticities are higher for rate reductions than for rate increases.

This study makes no assumption about the structure of the PNW grain transportation demand. However, it is important to observe that the previous considerations suggest an oligopolistic structure for PNW demand for wheat transportation by rail.

The Impact of the Staggers Rail Act of 1980 on the Overall Wheat Transportation Cost in the PNW

This section explains how the SRA has affected the cost of transporting wheat within the PNW. The variable "Average annual cost of transporting wheat from inland elevators within the PNW to the west coast" (AAC) was introduced; where: AAC = Q/C, Q = total PNW annual wheat exports and C = minimum cost of transporting "Q" from the different supply points to PNW ports.

The value of "C" is given by the value of the objective function for models A.1, B.1 and B.2. It is important to recall here that the variable "C" includes only transportation costs. This follows the assumption made in Chapter III.

The variable "AAC" defined above, expresses how much it cost, on average, to transport a metric ton of PNW wheat to the West Coast, in a given year (1977 and 1985 in this case). The nominal values of AAC, for 1977 and

1985, are presented in Table 12. The average annual cash price of wheat at Portland, OR (AWP) is also given. The AWP is used to calculate the average annual farm price of wheat (AAC - AWP), which is also presented in Table 12.

As was mentioned in the first section of Chapter II, farm prices are equal to the price at central markets (like Portland) minus transportation costs. This relationship suggest that lower transportation costs are translated into higher farm prices (all other things being equal). However, AWP is highly variable. Therefore, the effect of a particular change in transportation costs in farm prices will also depend on wheat prices prevailing at the central market at that moment. Consequently, values of AWP are presented in Table 12 as reference.

Table 12 shows that, according to model B.1, the value of AAC for 1985 (which was 14.23 $/MT) was lower than the value for 1977 (which was 15.03 $/MT). The results for Model B.2, on the other hand, suggest that the value of AAC would be 16.37 $/MT if only single car rates were used in the calculations for 1985.

The above results imply that, in nominal terms, overall transportation cost decreased in the PNW after the SRA. This decrease looks more significant if we take into account that AWP increased during the same period from 106.19 $/MT to 138.34 $/MT. This indicates an increase in farm price from 91.16 $/MT to 124.11 $/MT (see Table 12).

Analyzed in real terms, the impact of the SRA on the

Table 12. Average Annual Cost of Transporting Wheat Within the Pacific Northwest (AAC), Average Annual Cash Price of Wheat at Portland (AWP), OR, and Farm Prices (in dollars/metric tons).

	AAC	AWP	Farm Price
Model A.1 (1977)	15.03	106.19	91.16
Model B.1 (1985)	14.23	138.34	124.11
Model B.2 (1985) (Only single car rates)	16.37	138.34	121.97

NOTE: All figures are in nominal terms (not adjusted for inflation).

cost of transporting wheat within the PNW looks even more significant. Table 13 shows the percent change of AAC from 1985 to 1977. The changes are presented both, in real and nominal term. As reference, the average annual cash price of wheat at Portland (AWP) is also presented. The values of AAC and AWP were deflated using three different indexes. This was done to give a better idea of how transportation costs have changed with respect to different sectors of the economy. The indexes used were: the transportation index, the index of prices paid for all farm inputs, and the GNP deflator.

Again changes are presented according to model B.1 and B.2. Table 13 shows that, according to Model B.1, wheat transportation costs decreased both in nominal and real terms. In nominal terms AAC decreased by 5.32 percent since 1977. In real terms, AAC decreased by 43.18 percent, 47.90 percent, or 41.92 percent depending on the index used. Model B.2 assumes that single car is the only rail option available (as mentioned before). According to Model B.2, AAC increased 8.92 percent in nominal terms. On the other hand, in real terms, AAC decreased in 34.66 percent, 40.12 percent, or 33.18 percent (depending on the index used). Wheat prices, on the other hand, increased 30.28 percent in nominal terms; and decreased more than transportation cost in real terms.

The results suggest that, on the average, transportation cost decreased after the SRA in both real and nominal

Table 13. Percentage Change of the Variables "AWP" and "AAC" During the Period 1977-1985.*

	Change in AAC According to Model B.1	Model B.2	Change in AWP
In Nominal Terms	- 5.32	+ 8.92	+30.28
In Real Terms:			
Using GNP Deflator	-43.18	-34.66	-21.83
Using TI	-47.90	-40.12	-28.35
Using IPFP	-41.92	-33.18	-20.08

(*) Abbreviations:

ACC = Average annual cost of transporting wheat within the PNW to the west coast.

TI = Transportation index.

IPFP = Index of price paid for all farm inputs.

AWP = Average annual cash price of wheat at Portland, OR.

terms. Results also show that even without the use of multiple car rates, real transportation cost were reduced significantly. This reduction of real transportation costs contrast with the nominal increase of real annual average cash prices of wheat at Portland.

These reductions in transportation costs would have been accentuated if contract rate had been used in the calculations. This conjecture is based on the observation that contract rates are lower than tariff rates. Also, the drop by almost 50 percent in the 1985 of Montana wheat crop harvest could have influenced the calculation of AAC. The drop in Montana crop harvest was due to drought conditions. It implies that spatially, the wheat production was not equally distributed for the two years compared. Given that Montana shippers have higher transportation cost to the coast, it is obvious that for 1985 the value of AAC was lower than it would have been in a normal year. However, the exclusion of contract rates may have neutralized this effect.

Chapter Summary and Conclusions

This Chapter has presented and compared the results of models A.1, B.1, and B.2. A discussion of the validity of the models was also given. The following assumptions were made:

- Perfect information,

- Profit maximizing behavior,
- No charges other than transportation costs,
- PNW is significantly represented by supply areas,
- Each supply point exports the same proportion of its wheat production,
- Supply quantities and the wheat transportation flow are given,
- Truck-barge, truck and rail are the only transportation modes.

And these were the results:

In general, the models predict very well the distribution of wheat traffic between modes. The models, however, seemed to have some difficulties in predicting port share. This is due to not considering other factors such as corn export from PNW, other fees charged at the ports, shortages of port elevator capacity, rate parity, etc.

The models do not detect any change in port share that could be attributed to the SRA. This is mainly true because there is no cost advantage associated with shipping to a given port area. Rail rates are from a given supply point to the west coast regardless of the port area.

According to model A.1 and B.1, railroads modal share should have increased from 46.43 percent to 66.60 percent after the SRA. Model B.2. on the other hand suggest that unit train car accounts for a great deal of this modal share shift. In addition, these effects would be accentuated if contract rates were considered. Hence it can be concluded that the SRA in fact diverted wheat traffic from truck-barge to rail.

Sensitivity analysis showed that, overall, the transportation market has been very competitive since 1977. Also, rail modal share was shown to be more sensitive, the lower the change in rail rate. However, it was noted (for railroads) that the opportunities for capturing wheat traffic, by reducing rail rates, are higher after the SRA than they were before. In addition, results show that modal share was more sensitive to rail rate reductions before the SRA than after.

Overall wheat transportation cost decreased significantly both in real (5.32 percent) and nominal terms (44 percent approximately) since 1977. This decrease contrast with the relative increase of wheat prices in nominal term during the same period. When only single car rates were considered, results showed that transportation cost increased 8.92 percent in nominal terms. In real terms, on the other hand, transportation cost decreased an average of 35 percent, when only single car were considered.

Up to this point I have thus far presented a complete study including chapters on the objectives, the procedure, the theory, the methodology, and the results. I will now present a summary, the final conclusions, and the implications of the present research. This will be done in Chapter V. Recommendations for future research in this area will also be given.

CHAPTER V

STUDY SUMMARY, CONCLUSIONS AND EVALUATION

Government policy toward economic regulation has changed dramatically over the last ten years. Market inefficiency and several economic problems have caused government to reduce its intervention in many industries such as telecommunications, banking, and transportation.

This new tendency, called "Deregulation" should not be interpreted in its literal meaning, but rather as the reduction of economic regulation.

In the U.S., economic regulation began with the passage of the Interstate Commerce Act of 1887, to regulate the railroads industry. Since then, regulation has been extended to the other transportation industries: trucks, barges, airlines.

Interstate movements of agricultural bulk commodities by truck and barge, have always been exempt of economic regulation. Deregulation came to the transportation industry as a solution to a conflict. This conflict involves the need for an efficient competition between transportation modes, and the need to maintain common carrier obligations.

The first attempt to deregulate the transportation industry was in the year 1976. In that year, Congress passed the 4R Act of 1976, to reduce to some degree regulation in railroads industry.

The 4R Act was not enough to satisfy the needs of the competitive environment in the transportation industry of the late 70s. Consequently, Congress passed the Staggers Rail Act of 1980 to further deregulate the railroad industry. Truck, barge, and air transportation experienced deregulation as well, with the Motor Carrier Act of 1980, and The Air Cargo Deregulation of 1977.

The most important provisions regarding railroads deregulation are those pertaining to rate making. The Staggers Rail Act of 1980 (SRA) gave railroads more freedom to set rates and legalized contract rates. Another important consequence of the SRA, and possibly the most important one, was the introduction of multicar rates in the PNW.

Since deregulation was passed, there have been many studies attempting to determine if deregulation has provided the benefits it was expected to. Overall these studies agree that this is the case. According to these studies, competition has improved, transportation costs have gone down, and freight now seems to be moving by the more efficient carrier. This is a great benefit to society, since the welfare loss of regulation seems to have been reduced.

In the PNW, big changes occurred after deregulation. Specifically in the area of grain transportation. Grain for export is an important commodity in the area. Wheat accounts for most of this grain movement. The area is characterized by strong intermodal competition between two modes of transportation: truck-barge and rail transportation. Wheat movement by truck is mainly confined to Willamette Valley producers, which account for about five percent of the total wheat movement.

Interstate wheat movements by barge and truck have always been exempt from regulation with the PNW. Therefore, it is expected that changes in the wheat transportation in the area due to deregulation, should be attributed to the SRA. The SRA was expected to affect wheat transportation in the area by increasing competition between truck-barge and railroads.

With more freedom to increase and reduce rates after the SRA, railroads may now be able to capture more traffic from truck-barge. There is evidence that this is happening. Studies done in the area, and statistical figures, show that truck-barge traffic have been decreasing since the SRA. Another possible consequence of the SRA, could have been the diversion of grain traffic from the Lower Columbia ports (CR) to Puget Sound (PS). Figures show that the amount of wheat exported from PS have increased after the SRA.

The present study attempts to determine to what extent the SRA is responsible for this phenomenon. To accomplish this objective, hypothesis "A" and "B" were formulated. Hypothesis "A" posits that "the SRA is not the factor responsible for the increase in railroads wheat traffic at the expense of truck-barge". Hypothesis "B" on the other hand, posits that "the SRA has not caused a diversion of wheat traffic from CR to PS."

The general objective was to test these hypothesis and make a conclusion about the impact of the SRA on PNW wheat transportation. The specific objective was the calculation of the variables defined to test the hypothesis. These variables are: modal share, port share, annual average cost of transporting wheat to PNW ports, and rate sensitivity of rail traffic.

To accomplish these objectives, three linear programming transshipment models were used. These models were denominated A.1, B.1, and B.2. Model A.1 represents the conditions for a year before the SRA (year 1977); Model B.1 was used for year after deregulation (year 1985). Model B.2 was used as a hypothetical situation in which single car rate is assumed to be the only rail rate alternative available in 1985.

The PNW region is assumed to be divided in 80 supply areas in 1977, and 78 supply areas in 1985. The models determine the optimal (or least cost) flow of wheat from the supply areas, to PNW ports for export. Two transportation modes were considered namely truck-barge and rail. Barge terminals, acting as transshipment points were also included.

Rail, barge, and truck transportation rates were among the data required. In addition, statistics about annual wheat production and export from the PNW by county was also required. The data was collected from different transportation companies and government agencies, and through personal interviews.

The results show that, assuming perfect information and profit maximizing behavior, 66.60 percent and 25.66 percent of wheat traffic should have moved by rail and truck barge respectively in 1985. In comparison, in 1977 only 47.53 percent and 46.43 percent should have moved by truck-barge and rail respectively. These results suggest that in fact, there has been a diversion of wheat traffic from truck-barge to railroads after the Staggers Rail Act of 1980 (SRA). Solutions for model B.2 show that when only single car rates were considered in 1985, 20.37 percent and 66.60 percent of wheat traffic moved by rail and truck-barge respectively. This result suggests that multicar rates accounts for most of the impact of the SRA on PNW wheat transportation.

Port share was found not to be influenced by the SRA. The main reason for this is that the only way in which the SRA could have affected the wheat flow to a particular port is by making rates cheaper to any specific port. But rail rates are the same from a point in the PNW to the coast regardless of the port. There are other factors, which were not taken into account in this study, that could account for the changes in port share experienced by the PNW in recent years. They are: the exclusion of other commodities in the analysis, possible differences of fees paid at the ports, and temporary shortage of storage capacity at the ports.

The sensitivity analysis revealed an elastic demand for rail traffic both before and after deregulation. This means that the transportation market has been competitive even before the SRA. However, the SRA seems to have given railroads more ability to capture wheat traffic by lowering rates. Also, results show that a smaller percentage of wheat traffic is lost after the SRA, when rail rates are increased.

One of the most significant impacts of the SRA was on overall transportation costs. Results showed that, in nominal terms, it costs 5.32 percent less, in 1985 than in 1977, to transport a metric ton of wheat from inland terminal elevators within the PNW to the west coast. In real terms, average transportation costs decreased about 44 percent. This decrease in transportation costs contrast with the increase of 30.28 percent in nominal wheat prices during the same period. Real wheat prices, on the other hand, decreased by about 23 percent, a proportion relatively smaller than the decrease in real average transportation costs. These results suggest that more competition, influenced by the SRA, drove down transportation costs.

Finally, it seems that if contract rate had been included in the calculations, the modeled impact of the SRA on PNW wheat transportation would better reflect reality.

Contract rates are 10 percent to 25 percent lower than tariff rates. Because a significant quantity of wheat is now moving under these contracts, it may be expected that model B.1 results would have shown a greater volume of wheat moving by rail if contract rates had been considered.

Given these results, hypothesis "A" was rejected, and hypothesis "B" was accepted. Consequently, this study concludes that in fact the SRA has been responsible for the increase in railroads market share at the expense of truck-barge.

Thus far the study has been described completely from objectives through results. We are now ready to discuss the implications of these findings, and evaluate the different conditions under which the conclusions can be considered valid. This is done in the next section. The suggestions for future research on this topic are also given.

Research Implications

The findings of the present study have the following implications:

1. Barge and transportation çompanies will have to implement more innovative rate making policies to avoid continuing losses of wheat traffic to railroads. Tables 7 and 8 show that the amount of wheat that should be moving by truck-barge decreased from

47.53 percent in 1977 to 25.66 percent in 1985. These calculations are based on the assumptions of perfect information and profit maximizing behavior, which means that, potentially, railroads market share could have been 66.60 percent in 1985 rather than 54.40 percent (which was the real modal share for rail in that year). Therefore it is important that truck-barge take the appropriate measures in order to balance this potentially adverse effect of deregulation.

2. Railroads deregulation have provided the benefits it was expected to in the PNW. In general, transportation costs have gone down. Railroads and the transportation system in general have proved to be more efficient when they were given more freedom to compete. PNW society, in general, has benefitted from deregulation, because the innovations encouraged by the SRA, have provided a more efficient allocation of traffic among carriers in the area, and hence a cost saving through lower grain transportation costs.

   Railroads and grain producers have been the main beneficiaries of railroad's deregulation in the PNW. Railroads have benefitted in that their market share has increased. Grain producers are favored by the Staggers Rail Act of 1980 (SRA) because they are paying lower transportation costs. Barge companies, however, have been adversely influenced by the SRA because they have lost their modal share of wheat traffic to railroads. Shippers, while benefitting from lower rates, seem now more vulnerable to the potential of future rail rate increase.

Study Evaluation and Recommendation for Future Research

When judging the results of this study, and making decisions based on them, the reader has to take into account that this study neither implies the absolute truth nor is it perfect. Real life is a complicated net of causes and effects which is impossible to duplicate exactly, even with the most sophisticated mathematical models.

Limitations of different kinds arise when we are trying to analyze a given system. Based on those limitations, assumptions have to be made in order to simplify the real conditions, and make them possible to work with.

The results of the present study are conditioned by the following factors:

1. As opposed to the period before the SRA (before 1980), the post Staggers Rail Act period has been characterized by a relatively low demand for wheat transportation. This implies that after the SRA there has been a surplus of storage, handling, and

transportation capacity in the PNW. Consequently, we cannot be sure that the results obtained here would have been the same in the case of a strong demand for export wheat. A further study of the impact of deregulation for a year of strong wheat transportation demand is therefore recommended.

2. In 1985 the wheat production of the state of Montana was 50 percent lower than normal. Montana producers are the farthest from the coast. Therefore they are the most sensitive, within the PNW, to changes in transportation rates. Montana traditionally accounts for about 30 percent of PNW wheat exports, therefore production conditions for 1985 were significantly different from 1977. The drop in Montana crops in 1985 may have influenced significantly the results for that year given that wheat shipments are based only on wheat production (in this study). This consideration suggests that if Montana wheat crops had been normal in 1985, transportation costs would have been slightly higher than those obtained in this study. Consequently the replication of the analysis for a normal year after deregulation is recommended.

3. This study could not determine what real factors make wheat move to a specific port area. Among the possible factors, as discussed in Chapter IV, we could include handling charges at the ports, temporary

storage shortages, and other commodities that compete with wheat for the same elevator space. It is recommended that further research on the subject take these factors into consideration.

4. Truck rates for year 1977 were not available. So it was necessary to use cost formulas, to calculate truck transportation costs as substitute for truck rates. On the other hand, for year 1985 truck transportation rates were used. Therefore the comparisons made in this study are based on the assumption that truck costs calculated for 1977, in fact reflect the rates conditions in that moment. If this assumption is not valid, the result of this research could have been affected. For this reason, the use of either transportation costs only, or only transportation rates in the calculations is recommended in future studies.

5. This study could not determine quantitatively how contract rates have been affecting PNW grain transportation. Contract rates were not available, and hence were not used in the calculations. Given that the results of this study would have been influenced significantly by the inclusion of contract rates, it is recommended that future research take this factor into consideration.

6. It is expected that states within the PNW have been affected by deregulation to different degrees. How the SRA has affected shippers within a given state, depends on their proximity to the Columbia/ Snake River system and to the coast. Therefore, shippers located in Montana and southern Idaho are obviously more affected by the SRA than shippers in Oregon, Washington, and northern Idaho. This conclusion is based on the observation that Montana and southern Idaho shippers are the farthest from the coast and the Columbia/Snake River system. This possibility is not explored in this study; its consideration for future research is therefore recommended.

7. Because of data limitations, this study evaluates only a year before the SRA (1977) and a year after the SRA (1985). This implies that this study does not capture what happened between those years. An interesting year to study would be 1980. The study of year 1980 would determine the conditions of the transportation system immetiately before the SRA. Comparing the results obtained for years 1977 and 1985, with year 1980, would give a greater idea of the impact of the SRA on PNW wheat transportation.

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APPENDICES

APPENDIX I

PACIFIC NORTHWEST SUPPLY AREAS, SUPPLY POINTS, COUNTIES, AND WHEAT EXPORTS

APPENDIX I

PACIFIC NORTHWEST SUPPLY AREAS, SUPPLY POINTS, COUNTIES, AND WHEAT EXPORTS

Supply Area #	Supply Point	Counties	Wheat Export (metric tons)
		YEAR 1977	
OREGON			
1	Albany	Linn, Benton	70,132.35
2	Woodburn	Clackamas, Multnomah	19,292.17
3	Harrisburg	Lane	24,635.17
4	Dallas	Polk	56,440.43
5	Cornelius	Washington, Columbia	58,482.73
6	McMinnville	Yamhill	68,711.00
7	Condon	Gilliam	45,883.98
8	Lexington	Morrow	88,841.41
9	Moro	Sherman	71,282.17
10	Maupin	Wasco	44,420.71
11	Pendleton	Umatilla	220,535.73
12	Union	Union, Baker	54,057.38
13	Enterprise	Wallowa	13,388.93
14	Madras	Jefferson	24,346.73
15	Redmond	Deschutes, Crook, Lake	10,646.34
16	Nyssa	Malheur	28,199.31
17	Spray	Wheeler, Grant, Harney	3,380.15
18	Klamath Falls	Klamath	2,048.58
19	Roseburg	Douglas, Jackson, Josephine	9,797.64
20	Salem	Marion	80,918.85
TOTAL OREGON			**995,441.90**
WASHINGTON			
21	Burlington	King, Pierce, Skagit, Island, Lewis, Whatcom, Snohomish	25,749.38
22	Prosser	Benton	83,924.82
23	Ellensburg	Kittitas	10,635.89
24	Brewster	Okanogan	10,201.09
25	Goldendale	Klickitat	26,382.17
26	Wenatchee	Chelan	752.54

PACIFIC NORTHWEST SUPPLY AREAS, SUPPLY POINTS,

COUNTIES, AND WHEAT EXPORTS (continued)

Supply Area #	Supply Point	Counties	Wheat Export (metric tons)
27	Wapato	Yakima	53,894.33
28	Rockford	Spokane	130,831.00
29	Kettle Falls	Stevens, Pend Oreille Ferry	12,243.39
30	Lind	Adams	316,885.80
31	Mansfields	Douglas	118,148.63
32	Connell	Franklin	94,872.17
33	Wheeler	Grant	244,637.88
34	Davenport	Lincoln	291,888.97
35	Clarkston	Asotin	19,432.23
36	Dayton	Columbia	85,329.56
37	Pomeroy	Garfield	66,781.56
38	Walla-Walla	Walla-Walla	190,110.16
39	Colfax	Whitman	334,963.46
TOTAL WASHINGTON			**2,117,665.60**
IDAHO			
40	Bonners Ferry	Boundary, Bonner	8,098.15
41	Worley	Kootenai, Bennewah	43,202.01
42	Kamiah	Clearwater	5,784.10
43	Moscow	Latah	65,782.36
44	Craigmont	Lewis	40,946.49
45	Cottonwood	Idaho	54,724.22
46	Lenore	Nez Pierce	53,902.70
47	Weiser	Washington, Adams, Valley	14,919.08
48	Emmet	Payette, Gem	9,364.93
49	Caldwell	Canyon, Owyhee	54,903.99
50	Mt. Home	Elmore	33,026.01
51	Boise	Ada, Bose, Custer	8,052.17
52	Gooding	Gooding	15,404.05
53	Richfield	Lincoln, Camas, Blaine	15,669.53
54	Burley	Cassia, Minidoka	159,649.05
55	Twin Falls	Jerome, Twin Falls	91,458.57
56	Pocatello	Bannock, Bear Lake, Franklin, Caribou	84,428.60
57	Blackfoot	Bingham, Butte	150,560.06
58	Idaho Falls	Bonneville, Teton, Madison, Jefferson	138,774.46

PACIFIC NORTHWEST SUPPLY AREAS, SUPPLY POINTS,

COUNTIES, AND WHEAT EXPORTS (continued)

Supply Area #	Supply Point	Counties	Wheat Export (metric tons)
59	Ashton	Fremont, Clark, Lemhi	18,428.84
60	American Falls	Power, Oneida	143,254.16
TOTAL IDAHO			**1,210,333.50**
MONTANA			
61	Ronan	Lake	8,930.13
62	Hamilton	Other Northwest (Powell, Sanders, Mineral, etc.)	22,041.03
63	Shelby	Toole, Pondera, Teton, Glacier	344,179.98
64	Fort Benton	Chouteau	316,431.94
65	Malta	Phillips, Blaine	156,887.66
66	Glasgow	Valley, Garfield	167,561.17
67	Harrison	Beaverhead, Madison Silver Bow, Jefferson	15,468.86
68	Rapelje	Stillwater	37,246.50
69	Edgar	Carbon, Park, Sweet Grass	30,049.30
70	Hardin	Bighorn, Treasure, Yellowstone	113,547.68
71	Miles City	Custer, Prairie, Wibaux, Rosebud, etc.	144,861.67
72	Sidney	Richland,McCone,Dawson	211,484.36
73	Scobey	Daniels, Sheridan, Roosevelt	396,445.90
74	Lewistown	Fergus	104,592.47
75	Roundup	Petroleum, Wheatland, Judith Basin, Golden Valley, Musselshell	83,400.13
76	G. Falls	Cascade	103,549.36
77	Helena	Lewis and Clarck, Meagher, Broadwater	35,638.99
78	Bozeman	Gallatin	42,919.81
79	Chester	Liberty	116,810.90
80	Havre	Hill	284,699.28
TOTAL MONTANA			**2,736,733.50**

PACIFIC NORTHWEST SUPPLY AREAS, SUPPLY POINTS,

COUNTIES, AND WHEAT EXPORTS (continued)

Supply Area #	Supply Point	Counties	Wheat Export (metric tons)
		YEAR 1985	
OREGON			
1	Pendleton	Umatilla	340,817.97
2	Union	Union	56,885.55
3	Baker	Baker	19,541.04
4	Enterprise	Wallowa	16,307.10
5	Madras	Jefferson	55,884.51
6	Redmond	Lake, Deschutes, Crook	14,634.38
7	Nyssa	Malheur	90,884.62
8	Spray	Wheeler, Grant, Harney	5,303.44
9	Roseburg	Josephine, Douglas, Jackson	12,860.52
10	Albany	Linn, Benton	87,176.10
11	Woodburn	Clackamas, Multnomah	28,913.47
12	Harrisburg	Lane	23,615.22
13	Salem	Marion	67,842.54
14	Dallas	Polk	60,399.57
15	Cornelius	Washington, Columbia	45,409.90
16	McMinnville	Yamhill	77,697.34
17	Condon	Gilliam	95,026.23
18	Lexington	Morrow	172,889.54
19	Moro	Sherman	94,185.98
20	Dufur	Wasco	70,345.14
21	Klamath Falls	Klamath	16,703.89
TOTAL OREGON			**1,453,324.89**
WASHINGTON			
22	Rockford	Spokane	127,230.68
23	Kettle Falls	Stevens, Ferry, Pend Oreille	12,007.30
24	Lind	Adams	398,476.79
25	Mandfields	Douglas	229,072.30
26	Connell	Franklin	170,150.94
27	Wheeler	Grant	228,034.94
28	Davenport	Lincoln	94,807.27
29	Clarkston	Asotin	18,153.58
30	Dayton	Columbia	115,378.99

PACIFIC NORTHWEST SUPPLY AREAS, SUPPLY POINTS,

COUNTIES, AND WHEAT EXPORTS (continued)

Supply Area #	Supply Point	Counties	Wheat Export (metric tons)
31	Pomeroy	Garfield	66,390.25
32	Walla-Walla	Walla-Walla	204,742.19
33	Colfax	Whitman	266,183.00
34	Burlington	Skagit, Island, Lewis, Whatcom, Snohmish, Pierce, King	20,150.48
35	Prosser	Benton	102,982.69
36	Ellensburg	Kittitas	19,579.94
37	Brewster	Okanogan	8,739.66
38	Goldendale	Klickitat	40,871.50
39	Waterville	Chelan	2,982.38
40	Wapato	Yakima	132,936.10
T.30	Coulee City	Douglas	
TOTAL WASHINGTON			**86,622.82**
IDAHO			
41	Bonners Ferry	Boundary, Bonners	18,283.25
42	Worley	Kootenai, Bennewah	63,641.28
43	Kamiah	Clearwater	11,099.62
44	Moscow	Latah	123,781.50
45	Craigmont	Lewis	62,163.06
46	Cottonwood	Idaho	83,065.61
47	Lenore	Nez Perce	113,148.69
48	Weiser	Washington, Adams, Valley	9,777.00
49	Emmet	Payette, Gem	21,396.29
50	Caldwell	Canyon, Owyhee	74,092.56
51	Mt. Home	Elmore	39,860.08
52	Boise	Ada, Boise, Custer	28,890.14
53	Gooding	Gooding	16,338.22
54	Richfield	Lincoln, Camas, Blaine	27,826.85
55	Burley	Cassia, Minidoka	228,449.88
56	Twin Falls	Jerome, Twin Falls	138.978.64
57	Pocatello	Bannock, Bear Lake, Franklin, Caribou	140,405.00
58	Blackfoot	Bingham, Butte	211,541.11
59	Idaho Falls	Bonneville, Jefferson, Teton, Madison	245,877.32
60	Ashton	Fremont, Clark, Lemhi	45,046.82

PACIFIC NORTHWEST SUPPLY AREAS, SUPPLY POINTS,

COUNTIES, AND WHEAT EXPORTS (continued)

Supply Area #	Supply Point	Counties	Wheat Export (metric tons)
61	American Falls	Power, Oneida	164,341.79
TOTAL IDAHO			**1,868,003.70**
MONTANA			
62	Ronan	Lake	11,506.78
63	Plains	Powell, Sanders, Ravalli, Granite, Missoula, Mineral, Lewis and Clark, Meagher, Broadwater	39,678.56
64	Shelby	Toole, Pondera, Teton, Glacier	131,807.99
65	Fort Benton	Choteau, Liberty, Hill	297,145.63
66	Malta	Phillips, Blaine	70,080.61
67	Glasgow	Valley, Garfield	78,926.59
68	Sidney	Richland,McCone,Dawson	136,636.84
69	Wolf Point	Daniels, Sheridan, Roosevelt	130,734.33
70	Lewistown	Fergus	42,619.42
71	Harlowtown	Petroleum, Wheatland, Judith Basin, Golden Valley, Musselshell	33,571.16
72	Great Falls	Cascade	45,192.05
73	Bozeman	Gallatin	30,591.38
74	Harrison	Jefferson, Silver Bow	17,256.28
75	Rapelje	Stillwater	11,180.01
76	Edgar	Carbon, Park, Sweet Grass	14,636.97
77	Hardin	Bighorn, Treasure, Yellowstone	86,364.38
78	Miles City	Custer, Prairie, Wibaux, Rosebud, etc.	124,979.64
T.31	Moore	Fergus	
TOTAL MONTANA			**1,302,908.70**

APPENDIX II

TRUCK TRANSPORTATION OF GRAIN

APPENDIX II

TRUCK TRANSPORTATION OF GRAIN

Cost Estimates

Given:

- 1977 Semi-tractor w/trailer; $76,500
- Five year service life
- Intereat rate at 12.5%
- Capacity 850 bu. wheat
- Diesel fuel 45¢/gal.; average 5 mpg.
- Average trip of 200 miles round trip
- 100,000 miles/year

1) Fixed Costs/Year

•Interest & depreciation	$15,173
•Maintenance (5% purchase value)	3,825
•Administrative	600
•Insurance	7,000
•Licensing (multi-state)	3,000
•Tax	2,700
	$32,298/yr.

2) Variable Costs/Mile

•Fuel	9.0¢
•Lubrication	.6
•Tires	5.4
•Driver's wages	17.0
•Transfer	3.0
	35.0¢/mile

3) Total Costs

- The fixed costs are spread across the miles traveled per year. Thus, if annual mileage totaled 100,000 miles

Fixed Cost = \$32,298 ÷ 100,000	32.3¢/mile
Variable Cost	35.0¢/mile
TOTAL COST	67.3¢/mile

or

Fixed Cost	\$32,298/year
Variable Cost - \$.47(100,000)=	\$35,000/year
TOTAL COST	\$67,298/year

4) Cost Per Bushel

- Total Cost for 200 mile trip (100 miles one way and assuming 50% backhaul).

(67.3¢/mile)x(150 miles) = \$134.60

\$134.60 ÷ 850 bu. = 15.84¢/bu.

- Variable Costs Only for the 200 mile trip:

(47¢/mile) x (200 miles) = \$94

\$94 ÷ 850 bu. = 11.1¢/bu.

APPENDIX III

PACIFIC NORTHWEST SUPPLY POINTS, TRANSSHIPMENT POINTS, AND TRANSPORTATION RATES FOR YEAR 1977

(in \$/metric tons)

APPENDIX III

PACIFIC NORTHWEST SUPPLY POINTS, TRANSSHIPMENT POINTS, AND TRANSPORTATION RATES FOR YEAR 1977 (in $/metric tons)

Supply Point (Origin)	Transshipment Point (TP)	Truck Rate to			Barge Rate From TP to Lower Columbia Ports	Rail Rate to	
		TP	CR*	PS**		CR*	PS**
OREGON							
1. Albany	----------	-----	3.01	-----	----	7.50	-----
2. Woodburn	----------	-----	1.31	-----	----	5.40	-----
3. Harrisburg	----------	-----	4.80	-----	----	8.16	-----
4. Dallas	----------	-----	2.62	-----	----	6.50	-----
5. Cornelius	----------	-----	.74	-----	----	5.40	-----
6. McMinnville	----------	-----	1.66	-----	----	5.40	-----
7. Condon	Arlington	1.66	-----	-----	2.40	5.73	-----
8. Lexington	Hogue Warner	2.00	-----	-----	2.25	5.73	-----
9. Moro	Biggs	.74	-----	-----	1.93	-----	-----
10. Maupin	Umatilla	1.70	-----	-----	2.25	5.07	-----
11. Pendleton	Umatilla	1.67	-----	-----	2.25	6.50	-----
12. Union	Hogue Warner	6.02	-----	-----	2.25	8.60	-----
13. Enterprise	Lewiston	4.15	-----	-----	3.37	9.48	-----
14. Madras	The Dalles	3.88	-----	-----	1.80	6.17	-----
15. Redmond	Madras	1.13	-----	-----	----	7.72	-----
16. Nyssa	Arlington	12.96	-----	-----	2.40	12.79	-----
17. Spray	Arlington	3.97	-----	-----	2.40	-----	-----
18. Klamath Falls	----------	-----	12.31	-----	----	12.68	-----
19. Roseburg	----------	-----	7.72	-----	----	16.09	-----
20. Salem	----------	-----	2.05	-----	----	6.50	-----
WASHINGTON							
21. Burlington	----------	-----	-----	2.71	----	-----	5.40
22. Prosser	Kennewick	1.13	-----	-----	2.25	6.50	5.73
23. Ellensburg	----------	-----	-----	4.89	----	6.50	5.40
24. Brewster	----------	-----	-----	10.38	----	8.16	8.16
25. Goldendale	Biggs	.65	-----	-----	1.93	5.40	9.48
26. Wenatchee	Ellensburg	3.40	-----	-----	----	6.50	6.50
27. Wapato	Biggs	3.10	-----	-----	1.93	6.50	5.40
28. Rockford	Central Ferry	3.70	-----	-----	3.17	7.94	7.94
29. Kettle Falls	----------	-----	-----	15.01	----	12.46	12.46
30. Lind	Windust	1.53	-----	-----	2.66	6.50	6.50

APPENDIX III

PACIFIC NORTHWEST SUPPLY POINTS, TRANSSHIPMENT POINTS, AND TRANSPORTATION RATES FOR YEAR 1977 (in $/metric tons) (continued)

Supply Point (Origin)	Transshipment Point (TP)	Truck Rate to			Barge Rate From TP to Lower Columbia Ports	Rail Rate to	
		TP	CR*	PS**		CR*	PS**
31. Mansfield	Pasco	5.89	-----	-----	2.25	7.72	7.72
32. Connell	Pasco	1.44	-----	-----	2.25	6.50	6.50
33. Wheeler	Pasco	3.19	-----	-----	2.25	7.50	7.50
34. Davenport	Windust	4.06	-----	-----	2.66	8.82	8.82
35. Clarkston	Lewiston	.09	-----	-----	3.37	7.50	7.50
36. Dayton	Lyons Ferry	1.31	-----	-----	2.98	6.50	6.50
37. Pomeroy	Central Ferry	1.05	-----	-----	3.17	6.50	6.50
38. Walla-Walla	Sheffler	2.05	-----	-----	2.66	6.50	6.50
39. Colfax	Almota	.92	-----	-----	3.17	6.94	6.94
IDAHO							
40. Bonners Ferry	Central Ferry	9.25	-----	-----	3.17	14.00	14.00
41. Worley	Wilma	3.71	-----	-----	3.37	7.94	7.94
42. Kamiah	Clarkston	2.97	-----	-----	3.37	9.48	9.48
43. Moscow	Almota	1.92	-----	-----	3.17	7.50	7.50
44. Craigmont	Clarkston	1.75	-----	-----	3.37	9.48	9.48
45. Cottonwood	Craigmont	.39	-----	-----	----	9.48	9.48
46. Lenore	Lewiston	1.13	-----	-----	3.37	7.50	7.50
47. Weiser	Lewiston	10.26	-----	-----	3.37	12.79	15.32
48. Emmet	Weiser	2.09	-----	-----	----	12.79	15.32
49. Caldwell	Lewiston	12.31	-----	-----	3.37	12.79	15.32
50. Mt. Home	Clarkston	14.05	-----	-----	3.37	7.94	7.94
51. Boise	Clarkston	12.04	-----	-----	3.37	12.79	15.32
52. Gooding	Pasco	22.74	-----	-----	2.25	14.66	15.32
53. Richfield	Pasco	24.13	-----	-----	2.25	15.54	15.54
54. Burley	Lewiston	19.03	-----	-----	3.37	16.09	16.09
55. Twin Falls	Lewiston	17.76	-----	-----	3.37	16.09	16.09
56. Pocatello	Lewiston	22.34	-----	-----	3.37	20.72	20.72
57. Blackfoot	Lewiston	22.34	-----	-----	3.37	21.94	21.94
58. Idaho Falls	Lewiston	21.64	-----	-----	3.37	24.14	24.14
59. Ashton	Lewiston	22.56	-----	-----	3.37	25.79	25.79
60. American Falls	Lewiston	21.25	-----	-----	3.37	17.86	17.86

APPENDIX III

PACIFIC NORTHWEST SUPPLY POINTS, TRANSSHIPMENT POINTS, AND TRANSPORTATION RATES FOR YEAR 1977 (in $/metric tons) (continued)

Supply Point (Origin)	Transshipment Point (TP)	Truck Rate to			Barge Rate From TP to Lower Columbia Ports	Rail Rate to	
		TP	CR*	PS**		CR*	PS**
MONTANA							
61. Ronan	Lewiston	14.48	-----	-----	3.37	16.64	16.64
62. Hamilton	Lewiston	11.56	-----	-----	3.37	16.64	16.64
63. Shelby	Lewiston	19.38	-----	-----	3.37	22.60	22.60
64. Fort Renton	Lewiston	18.68	-----	-----	3.37	22.60	22.60
65. Malta	Lewiston	25.62	-----	-----	3.37	28.00	28.00
66. Glasgow	Lewiston	28.67	-----	-----	3.37	30.75	30.75
67. Harrison	Lewiston	18.24	-----	-----	3.37	20.61	20.61
68. Rapelje	Lewiston	24.18	-----	-----	3.37	26.24	26.24
69. Edgar	Lewiston	24.44	-----	-----	3.37	26.24	26.24
70. Hardin	Lewiston	26.31	-----	-----	3.37	27.78	27.78
71. Miles City	Lewiston	29.63	-----	-----	3.37	31.97	31.97
72. Sidney	Lewiston	33.25	-----	-----	3.37	32.52	32.52
73. Scobey	Lewiston	33.20	-----	-----	3.37	32.52	32.52
74. Lewistown	Lewiston	21.42	-----	-----	3.37	24.03	24.03
75. Roundup	Lewiston	23.26	-----	-----	3.37	27.12	27.12
76. Great Falls	Lewiston	16.84	-----	-----	3.37	21.72	21.72
77. Helena	Lewiston	14.53	-----	-----	3.37	21.72	21.72
78. Bozeman	Lewiston	18.28	-----	-----	3.37	21.27	21.27
79. Chester	Lewiston	21.99	-----	-----	3.37	23.37	23.37
80. Havre	Lewiston	21.77	-----	-----	3.37	24.03	24.03

NOTE: Dashes indicate either that the option is not available for that particular point or the option was not used, and hence the information was not available.

* Lower Columbia River Ports

** Puget Sound

APPENDIX IV

PACIFIC NORTHWEST SUPPLY POINTS, TRANSSHIPMENT POINTS, AND TRANSPORTATION RATES FOR YEAR 1985

(in $/metric tons)

APPENDIX IV

PACIFIC NORTHWEST SUPPLY POINTS, TRANSSHIPMENT POINTS, AND TRANSPORTATION RATES FOR YEAR 1985 (in $/metric tons)

Supply Point (Origin)	Transshipment Point (TP)	Truck Rate to			Barge Rate From TP to Lower Columbia Ports	Rail Rate to Either Columbia River Ports (CR) of Puget Sound (PS)			
		TP	CR*	PS**		Single Car	3 Cars	25/26 Cars	52 Cars
OREGON									
1. Pendleton	Umatilla	5.88	-----	-----	4.38	10.58	8.38	5.95	-----
2. Union	Arlington	8.00	-----	-----	4.38	15.21	13.01	10.80	-----
3. Baker	Umatilla	8.00	-----	-----	4.38	16.09	13.80	11.46	-----
4. Enterprise	Lewiston	9.19	-----	-----	5.70	15.09	13.89	11.46	-----
5. Madras	----------	-----	9.04	-----	----	-----	9.48	-----	-----
6. Redmond	Madras	3.58	-----	-----	----	-----	12.30	-----	-----
7. Nyssa	Arlington	11.15	16.53	-----	4.38	20.17	15.76	13.62	-----
8. Spray	----------	6.60	-----	-----	4.38	-----	-----	-----	-----
9. Roseburg	----------	-----	9.94	-----	----	32.19	-----	-----	-----
10. Albany	----------	-----	7.50	-----	----	9.26	-----	-----	-----
11. Woodburn	----------	-----	6.00	-----	----	11.02	-----	-----	-----
12. Harrisburg	----------	-----	7.60	-----	----	11.02	-----	-----	-----
13. Salem	----------	-----	6.00	-----	-----	9.26	-----	-----	-----
14. Dallas	----------	-----	7.00	-----	----	13.23	-----	-----	-----
15. Cornelius	----------	-----	8.81	-----	----	10.58	-----	-----	-----
16. McMinnville	----------	-----	6.00	-----	----	11.02	-----	-----	-----
17. Condon	Arlington	5.14	-----	-----	4.38	11.24	6.61	6.61	-----
18. Lexington	Hogue Warner	5.14	-----	-----	4.38	11.24	6.61	6.61	-----
19. Moro	Biggs	2.57	-----	-----	3.86	-----	-----	-----	-----
20. Dufur	The Dalles	2.20	-----	-----	3.46	-----	-----	-----	-----
21. Klamath Falls	----------	-----	14.00	-----	----	17.86	-----	-----	-----
WASHINGTON									
22. Rockford	Central Ferry	6.61	-----	-----	5.46	13.89	11.46	9.48	-----
23. Kettle Falls	Central Ferry	13.60	-----	-----	5.46	22.27	-----	18.96	-----
24. Lind	Windust	3.67	-----	-----	4.85	11.24	-----	8.60	-----
25. Ritzville	Windust	4.39	-----	-----	4.85	11.68	-----	8.60	-----
26. Mansfield	Coulee City	2.94	-----	-----	----	-----	-----	-----	-----
27. Connell	Burbank	4.04	-----	-----	4.38	11.24	-----	8.38	-----
28. Wheeler	Pasco	6.61	-----	-----	4.38	12.13	-----	8.82	-----
29. Moses Lake	Pasco	6.25	-----	-----	4.38	12.35	11.02	9.04	-----
30. Davenport	----------	-----	-----	-----	----	11.02	-----	11.02	-----

APPENDIX IV

PACIFIC NORTHWEST SUPPLY POINTS, TRANSSHIPMENT POINTS, AND TRANSPORTATION RATES FOR YEAR 1985 (in $/metric tons) (continued)

Supply Point (Origin)	Transshipment Point (TP)	Truck Rate to			Barge Rate From TP to Lower Columbia Ports	Rail Rate to Either Columbia River Ports (CR) of Puget Sound (PS)			
		TP	CR*	PS**		Single Car	3 Cars	25/26 Cars	52 Cars
31. Odessa	Windust	6.61	-----	-----	4.85	13.89	12.35	10.36	-----
32. Clarkston	Lewiston	1.39	-----	-----	5.70	11.46	9.48	7.05	-----
33. Dayton	Lyons Ferry	2.94	-----	-----	5.23	11.46	9.48	7.05	-----
34. Pomeroy	Central Ferry	2.76	-----	-----	5.46	-----	-----	-----	-----
35. Walla-Walla	Wallula	3.31	-----	-----	4.38	11.24	9.04	6.61	-----
36. Waitsburg	Kennewick	3.67	-----	-----	4.38	11.90	9.48	9.04	-----
37. Colfax	Almota	2.57	-----	-----	5.46	11.46	9.48	7.05	-----
38. Oakesdale	Central Ferry	7.05	-----	-----	5.46	12.13	9.92	6.17	-----
39. La Crosse	Central Ferry	3.34	-----	-----	5.46	10.80	8.60	8.82	-----
40. Uniontown	Clarkston	1.80	-----	-----	5.70	13.45	11.02	-----	-----
41. Burlington	----------	-----	-----	7.00	----	-----	-----	9.26	-----
42. Prosser	Umatilla	3.67	-----	-----	4.38	12.13	8.60	9.26	-----
43. Ellensburg	Umatilla	10.45	-----	8.92	4.38	12.13	8.60	9.26	-----
44. Brewster	----------	-----	-----	-----	----	15.65	-----	-----	-----
45. Goldendale	The Dalles	3.69	-----	-----	3.46	10.14	8.16	-----	-----
46. Waterville	Kennewick	10.66	-----	-----	4.38	-----	-----	15.21	-----
47. Wapato	Biggs	6.06	-----	-----	3.86	12.13	8.60	9.26	-----
T.30 Coulee City	Windust	11.02	-----	-----	4.85	14.53	13.23	11.02	-----
IDAHO									
48. Bonners Ferry	Central Ferry	14.70	-----	-----	5.46	20.28	-----	17.20	-----
49. Worley	----------	-----	-----	-----	----	11.41	11.68	9.70	-----
50. Kamiah	Wilma	5.57	-----	-----	5.70	13.67	11.46	-----	-----
51. Moscow	Lewiston	4.04	-----	-----	5.70	11.90	9.92	7.50	-----
52. Craigmont	Lewiston	4.23	-----	-----	5.70	12.57	10.58	9.48	-----
53. Cottonwood	Lewiston	5.70	-----	-----	5.70	13.67	11.46	-----	-----
54. Lenore	Lewiston	7.35	-----	-----	5.70	11.68	9.70	-----	-----
55. Weiser	Lewiston	8.82	-----	-----	5.70	20.06	15.65	13.56	-----
56. Emmet	Burbank	8.82	-----	-----	4.38	-----	-----	15.87	-----
57. Caldwell	Arlington	11.02	-----	-----	4.38	20.28	15.87	13.67	-----
58. Mt. Home	Clarkston	15.01	-----	-----	5.70	22.93	18.52	16.31	-----
59. Boise	Clarkson	13.40	-----	-----	5.70	20.28	15.87	13.67	-----
60. Gooding	----------	-----	-----	-----	----	24.69	20.28	18.08	-----

APPENDIX IV

PACIFIC NORTHWEST SUPPLY POINTS, TRANSSHIPMENT POINTS, AND TRANSPORTATION RATES FOR YEAR 1985 (in $/metric tons) (continued)

Supply Point (Origin)	Transshipment Point (TP)	Truck Rate to			Barge Rate From TP to Lower Columbia Ports	Rail Rate to Either Columbia River Ports (CR) of Puget Sound (PS)			
		TP	CR*	PS**		Single Car	3 Cars	25/26 Cars	52 Cars
61. Richfield	Lewiston	9.19	-----	-----	5.70	26.46	22.05	19.84	-----
62. Burley	----------	-----	-----	-----	----	27.12	22.71	20.50	-----
63. Twin Falls	Lewiston	17.98	25.72	-----	5.70	27.12	22.71	20.50	-----
64. Pocatello	----------	-----	-----	-----	----	28.44	24.03	21.83	-----
65. Blackfoot	----------	-----	-----	-----	----	28.54	25.13	22.83	-----
66. Idaho Falls	----------	-----	27.56	-----	----	30.64	26.24	24.03	-----
67. Ashton	Lewiston	23.69	-----	-----	5.70	31.31	26.90	24.70	-----
68. American Falls	Lewiston	18.07	-----	-----	5.70	27.78	23.37	21.16	-----
MONTANA									
69. Ronan	Lewiston	15.43	-----	-----	5.70	26.24	-----	20.94	18.52
70. Plains	Lewiston	15.62	-----	-----	5.70	25.13	-----	21.38	17.64
71. Shelby	Lewiston	20.02	-----	-----	5.70	34.83	-----	29.76	26.46
72. Fort Benton	Lewiston	20.75	-----	-----	5.70	-----	-----	-----	26.46
73. Malta	Lewiston	25.90	-----	-----	4.70	40.01	-----	35.27	31.53
74. Glasgow	----------	-----	-----	-----	----	43.65	-----	38.58	34.39
75. Sidney	Lewiston	34.17	-----	-----	5.70	45.42	-----	41.23	37.26
76. Wolf Point	----------	-----	-----	-----	----	43.21	-----	40.34	35.49
77. Lewistown	Moore	2.67	-----	-----	----	-----	-----	-----	-----
78. Harlowton	Lewiston	25.35	-----	-----	5.70	-----	-----	-----	-----
79. Great Falls	Lewiston	18.18	-----	-----	5.70	33.73	-----	28.66	25.57
80. Bozeman	----------	-----	-----	-----	----	33.51	-----	29.54	26.46
81. Harrison	Lewiston	18.74	-----	-----	5.70	33.95	-----	28.98	26.90
82. Rapelje	Lewiston	23.12	-----	-----	5.70	38.14	-----	33.73	30.20
83. Edgar	Lewiston	18.74	-----	-----	5.70	36.82	-----	32.63	29.10
84. Mardin	Lewiston	15.43	-----	-----	5.70	38.36	-----	32.19	29.98
85. Miles City	Lewiston	27.49	-----	-----	5.70	44.09	-----	38.14	33.95
T.31 Moore	Lewiston	17.64	-----	-----	5.70	37.04	-----	33.95	27.78

NOTE: Dashes indicate either that the option is not available for that particular point, or the option was not used and hence the information was not available.

* Lower Columbia River Ports
** Puget Sound