THE EFFECT OF USER FEES ON GREAT LAKES GRAIN TRANSPORTATION

By

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ABSTRACT

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Three alternative versions of deep draft user fee legislation are presented and analyzed in this dissertation. The framework of institutional economics is used to analyze the impact of each alternative on the structure of property rights within the export grain transportation system. Each alternative has different provisions for the treatment of the Great Lakes - St. Lawrence Seaway system and these are explored in detail.

A multinomial logit technique is used to model the export shipments of corn from the Great Lakes hinterland to the four alternative coastal ports: East Coast, West Coast, Gulf Coast, and Great Lakes. This model is then used to estimate the impact of two alternative user fee proposals on the pattern of shipments for export. The model is based on a theory of shipper choice, where inland grain elevators respond to the difference between price offered at the destination port and the transport charge of shipping to that port.

The results of both the institutional analysis and the empirical analysis show that the Hatfield proposal for a deep draft user fee would be more beneficial for the Great Lakes ports than the Moynihan or Reagan administration proposals. However, the empirical estimation

showed little diversion of corn shipments under any of the currently proposed levels of user fees.

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INTRODUCTION

1.1 Problem Setting

1.1.1 Importance of Agricultural Exports

The United States has increasingly relied upon export markets as an outlet for agricultural grain production. The increased productivity of American farmers has resulted in a situation of domestic oversupply and the need to look elsewhere for markets in feed and food grains. Over the last 30 years, corn exports have gone from 4.2 percent to 35.3 percent of total production. Wheat exports have nearly doubled their share of total production, going from 33.9 percent in 1950 to 63.7 percent in 1980. Over the same period, the export share of soybean production has increased five times, from 9.4 percent to 39.6 percent (see Table 1.1). This clearly shows the increased importance of exports to U.S. agriculture.

Agricultural exports also play a large role in the United States balance of trade. The consistently positive agricultural trade balance offsets a large portion of the negative nonagricultural balance. In 1975 and 1976, the agricultural trade balance completely offset the nonagricultural trade balance, leaving the U.S. with a positive total balance of trade. Since that time, the agricultural balance has more than doubled, but a sixfold increase in the negative nonagricultural balance (mostly due to expensive energy imports) has resulted in a total balance

Table 1.1

Exports as a Percentage of Total Production
(Selected Commodities and Years)

	1950	1955	1960	1965	1970	1975	1980	1981
Corn	4.2	4.2	7.5	16.8	12.5	29.4	35.3	24.9
Wheat	33.9	34.4	48.3	65.9	54.8	55.3	63.7	63.5
Soybeans	9.4	18.2	24.3	29.7	38.5	35.9	39.6	45.8

Source: Stanley R. Thompson and Rebecca L. Johnson, Grain Transportation on the Great Lakes - St. Lawrence Seaway, Michigan State University Extension Bulletin E-1432, December 1982.

of trade deficit of $23,436.[1] Without the large volumes of agricultural exports, the U.S. balance of trade would suffer enormously.

It is clear that agricultural exports have important implications for the United States as a whole, as well as for the agricultural and agribusiness community. It follows that many people in the U.S. stand to benefit if agricultural exports can be increased or can be supplied at lower cost. A large portion of the cost of providing exports lies in transporting the product from the producing region to the overseas destination. Given the importance of agricultural exports, it is easily understood why transportation issues are of such concern to the agricultural sector.

[1] Thompson and Johnson, 1982.

1.1.2 The Grain Export Transportation System

The current United States grain transportation system reflects the important role that is played by the export grain trade. The magnitude and location of overseas demand for our agricultural products is a determining factor in the origins and destinations of internal grain flows. Port areas and alternative transportation modes strongly compete for the large volumes of cargo involved in overseas trade.

There are four major port areas in the United States which currently handle export grain. The Atlantic Coast includes the North Atlantic ports of Portland, Maine; Albany, New York; and Philadelphia, Pennsylvania; as well as the South Atlantic ports of Baltimore, Maryland; Norfolk, Virginia; and North Charleston, South Carolina. The most important of these, in terms of volume of grain handled, are Baltimore and Norfolk. The Gulf area includes the East Gulf, Louisiana Gulf, North Texas Gulf, and South Texas Gulf. Most of the grain goes through the ports of Mobile, Alabama; New Orleans (and other Mississippi River ports); Houston and Galveston, Texas. The Pacific port area has become increasingly important for grain shipments in recent years, although relatively little grain goes through any of the California ports. The Puget Sound ports of Seattle and Tacoma, Washington, and the Columbia River ports, especially Portland, are the most heavily used for grain exports. Finally, there are the Great Lakes ports, which have experienced a recent decline in grain exports. These include Duluth-Superior at the western end of Lake Superior; Chicago, Illinois; Saginaw, Michigan; and Toledo, Ohio. Figure 1.1 shows the location of all of the ports, and Table 1.2 lists the shares of export grain moving out of each of the major port areas from 1976 to 1981.

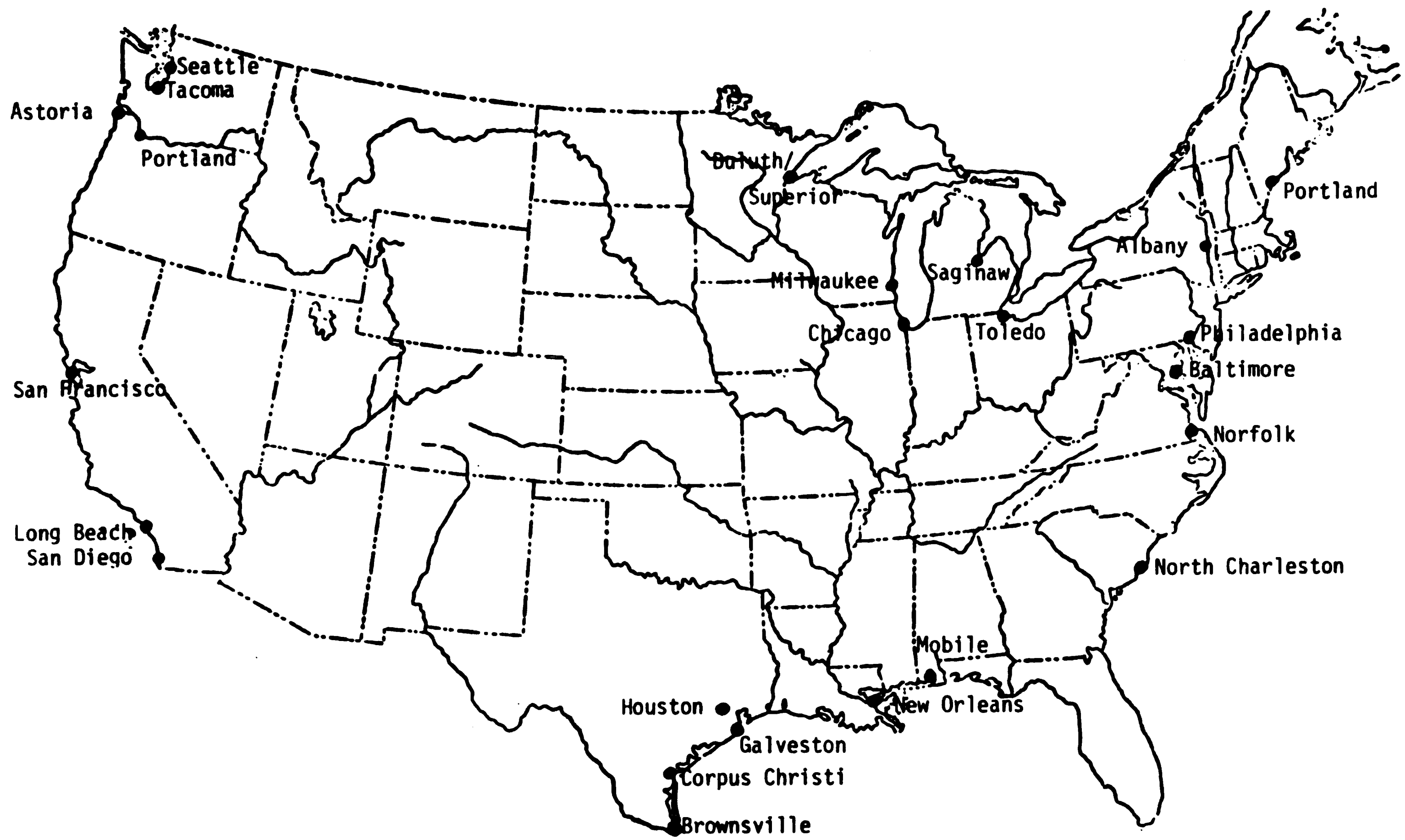

Figure 1.1

Major Ports in the U.S. for Exporting Grain

Table 1.2

Grain Inspections for Export by Port

Year/Commodity	Lakes	Atlantic	Gulf	Pacific	Total
			- Percent -		
1976					
Wheat	5.9	6.7	50.7	36.7	100.0
Corn	8.9	23.2	67.5	0.4	100.0
Soybeans	10.7	11.5	77.8	0.0	100.0
Total[a]	8.7	15.0	65.4	10.9	100.0
1977					
Wheat	12.2	4.2	53.0	30.6	100.0
Corn	9.0	22.7	67.3	1.0	100.0
Soybeans	10.6	11.0	78.2	0.2	100.0
Total[a]	10.9	13.7	66.0	9.4	100.0
1978					
Wheat	16.4	3.7	50.2	29.7	100.0
Corn	12.0	19.2	62.8	6.0	100.0
Soybeans	12.1	11.2	76.7	0.0	100.0
Total[a]	13.2	12.1	62.4	12.3	100.0
1979					
Wheat	12.5	2.1	52.8	32.6	100.0
Corn	11.9	19.4	58.1	10.6	100.0
Soybeans	8.1	13.7	78.2	0.0	100.0
Total[a]	11.1	12.9	60.9	15.1	100.0
1980					
Wheat	10.4	5.0	49.1	35.5	100.0
Corn	9.7	15.3	59.8	15.2	100.0
Soybeans	7.7	11.6	80.7	0.0	100.0
Total[a]	9.9	11.0	60.1	19.0	100.0
1981					
Wheat	8.0	6.3	54.2	31.5	100.0
Corn	7.3	15.5	64.4	12.8	100.0
Soybeans	8.6	10.5	79.5	1.4	100.0
Total[a]	8.1	10.6	62.7	18.6	100.0

Source: Grain Market News, USDA.

[a]Includes: wheat, rye, corn, oats, barley, sorghum, and soybeans.

As Table 1.2 shows, the Gulf port area is by far the largest in terms of total volume of grain exports. The Great Lakes area is the smallest, having barely more than one-eighth of the volume of the Gulf port area in 1981. The largest share of total grain exports that the Lakes area has ever had is 13.2 percent in 1978. That share exceeded the percentage of the Atlantic and Pacific port areas, but by 1981 the Great Lakes share of 8.1 percent was the lowest of all port areas.[2] The figures in Table 1.2 indicate that all of the port areas are competitive with one another to some degree, since the port shares vary over time, and an increase in one area's share must necessarily result in a decrease for another. The dominance of the Gulf area in terms of total magnitude would be expected to continue, however.

The relative attractiveness of alternative port areas is extremely dependent upon the inland transportation system. The cost of transporting the product from the producing region to each of the alternative ports is the major factor determining port choice. Some grain moves directly from farmers to port elevators, but country and terminal elevators account for the largest part of grain movements to ports. In almost all cases, the inland elevators have a choice between rail and truck transportation for moving their grain. River elevators have the additional alternative of using barge transportation. Because of the high fixed costs relative to variable costs for the rail and barge industries, these modes are used more frequently for long distance movements. Trucks have a much smaller ratio of fixed to variable costs, and are used for

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[2]It should be noted that the Great Lakes ports did not serve as export ports until 1958 when the St. Lawrence Seaway system opened. In light of that, the rapid increase in exports from Great Lakes ports to comparable levels with the Atlantic and Pacific ports is remarkable.

shorter hauls and by smaller elevators more frequently. There is a great deal of competition for export grain movements among these three modes of transportation, and shippers can benefit from lower rates when all three alternatives are available for them. In the same sense, a port area can benefit if all three modes have service to the port. The lower transportation rates from the producing regions will lead to greater volumes delivered at the port. The Gulf port area is a prime example of this. Barge, rail, and truck transportation are all available from the largest grain producing areas of the country. The Pacific Coast can use barge transportation for products grown near the Columbia River basin, but rail or truck transportation must be used to draw grain from the major producing areas. The Great Lakes ports have only a limited access to barge transportation, that being on the Illinois River moving up to Chicago. Very little grain is moved this way, and almost all grain shipments move to the Great Lakes ports by either rail or truck. The same is true for the Atlantic ports.

Because of their nearness to the producing regions, it would seem that Great Lakes ports would enjoy an advantage for drawing grain shipments for export. There are two factors which combine to offset this locational advantage, in most instances. The first is that elevators consider another important factor besides transportation costs. This is the price being offered at the port for their product. The second factor is that ocean shipping rates have a large bearing on what that port price will be at any given time. Since ocean transportation rates are generally higher from Great Lakes port origins than from other ports, the price offered for grain by the port elevators must be lower. There are a number of factors which combine to make ocean rates higher from the

Great Lakes ports, and these factors will probably remain in effect for the foreseeable future. Therefore, it is unlikely that the Great Lakes ports will be able to capitalize to any greater degree on their locational advantage with respect to the producing areas.

1.1.3 Recent Transportation Policy Changes

It is apparent that both inland and ocean transportation rates have a large impact on relative port competitiveness. Therefore, any policies which affect transportation rates can have important implications for any of the U.S. port areas. There have been two important policy changes in recent years which have had, and will continue to have, large impacts on transportation rates. The first of these was the institution of inland waterway user fees in 1978. While the current level of the user fee is low enough to minimize traffic diversions from the waterway, there is already discussion of raising the fee substantially. If 100 percent cost recovery is the objective of the policy, the user fee will have to be greatly increased, resulting in severe rate changes for the barge mode.

The second policy change was the deregulation of the railroad industry, brought about by the Staggers Act of 1980. The repercussions of railroad deregulation have yet to be fully realized, and the impact on rail rates in the long-run cannot be ascertained. There is certain to be a change in the rates that shippers face, but the overall structure of rates has not yet settled into an equilibrium situation.

Both of the above policies are a move toward making the transportation industry a part of the "free market." The inland waterway fees are an attempt to make the barge industry "pay its own way" rather than have taxpayers finance the maintenance and operation of the nation's waterways. The Staggers Act was intended to promote competition in the rail industry so that rates would more closely reflect the cost of service. Following this same reasoning, the administration has proposed that the deep draft shipping industry should also pay for the services provided by the federal government. Deep draft user fees are not a new idea, having been proposed by every administration since Roosevelt in 1940.[3] However, with the policy changes instituted for the rail and barge industries, it is more likely than ever that a deep draft user fee proposal will become law during the present administration's term.

The user fee concept seems very simple in its logic. If a facility or service has to be provided for a transportation mode (e.g., harbors or Coast Guard service for ships), then the users or beneficiaries should pay. However, the issue becomes much more complicated when implementation of the user fee concept is attempted. Identification of the beneficiaries, both direct and indirect, is very difficult. Measuring the relative benefits to alternative users is equally difficult. Compensation may be necessary where abrupt policy changes cause severe hardships to investors and business that expected the status quo to remain in effect. Finally, equity of federal subsidies among alternative transportation modes will have to be strived for when deciding at what level to set the charges. There are many other difficulties associated with implementing a user charge policy, and the effects of any given user fee scenario should be known ahead of time to whatever extent possible.

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[3] James K. Binkley, Joseph Havlicek, Jr. and Leonard A. Shabman, The Effects of Inland Navigation User Charges on Barge Transportation of Wheat, Research Division Bulletin 137, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 1978, p. 2.

1.1.4 Deep Draft User Fees and Export Grain

One area where the effects of deep draft user fees can be somewhat isolated and assessed is that of export grain transportation. The effect of increased ocean transportation rates from user fees should be readily seen in the prices offered for grain at the ports. Those prices will, in turn, have an effect on relative port competitiveness and the inland movement of grain. While the grain transportation system is not totally isolated from changes in the movements of other commodities, it is relatively so because of the large amount of transportation equipment suitable for grain shipping. Within certain extremes, it should be possible to model the export grain transportation system separately from the rest of the transportation system. Of course, certain constraints in the system arising from the flow of other commodities would have to be included where appropriate.

The enactment of deep draft user fees will certainly have effects on commodity movements other than export grain, and these other effects could be much greater for certain port areas. Nevertheless, export grain is an extremely important commodity, not only to the U.S. transportation industry, but to the U.S. economy as a whole. With respect to the Great Lakes - St. Lawrence Seaway, export grain represents the largest volume commodity movement on the system. A decrease in export grain movements through the Seaway can have a serious effect on the Great Lakes ports and shipping industries. It would be useful to know to what extent the alternative forms of user fee proposals would impact Great Lakes grain shipping. A model of the export grain transportation system would be helpful for assessing those impacts and for aiding in policy evaluation. Such a model would not show all of the effects of any user fee proposal, however, and careful attention must be paid to the secondary and nonmonetary impacts of any policy change.

1.2 Problem Statement and Scope

The purpose of this study is to assess the impact of deep draft user fees on St. Lawrence Seaway movements of export grain. In particular, the allocation of export grain among competing modes of transportation and port destinations will be investigated. In addition, a descriptive policy analysis of alternative user fee proposals will be done. Particular attention will be paid to how the proposed legislation compares to past and current transportation policy in the United States. Identification of those who benefit and those who lose from any policy change will be important in the analysis.

The model which will be used for the export grain transportation system will be based on a theory of shipper choice. In this case, the shippers are either country or terminal elevators. The choice will be modeled using a multinomial logit equation which estimates the probability that a shipper will ship grain to a particular port by a particular mode of transportation. The relative attractiveness of a port to a grain shipper will depend in part on the price offered by the port for the grain. That price will, in turn, be affected by ocean transportation rates that the port elevator faces. Since a deep draft user fee will affect ocean transportation rates directly, the model can show the direct impact of a given user fee on grain exports out of a particular port area.

The inland transportation system will be included in this model and the impact of any changes in inland transportation rates could also be assessed. This is not the purpose of this study, however, and the assumptions involved here may have to be modified to suit a different scope of analysis.

The focus of this study is on the Great Lakes - St. Lawrence Seaway transportation system. The Great Lakes ports are in direct competition with ports on all three of the United States coastlines. The drawing area for the Great Lakes ports is limited, however, and this study will only consider origins for grain shipments within this drawing area. The states included in the analysis are Minnesota, Iowa, Illinois, Wisconsin, Indiana, Michigan, and Ohio. North Dakota is also within the drawing area for the Great Lakes ports, but comparable data are not available for this state to be included in the model. This is a drawback, but not a serious limitation for the study.

CHAPTER 2

U.S TRANSPORTATION POLICY REGARDING ALTERNATIVE MODES

2.1 Introduction

This chapter will summarize past and current federal transportation policy regarding the rail, truck, and water modes of freight travel. Comparisons will be made across modes with respect to levels of subsidization, levels of regulation, and consistency of modal programs with the overall federal transportation policy. An analysis will then be made of how the proposed deep draft user fees fit into the overall transportation policy setting.

2.1.1 Goals and Objectives of Federal Transportation Policy

There appears to be general agreement between government officials, academicians, and industry representatives that the U.S. does not have a well-defined transportation policy. Instead, there are numerous transportation programs which call for a federal role, and some policy statements that have been made regarding mode-specific problems. The development of the programs has been in response to problems which have been encountered in the different transportation industries, and not in response to an overall direction for federal transportation policy. A General Accounting Office (GAO) report described this policy development as follows:

> Historically, new transportation programs and agencies were created whenever new problems arose, and little emphasis

was placed on coordinating the new activities with existing programs. Over the years, this process of piecemeal and incremental growth produced the present decentralized organization of federal transportation programs.[1]

In 1979, 64 federal agencies were identified as having some involvement in transportation policy development and program implementation.[2] The cost for this federal involvement was over $22 billion per year, which included costs for financial aid, technical aid, development and operation of transportation facilities and support services, economic regulation, research and development, and safety regulation.[3] Nearly all of the programs are mode specific, and very little attention has been paid to multimodal and intermodal issues. It is important to note that while the numerous programs which have been developed indirectly constitute some type of overall policy, that policy has not been arrived at through a consideration of the total transportation system.

Although the history of transportation policy lacks any overall direction, there have been recent attempts to develop this direction for the future. The National Transportation Policy Study Commission was formed for this purpose, and their 1979 final report contained the following guidelines or themes for making policy recommendations:

(1) National transportation policy should be uniform.

(2) There should be an overall reduction in federal involvement.

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[1] General Accounting Office, Transportation Issues in the 1980s, CED 80-133, September 1980, p. 6.

[2] National Transportation Policy Study Commission, National Transportation Policies Through the Year 2000, U.S. Government Printing Office, Washington, D.C., 1979.

[3] General Accounting Office, 1980, p. i.

(3) Economic analysis of intended federal actions should be performed.

(4) When the transportation system is used to pursue non-transportation goals, do so in a cost-effective manner.

(5) Federal involvement in (including financial assistance for) transportation safety and research is required.

(6) Users and those who benefit from federal actions should pay.[4]

These guidelines address the types of policies that the Commission feels are most appropriate for the transportation system. They do not state the goals and objectives of federal transportation policy, however. These goals have been summarized by the GAO study as:

(1) Promote the development of an efficient and accessible national transportation system.

(2) Encourage fair competition and protect the public from abuse of monopoly power.

(3) Protect the safety of travelers and cargo.

(4) Balance environmental, social, and energy goals with transportation needs.[5]

It is clear that these are policy goals, while the six guidelines set out by the Study Commission are one view of how to move toward these goals. There is probably very little disagreement over the above goals, but there is considerable disagreement over whether the Commission's policy guidelines are the appropriate ways to achieve these goals.

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[4]National Transportation Policy Study Commission, 1979, p. 247.

[5]General Accounting Office, 1980, p. 1.

2.1.2 Rationale for Alternatives to the "Free Market" Policy

The degree to which government needs to be involved in order to meet the above objectives is a topic of continuing debate. When the Study Commission made the statement that there should be an overall reduction in federal involvement, it implied that less regulation and subsidization would constitute less "involvement." This is not necessarily the case. The government allocates rights to different market participants by defining the rules under which the market must function. If the rules state that sellers can charge whatever the market will bear for their products and services, then the government has allocated a right to what is typically referred to as a "free market" to those sellers. If the rules state that sellers who enjoy a monopoly cannot charge whatever the market will bear, then the government has allocated a right to the buyers. In either case, the government has set the rules of commerce and is "involved" in both cases. The difference is that in the second case, more bureaucracy is needed to enforce the rules that have been set. It is this ever-increasing need for bureaucracy when the rules are changed from the "free market" scenario, that is seen as increased government involvement. While the implementation costs of any policy need to be considered, these should not be confused with the allocation of rights that go along with any policy.

Since the U.S. originally adopted a constitution with both individual rights and "free market" concepts, there are inherent contradictions which will occur in the economy. The public policies which have evolved in transportation have been an attempt to resolve the conflicts as they happen. There are certain characteristics of transportation which produce these conflicts and lead to what neoclassical economics calls "market failure." Breimyer has focused on the property rights of access and use to distinguish transportation from other types of market commodities or services.[6] He notes that any transportation corridor can "physically accommodate one or a hundred passages equally well,"[7] and determining who has the right to access and use of a publicly-owned corridor is one of the responsibilities of federal policy. If the corridor itself is controlled by a profit-seeking entity, "the potential for extortion never disappears."[8] If the extortion is considered unfair or unreasonable, a rationale for deviation from the "free market" policy exists.

Further characteristics of transportation that lead to policy problems are what Breimyer calls the "essential yet subordinate nature of transportation, and the extremely high overhead element in the cost structure (which) give a public utility aspect to transportation."[9] Regarding the first of these, it is possible that what is in the interest of the transportation firm may not be in the interest of the firm whose goods are being shipped. This is often true for grain transportation where the railroad, barge, and trucking firms would like to have all their equipment fully utilized, but the grain elevators would like to have equipment available for shipments at all times, even at peak loading times. If equipment is available at peak times, it must necessarily be idle at nonpeak times. The question becomes whether

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[6]Harold F. Breimyer, "An Academician's View of Rural Transportation Policy," University of Missouri - Columbia, Agricultural Economics Paper No. 1980-1, 1980.

[7]Ibid., p. 1.

[8]Ibid., p. 1.

[9]Ibid., p. 2.

transportation policy should be directed to the needs of the transportation industry or to the needs of the shippers and receivers. If the latter is chosen, then subsidization of the transportation industry may be necessary and this would constitute another rationale for public policy changes.

With respect to the high overhead costs of transportation, these can be partially offset by public provision or financing of rights-of-way. The problems of access and use become relevant then, and public policies will be necessary to allocate these rights among market participants.

This allocation of rights to achieve certain objectives is the essential definition of public policy making. The policies can be evaluated in terms of their effectiveness in meeting the goals at the lowest possible costs. This assumes, however, that there is agreement on the definitions of goals and costs. Assuming that the goals stated previously are generally accepted, past and current transportation policy can be analyzed with respect to how rights have been allocated, who has gained and who has paid the costs, and whether the goals have been effectively met.

2.2 Federal Transportation Policies Affecting Alternative Modes

This analysis will only consider the rail, truck, and water modes of freight transportation, since these are the only ones significantly involved in grain transportation. Each of these transportation industries has developed problems which are unique and which have required specific policies to address them. It is often the case, however, that a policy which attempts to remedy a problem for one mode will have unintended impacts on other modes. The need to examine intermodal and multimodal policy issues has only recently been recognized. The history of transportation policy is almost entirely mode-specific.

2.2.1 Rail Freight Transportation Policy

Most of the problems that have developed in the history of the railroad industry have been either directly or indirectly related to the abuse of monopoly power. The early policies were intended to regulate this abuse, while the most recent policies are attempting to remedy the adverse effects of the regulations.

The rail industry is unique among transportation industries in that it owns, operates, and maintains its own rights-of-way. The land for these transportation corridors was originally provided at public expense, however, and Breimyer states that the "land grants essentially paid for the railroad track."[10] This original grant of real property, along with the rights of commerce for companies which own their own resources, constituted the first policy with respect to the rail industry. Since 1850, the industry has irregularly received direct subsidies from the federal government,[11] but most of the policy issues for the rail industry have involved regulation instead of subsidization.

In 1887, federal regulation of railroad rates was established through the Interstate Commerce Commission (ICC). The objective of the regulation policy has been to keep rates fair and reasonable, as defined by the ICC. In other words, they were allocating a right to fair

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[10]Breimyer, 1980, p. 3.

[11]National Transportation Policy Study Commission, Current Transportation Issues in the U.S.: Executive Summary, Report No. NTPSC-SR-78-01-A, Vol. I, September 1978, p. 20.

and reasonable rates to the buyers of rail services. The rail industry was further regulated as to the ability of any firm to exit the market by abandoning a particular rail line. This regulation gave the right of rail service to all locations where rail lines were originally established, unless the rail company could convince the ICC that the line should be abandoned. The abandonment hearings were extremely lengthy and cumbersome for a company already losing money on these lines. Numerous bankruptcies are alleged to have been the result of the combination of rate and exit regulations.

There has also been an unwillingness to invest the necessary capital for construction and maintenance into the declining rail industry. Recent public policy has been aimed at revitalizing the rail industry through a combination of deregulation and subsidization. The Railroad Revitalization and Regulatory Reform Act of 1976 and the Stagger's Rail Act of 1980 are the most prominent examples of this type of policy.

Congress has recently identified particular policy statements with respect to the rail industry which show a clear relationship to the problems of rates and revenues. Four of these statements which relate to grain transportation are:

(1) Allow competition and the demand for services to: establish reasonable rates.

(2) Minimize the need for regulatory control.

(3) Allow rail carriers to earn adequate revenues.

(4) Maintain reasonable rates where there is an absence of effective competition.[12]

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[12]Stanley K. Seaver, "The Stagger's Rail Act: Provisions Important to Agricultural Shippers and Receivers," WRDC 16, January 1983.

These statements are very similar to the guidelines of the Policy Study Commission stated earlier. They indicate that a movement toward the "free market" allocation of rights is desirable whenever possible. The wording is sufficiently vague, however, to allow for a large deviation from this policy if "unreasonable" rates were to result.

It appears that the right mix of regulations and free enterprise has not yet been found for the rail industry to produce the desired goals of transportation policy. Too much attention has been focused on the merits and drawbacks of regulation itself, without enough consideration for the overall goals of transportation policy and where regulation fits in as a policy tool to meet those goals.

Federal subsidization of the rail industry has not been as prominent a policy issue as regulation. Nevertheless, there are a number of direct and indirect subsidies which have accrued to the rail industry in recent years. The most expensive of these was the creation of the Consolidated Rail Corporation (Conrail) in 1973. The Federal Railroad Reorganization Act of 1973 created the U.S. Railway Association (U.S.R.A.), a government corporation, to merge the bankrupt Penn Central and five other companies into Conrail. During the 1976-81 period when it existed, total federal funds for operation assistance to Conrail totaled $3.3 billion, and property valuation settlements for the acquisition of properties totalled $2.8 billion.[13] The sale of Conrail is anticipated in the near future at which time some of these costs will be recovered.

The federal government subsidizes other aspects of the rail industry in less direct ways. These include the interest cost to the government

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[13]William W. Gallimore, Federal Transportation, "Subsidy Programs and Impacts on Agricultural Exports," unpublished paper, 1983, p. 6.

of rehabilitation and improvement loans, funds for local rail service assistance, funds for protecting the retirement system financial interests of railroad workers, and the administrative costs of the USRA. In 1983, the total federal outlay for these subsidies amounted to $117.8 million.[14] In addition, the Railroad Retirement Solvency Act of 1983 could result in federal "loans" to the Railroad Retirement Board of $600 million during the 1983-88 period.[15] These loans will almost surely become subsidies since there are no payback or interest charge provisions in the Act.

2.2.1.1 Summary of Rail Policy

The rail policy situation can be summarized as one where regulations have played a more central role than subsidies or other types of policies. This has been a function of the structure of the rail industry, primarily the fact that rail companies have owned their own transportation corridors. This very important property right was the result of a government action and should not be overlooked when comparing federal policies between modes.

The fact that the rail companies own the rights-of-way also means that other companies are not allowed access to these rights-of-way. The extremely high overhead cost that would be involved in creating a duplicate right-of-way for another company gives the rail industry the right to an effective monopoly. Federal policy has treated this situation much like it would a public utility and has required fair and reasonable rates, as well as control over the abandonment of rail branch lines.

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[14] Ibid., p. 6.

[15] Ibid., p. 7.

The long-run effect of this regulation, combined with increased competition from other modes, has been a deteriorating rail industry. The recent federal policy has therefore contained more provisions for subsidies, while retaining some of the regulations already in place.

2.2.2 Trucking Industry Policy Situation

The trucking industry differs substantially from the railroad industry in a number of ways. The ownership of the rights-of-way (the highways) remains with the government, but the users pay for substantial portions of both construction and operating and maintenance costs through a highway user fee. Since access to the transportation corridor is not limited by either government regulation[16] or high overhead costs of starting a trucking firm, the trucking industry is characterized by many firms in competition with each other for the same market share. The need for rate regulation has therefore not been as much of a policy issue for trucks as it has for railroads. The main focus of trucking policy has been on the methods for financing the nation's highway system.

In 1956, the Federal Highway Trust Fund was established "to build a national system of interstate and defense highways."[17] Since that time, the Trust Fund has been the major source of federal money for financing the construction, operation, and maintenance of the Federal-Aid Highway System. Most of these funds go to state and local governments on a matching-fund basis and are allocated to various categories

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[16]Access is regulated for some commodities; however, for most agricultural commodities, including bulk movements of grain, there are no economic regulations for truckers.

[17]National Transportation Policy Study Commission, 1979, p. 50.

of roads according to statutory formulas.[18] The federal contribution accounts for only 25 percent of all national highway expenditures, the remainder coming from state and local governments.

The Highway Trust Fund is not the sole source of federal aid to highways, although some trucking industry representatives have implied this.[19] The Policy Study Commission reports that in 1975, federal disbursements for highways exceeded federal user charge revenues by $2.042 billion. The majority of this shortfall was made up by General Fund appropriations.[20] The Policy Study Commission expects the user charge revenues to account for only 26 percent of federal disbursements by the year 2000.[21]

The allocation of highway costs among users and the general taxpayers is one source of policy debate. A related and more frequently contested issue is how to allocate costs (and revenues) among highway user groups and geographic areas. The allocation of variable costs is not so difficult a problem as the allocation of fixed or common costs. Unfortunately, the common costs, which include almost all construction costs, account for the bulk of the expenditures. The results of a study which attempted to measure the allocation of costs arrived at the following conclusions:

(1) Rural road expenditures exceeded rural user-charge revenues.

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[18] Ibid., p. 224.

[19] See American Trucking Associations, Inc., "American Trucking Trends, 1979-1980," Department of Research and Statistical Services, Washington, D.C., 1981, for an alternative accounting.

[20] National Transportation Policy Study Commission, 1979, p. 223.

[21] Ibid., p. 224.

(2) Urban road revenues from users exceeded urban road expenditures.

(3) Total expenditures on all classes exceeded user charge payments.

(4) User charge revenues derived from medium and heavy trucks did not fully cover all the public costs potentially attributable to them. Receipts from truckers equal or exceed the public costs for which they are directly accountable. But the degree to which payments exceed direct costs is so slight that almost any reasonable allocation to them of a share of the costs common to all users would result in underpayment.[22]

The definition of "any reasonable allocation" to trucks of common costs is not elaborated upon. This is exactly the issue that creates policy problems.

The user fees that contribute to the Highway Trust Fund actually come from a number of separate excise taxes. Table 2.1 shows the revenues generated from these separate taxes in fiscal year 1976. It is not clear whether this allocation of costs has any relationship to policy objectives. It is true that a motor fuel tax encourages more energy-efficient vehicles, but it is not necessarily true that less energy-efficient vehicles contribute more to the cost of the highway system and therefore should pay more. Trucks pay taxes that cars don't under the current system, but there is no indication that those taxes are accurately based on the greater cost to the system of trucks over

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[22] Ibid., p. 227.

Table 2.1

1976 Fiscal Year Trust Fund Receipts

Excise Taxes	(Millions of $) FY 1976	Percent
Motor Fuel	4,219	77.9
Tires	546	10.1
Innertubes	25	.5
Tread Rubber	23	.4
Trucks, Buses, Trailers	219	4.0
Federal Use	209	3.9
Lubricating Oil	56	1.0
Parts and Accessories	116	2.1
Subtotal	5,413	100.0
Interest	587	
Total	6,000	

Source: National Transportation Policy Study Commission, 1979, p. 468.

cars. The large number of taxes for highways, many of which users don't even know they are paying, hides the issue of cost allocation from direct scrutiny. Nevertheless, every policy which raises revenues, whether it be from users or from the general taxpayers, is a specification of cost allocation. These issues need to be brought to the forefront of the policy debate so that preferences can be more accurately expressed in the policy making process.

2.2.2.1 Summary of Trucking Policy

There are two fundamental differences between the rail system and the trucking system which have implications for policy. The first is that the technical constraints of a rail system do not allow many separate carriers to simultaneously use a single transportation corridor as is the case with the highway system. Rail tracks do not allow for easy movements of equipment in both directions and at different speeds in the same direction. These physical limitations give the rail industry the character of a public utility, while the trucking industry represents a very competitive market structure. As a consequence, there is much less need for economic regulation of the trucking industry, especially with respect to agricultural commodities.

The second difference between the two systems is that the rail industry owns its rights-of-way while the highway system is publicly owned. The problems involved in financing the highway system have been a major policy issue. Publicly owned facilities are not "free," and the methods developed for raising revenues represent cost allocation among different sectors of the population. An attempt has been made to have "users" pay for the highway system, but the issues of who those users are and what their relative contributions should be have not been resolved.

2.2.3 Inland Waterway Policy

The inland waterway system shares some institutional characteristics with the highway system, yet there are some fundamental differences as well. The waterway itself allows for simultaneous use by many separate firms, but the overhead cost of entering the industry is higher than that of the trucking industry. Bulk agricultural commodities are exempt from economic regulation on the waterway system, but reasonable rates result from the competitive structure of the barge industry. Similar to the trucking industry, therefore, more emphasis has been placed on financing policy than on regulatory policy.

The U.S. inland waterway system has more than 25,000 miles of navigable rivers and 255 navigation locks.[23] The federal government owns the rights-of-way to this system, and until 1980, all of the construction, operation, and maintenance costs were paid for by federal funds. Table 2.2 shows the federal expenditures on inland waterways from 1979 to 1982.

In 1978, the Inland Waterways Revenue Act was passed which established a fuel tax for commercial transportation on inland and intracoastal waterways. The revenues from the tax are deposited in the Inland Waterways Trust Fund which will be used for construction and rehabilitation expenditures for the system.[24] It has been estimated that the fuel tax covers only 20-25 percent of operations and maintenance costs of

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[23]National Transportation Policy Study Commission, 1978.

[24]National Transportation Policy Study Commission, 1979, p. 319.

Table 2.2

Federal Expenditures on Inland Waterways
1979-1982

Year	Expenditures		
	Operations and Maintenance	Capital	Total
	Million Dollars		
1979	230.8	349.0	579.8
1980	233.5	433.8	667.3
1981	269.6	436.8	706.4
1982	294.6	434.5	729.1

Source: Gallimore, 1983, p. 4.

the inland waterways.[25] Full cost recovery for the system would require a tax of around 70 cents per gallon of fuel, while the current legislation calls for a maximum of 10 cents per gallon by 1985.[26]

The same issues of cost allocation that were relevant for the highway system are relevant for the waterway system. Federal expenditures on waterways contribute to nontransportation programs, such as recreation and flood control. Allocating costs which are common to a number

[25]Gallimore, 1983, p. 3; the National Transportation Policy Study Commission estimated that the fuel tax covered less than 16 percent of waterway expenditures in 1980, and that by the year 2000, only 11 percent would be covered (p. 319).

[26]James K. Binkley and Douglas A. Barnett, "The Great Lakes and Seacoast Ports: A Case Study of Competition in Grain Exporting," Station Bulletin No. 425, Agricultural Experiment Station, Purdue University, September 1983, p. 20.

of users is a difficult policy problem for all of the transportation modes.

There is also a problem with allocating costs among segments of a waterway. There are some segments of the inland rivers that are more costly to maintain than others (e.g., more locks and dams may be required in certain segments), yet the navigability of the costly sections benefits users who navigate the entire river. Since segment specific cost allocation would have significantly different impacts than a uniform charge,[27] the decision of who should pay becomes a very important policy issue.

It should be emphasized that programs which do not use cost allocation formulas and, instead, get revenues from the General Fund, are nevertheless allocating costs to a particular segment of the public. The current waterway user charge is a cost allocation system as well, one which calls for a mix of funding by users and taxpayers. The current charge is a flat rate tax on fuel with no variation by geographic area or waterway segment.[28] Therefore, a firm which operates a tug full-time on only a segment of a river (perhaps a segment without any locks or dams) pays the same user fees as a tug that operates full-time along the entire river. With respect to policy, the conclusion which can be drawn from this is that a cost allocation has been made which

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[27] See, for example, James K. Binkley, Joseph Havlicek, Jr. and Leonard A. Shabman, "The Effects of Inland Navigation User Charges on Barge Transportation of Wheat," Research Division Bulletin 137, Virginia Polytechnic Institute, 1978; and Leonard Shabman, Joseph Havlicek, Jr., et al., "Navigation User Charges: Impact on the Transportation of Agricultural Products," Bulletin 121, Virginia Water Research Center, Virginia Polytechnic Institute, 1979.

[28] National Transportation Policy Study Commission, 1979, p. 319.

implies that commercial users are responsible for 25 percent of the costs, and all commercial users are equally responsible.

2.2.3.1 Summary of Inland Waterway Policy

The physical and economic structure of the highway and waterway systems are similar in many respects, especially with regard to agricultural commodities. However, public policy has dealt with these two systems in different ways. Direct users of the waterway system have had to pay user charges only in the last few years, while highway users have paid for nearly 30 years. Under the current law, waterway users will never pay the amount needed for full cost recovery of federal funds.

Barge movements of agricultural commodities have been exempt from economic regulation of rates. The market structure of the barge industry, like that of the trucking industry, has kept rates competitive.

The ownership rights to the waterways remain with the federal government, and responsibility for development and maintenance has accompanied those rights. The current policy problem for the waterways, like the other transportation modes, is to determine how direct and indirect users should share in the financial responsibility for the transportation corridor.

2.2.4 Deep Draft Waterway Policy[29]

The seacoast and Great Lakes ports and channels make up the U.S. deep draft port system. Access to the Great Lakes ports is restricted

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[29] Chapter 3 will provide much greater detail about the institutional structure of the deep draft shipping industry and the policies which affect it. This section will only highlight the aspects necessary to compare deep draft policies with the policies of other transportation modes.

by the system of locks on the St. Lawrence Seaway, while access to the seacoast ports is relatively unlimited. The physical nature of the entire system, like that of the highway and inland waterway systems, allows for the passage of many ships moving in both directions. In the absence of regulations, therefore, the ports could easily be served by many different ship-owning firms. In the case of agricultural commodities, which are transported almost entirely by "tramp" ships, this is the case. The international shipping industry for nonagricultural products which move by "liners" is structured much differently, and will not be included in this analysis.

The nation's deep draft port system serves a variety of interests, of which national defense and international commerce are most important. The Merchant Marine Act of 1920 established these interests as national goals when it stated that the purpose of deep draft policy was for the national defense and for the proper growth of foreign and domestic commerce.[30] Because of the necessity to keep access to these ports relatively open, the ownership rights to deep draft harbors and channels has remained with the federal government. The responsibility for operating and maintaining these waterways has accompanied the ownership rights.

The federal government has dredged main shipping channels and harbors since 1824.[31] The agency responsible for this maintenance, as well

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[30]H. David Bess and Martin T. Farris, "U.S. Maritime Policy: A Time for Reassessment," in Transportation Journal, American Society of Traffic and Transportation, Inc., Vol. 21, No. 4, summer 1982, pp. 4-14.

[31]Committee on Environmental and Public Works, "Report on the 'National Harbors Improvement and Maintenance Act of 1981'," Report No. 97-301, December 15, 1981, p. 3.

as for any necessary construction projects, is the Corps of Engineers. State and local governments, including local port authorities, provide and maintain many of the shoreside facilities that are necessary for commerce.[32] These nonfederal interests are also responsible for the diking of dredged disposal areas, which can be very costly if the dredged material is found to be toxic.

In addition to the construction, operation, and maintenance of the deep draft system, the federal government supports programs which aid the U.S. flag fleet. These include:

(1) An operating differential subsidy (ODS), which helps to offset the higher costs of operating U.S. flag vessels.

(2) A construction differential subsidy (CDS), which helps to offset the higher costs of shipbuilding in U.S. shipyards.

(3) Cabotage laws which reserve trade along the nation's seacoast to ships of the U.S. flag.

(4) Cargo preference laws which reserve all military and one-half of other government cargoes for U.S. flag ships.[33]

It has been estimated that the total annual federal expenditure on deep draft navigation, including both Corps of Engineers and Coast Guard expenses, has averaged $710 million annually for the last several years.[34] This does not include the increased cost to shippers and

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[32]R. Bruce Schulte, "Maritime User Fee Issue Synopsis," Minnesota Sea Grant Extension Program, University of Minnesota, 1983.

[33]National Transportation Policy Study Commission, 1978.

[34]Gallimore, 1983, p. 5.

taxpayers of the requirement to ship certain cargoes by U.S. flag vessel. Currently, none of these federal expenditures are financed by user fees.

An exception to the financial policy of the deep draft system is the St. Lawrence Seaway. The Seaway has charged user fees to cover construction, operations, and maintenance costs since its opening. The level of fees has not been enough to cover the principal and interest on debt, plus operations and maintenance costs, however. Because the level of fees is set jointly by the U.S. and Canada, a unilateral decision cannot be made to set the fees at a cost recovery level. In light of this, the U.S. has "forgiven" both the interest and debt of the St. Lawrence Seaway Development Corporation. Fees are still charged on the system in an effort to recover operations and maintenance costs, however.

The use of the deep draft system for shipment of agricultural commodities is not regulated with respect to rates. The structure of the tramp shipping industry, however, is such that competitive rates have remained in effect. As a result, much more attention is given to the financing policies of the deep draft system, than to the economic regulation policies. In this regard, the deep draft system is similar to both the trucking and inland waterway systems.

2.2.4.1 Summary of Deep Draft Waterway Policy

The deep draft system of ports and channels in the U.S. is really made up of two systems. The seacoast ports and channels have been treated distinctly differently than the Great Lakes - St. Lawrence Seaway system by federal transportation policy. Part of this difference is due to the international structure of the Seaway and the necessity to keep U.S. policies on the Seaway consistent with Canadian policies.

With the exception of the Seaway, the deep draft system is the only transportation system which does not charge direct users for at least partial recovery of federal costs. Since costs have been allocated completely to taxpayers, many of the cost allocation problems of the highway and inland waterway systems have been avoided. This avoidance does not mean that costs have been allocated in a "fair" or "just" manner to everyone's agreement, however. If user fees are instituted for the deep draft system, the familiar problems of how to allocate costs among different geographic regions and economic users will have to be faced.

2.3 Interaction and Competition Among Transportation Modes

While it is clear from public policy debates that transportation modes compete with one another, it is important to recognize that they are also linked in positive ways. This is most clearly demonstrated in the export grain market. Trucks are used to transport grain to country elevators, terminal elevators, river elevators, and port elevators. Trucks may be competing with trains along some of these routes, but in many cases, trucks are the only alternative for moving grain to a rail facility. Barges are dependent upon both trucks and trains for bringing grain to their elevators, while port elevators receive grain from all three inland transportation modes. Because of different efficiencies among the modes, it is economical to coordinate the transportation system using all modes, rather than to rely on a single mode. Recent transportation policy has recognized this desire for a coordinated system, and there has been much more emphasis on developing consistent public policy among transportation modes. The policies described in the last sections, however, do not meet the criteria of consistency. The policies of the past were based on piecemeal strategies for addressing the problems of each transportation mode separately. As a result, the different modes operate under different levels of subsidization and regulation.

It has been demonstrated that all transportation modes are subsidized to some degree.[35] The amount, type, and timing of the subsidization varies greatly, as the preceding sections described. The rationale for instituting user fees is to eliminate the need for subsidization. In order to evaluate this rationale, the arguments in favor of subsidization must be analyzed.

There have been a number of rationales put forward for the subsidization of the U.S. transportation system in general. Most of these, in one form or another, appeal to the important role that transportation plays in our economy and our way of life. The National Transportation Policy Study Commission (NTPSC) claimed that transportation has served to stimulate regional economies by decreasing the costs of transporting goods to market.[36] Regional economic development has also been enhanced by the new opportunities that a transportation system can bring to an area. Cornelius and Casavant point out that "a highway, airline, or rail line linking two regions having different resource endowments may provide

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[35]The term "subsidy" is often used to describe any public funding. It will be used here to describe a situation where nonbeneficiaries bear part or all of the costs of a program.

[36]National Transportation Policy Study Commission, 1978.

route through less well-endowed intermediate areas otherwise not able to support such a system."[37]

Related to these regional development arguments are demonstrations of the direct income and employment impacts of the transportation industry. The NTPSC claims that approximately 10 percent of the Gross National Product (GNP) is derived from transportation.[38] The port industry alone is credited with creating one million jobs in the national economy and contributing $70 billion to the GNP.[39] These claims can be misleading, of course, since it is not clear whether "derived from" and "contributing to" refers to direct or indirect impacts of these industries. It is also not clear that the transportation industry provides some kind of inherently different type of income or job than other industries, that therefore justifies public financing of the industry. Many industries can claim that they provide jobs and income, but proponents of subsidization for the transportation industry must provide a rationale for differential treatment with respect to financing.

One rationale for subsidization which is often proposed is that the transportation industry provides "public goods."[40] More precisely, the argument is that the transportation system provides benefits from which people can't be excluded. The benefits most often mentioned are related

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[37]James C. Cornelius and Kenneth L. Casavant, "Planning Transportation Services for Rural Communities," Western Rural Development Center, No. 20, January 1983.

[38]National Transportation Policy Study Commission, 1978.

[39]Mario Biaggi, "Port Development and Navigation Improvement Act of 1983," in Congressional Record, 1983, pp. 2-17.

[40]Nancy Berini, ed., Maritime User Fees: Perspectives on the Upper Great Lakes, Conference Highlights, Minnesota Sea Grant Extension Program, University of Minnesota - Duluth, 1983.

to national defense and the U.S. balance of payments. The transportation system that serves the export grain industry also serves many of the other international trades. The U.S. ports and flag fleet provide defense preparedness through the capability to move large quantities of bulk materials and heavy equipment.[41] The export of agricultural products, which relies upon the entire transportation system, has become essential to the nation's balance of international payments. Both national defense and a strong balance of payments are goods from which people can't be excluded. While this may be a rationale for financing by general taxpayers, it is not a rationale for subsidization in the sense of payment by nonbeneficiaries. If the benefits from the transportation system could be divided into those which accrue to the public at large versus those which accrue to private industry, then a portion of the financing could be done through the General Fund without any subsidization taking place. However, if the general public pays for the entire system just because <u>some</u> nonexcludable benefit can be identified, then there is clearly a subsidy. None of the preceding arguments provide a rationale for payment by nonbeneficiaries.

In the absence of a perfectly competitive market, cost allocation problems are likely to lead to some degree of subsidization. The problems inherent in identifying the relative costs and benefits for each participant in the market prohibit an exact allocation of costs to those who benefit. As a result, a political decision must be made regarding which publics will pay the costs of any program. Since perfectly competitive markets do not exist in the transportation industries, these

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[41]Ibid.

political decisions cannot be avoided. The institution of user charges will not change the political nature of the cost allocation decision. User charges, like those already in place for the highway system, do not allocate costs in exact proportion to benefits. They are simply an alternative to the system which allocates costs to the general public. The decision as to which cost allocation system is "better," or "more fair," requires a normative analysis and a judgment as to whose preferences count in the decision making process.

2.4 Summary of U.S. Transportation Policy

The alternative transportation modes are characterized by different institutional structures, although there are similarities that can be found. The rail industry is significantly different than the other modes with respect to both ownership rights and physical infrastructure. This has led to an emphasis in public policy on rate regulation for the rail industry. The highway, inland waterway, and deep draft waterway systems are all publicly owned, which has led to a public policy emphasis on financing these systems as opposed to regulating rates. The ability of many firms to use these systems at one time has resulted in reasonably competitive transportation industries. Therefore, rate regulation has not been an important public policy issue.

It has been demonstrated that the institutional structure of each transportation industry is different, and there have also been different treatments of each mode by public policy decisions. When the physical and institutional structures of industries differ, there is no a priori reason to argue that they should be treated identically by public policy. Yet, this argument has been made often by proponents of user fees. It must be emphasized that user fees are only one option for financing the publicly-owned transportation systems. They represent a different cost allocation system than is currently used, and this different system should be analyzed with respect to who benefits and who pays the costs. The next chapter will undertake this analysis with respect to alternative user fee proposals.

CHAPTER 3

ALTERNATIVE USER FEE PROPOSALS

3.1 Introduction

President Reagan followed the lead of every administration before his since 1940 when, on September 24, 1981, he called for enactment of user fees for the recovery of federal expenditures on deep draft ports and channels. In a televised speech, Reagan said that user fees were to be a "tool in moving toward a balanced budget."[1] While the objective of enhancing revenues may be part of the reason this administration wants to impose user fees, the issues go much deeper than that. User fees fit in with the overall philosophy of the Reagan administration on the role of the federal government in private enterprise. Secretary of Transportation, Elizabeth Hanford Dole, stated Reagan's philosophy as one where the users bear the costs of federal transportation services when they "can be allocated in a fair and equitable manner."[2] In other words, when the beneficiaries of federal projects can be readily identified, those beneficiaries should reimburse the government for the costs incurred from the projects. Deep draft water projects are one area where the administration feels that the beneficiaries can be readily identified.

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[1]R. Bruce Schulte, 1983, p. 3.

[2]Robert F. Morison, "Plan Sent to Congress for Coast Guard User Fees," Journal of Commerce, 4-22-83, 1983.

Since 1981, more than 40 bills which are related to user fees on the nation's deep draft system have been introduced in Congress.[3] This is in response to a growing consensus among both port interests and politicians that some type of user fee bill is inevitable. Most of the efforts by the alternative interest groups have now turned from trying to stop all types of user fee legislation, to ensuring that an acceptable form of user fee is enacted. Of course, what is acceptable to some ports and politicians is not acceptable to others. A true compromise is being strived for, but the differences in opinion may be so great as to make that impossible.

The major provisions which are being contested in the alternative user fee bills are:

(1) The relative share of federal versus local financial responsibility for:
  (a) operations and maintenance costs;
  (b) new construction costs.

(2) A port specific (each port charges a user fee necessary to cover only its own costs) versus a national uniform user fee (all ports pay the same user fee).

(3) An ad valorem (based on the value of cargo) versus a tonnage based user fee.

Two groups of ports have formed to represent the interests of their members. The National Coalition for Port Progress is made up of ocean ports which generally have low costs per tonnage for operations and maintenance (O&M). On the other side are The U.S. Port Systems

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[3] Schulte, 1983.

Advocates, which include the Great Lakes ports and small- to medium-sized ocean ports. These ports are characterized by having larger operations and maintenance costs per ton (see Tables 3.1 and 3.2). It is clear that the first group of ports would prefer a port specific user fee system where each port would be responsible for covering its own costs. These ports are also more likely to deal in general cargo traffic which has a much higher value per ton than bulk commodities. Therefore, these ports would bear a smaller impact from a tonnage based user fee than from an ad valorem fee. Of course, the second group of ports has the opposite interests. They would prefer a national uniform, ad valorem user fee which would base the amount of the fee on the value of the cargo, and spread the costs over the entire national port system.

There are many other issues regarding user fees which separate both ports and industries which use the ports. In this chapter, alternative user fee proposals will be analyzed with respect to the different interest groups they affect. An institutional framework will be used which focuses on the initial distribution of property rights and how they would be changed by the adoption of new legislation. The initial proposal by the current administration will be discussed, since it represents an extreme position on the user fee issue. In addition, the two proposals most likely to be passed are considered.

3.2 Initial Distribution of Property Rights

3.2.1 Ownership Rights

The ownership of the rights-of-way along the navigable waters of the U.S. lies with the federal government. Therefore, any users of the waterways only have rights which are granted to them by the owners (the

Table 3.1

Average Costs, 1978 Tonnage, and Costs Per Ton
(National Coalition for Port Progress)

Port	Average O&M Costs	1978 Tonnage	O&M Costs Per Ton
New York	$13,238,700	120,600,100	$0.110
New Orleans	17,342,100	81,839,000	0.212
Norfolk	3,157,600	25,286,900	0.125
Corpus Christi	6,130,900	46,244,400	0.133
Galveston	1,562,800	7,004,300	0.223
Houston	7,530,800	81,223,000	0.093
Los Angeles	144,000	60,780,900	0.002
San Francisco	39,100	2,068,700	0.019
Oakland	1,143,300	6,232,500	0.183
Stockton	780,900	2,227,600	0.343
Seattle	377,000	11,357,500	0.033

Source: R. Bruce Schulte, 1983.

Table 3.2

Average Costs, 1978 Tonnage, and Costs Per Ton
(Selected Members, U.S. Port Systems Advocates)

Port	Average O&M Costs	1978 Tonnage	O&M Costs Per Ton
Cleveland	$13,864,300	19,583,600	$0.708
Duluth/Superior	2,384,100	45,840,300	0.052[a]
Chicago	1,020,200	1,563,100	0.653
Portland	13,096,000	16,524,900	0.792
Sacramento	1,447,300	1,622,600	0.892
Philadelphia	6,768,900	37,067,600	0.183
Charleston	5,483,200	9,548,800	0.574
Savannah	10,133,700	10,633,400	0.953

Source: R. Bruce Schulte, 1983.

[a]Although the port of Duluth/Superior has a low ratio of costs to tonnage, it should be noted that only harbor costs are included here. If the O&M costs of all channels and facilities used to transport commodities to and from the port are included, the cumulative user charge for grain would be $0.265 per short ton. (Schulte, 1983)

government). In 1787, the government granted all U.S. inhabitants the right of free passage along these waterways when it passed the Northwest Ordinance. Article IV of this legislation states:

> The navigable waters leading into the Mississippi and St. Lawrence, and the carrying places between the same, shall be common highways and forever free, as well to the inhabitants of said territory as to citizens of the United States, and those of other states that may be admitted into the confederacy without any tax, impost, or duty therefore.[4]

3.2.2 Development Rights

Since free passage is guaranteed, it becomes the responsibility of the federal government to build and maintain the public works on the nation's rivers and harbors. The U.S. Army Corps of Engineers has this responsibility, and it operates within a given budget and certain rules set out by Congress over the years. Theoretically, the responsibility for the nation's ports, and the rights to develop them, can be traced back to the voting public. All expenditures on new projects, as well as the overall budget for operations and maintenance at the ports, must be authorized by a majority of the elected members of Congress. However, because of the structure of the political system and the limited number of people who are directly affected by these decisions, the general voting public really does not play a role in the authorization process. Small factions of the voting public, however, can have a large influence on spending decisions. Since water projects have traditionally been part of the "pork barrel" in Congress, those representatives with vested interests in a particular project can usually bargain for passage of a

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[4]William J. Hull and Robert W. Hull, The Origin and Development of the Waterways Policy of the United States, National Waterways Conference, Inc., Washington, D.C., 1967, p. 6.

bill which benefits their constituents. In only a remote way then, by granting voting rights, the government has granted the public the right to at least indirectly influence spending decisions on the nation's harbors and ports.

3.2.3 Rights of Commerce on the Waterways

Any U.S. flag vessel wishing to serve a U.S. port has the right to do so. The same right is extended to all foreign flag vessels, but that right can be terminated by any individual port, as was the case when Great Lakes ports refused to serve Russian vessels during the U.S. grain embargo. The grain trade is serviced by "tramp" vessels from a number of different countries. Since the international grain shipping industry is unregulated, most tramp ships will register with the country offering the lowest costs and fewest regulations for registry. This accounts for the very few numbers of U.S. flag vessels engaged in grain shipping.

The tramp shipping industry is one which closely models the neo-classical definition of perfect competition. Martin[5] outlines the following structure of the industry:

(1) Large number of firms competing in worldwide markets.

(2) Required technology, capital, and labor inputs are readily available to all potential market entrants.

(3) Industry is unregulated.

(4) Services offered are fundamentally homogeneous between suppliers.

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[5]Michael V. Martin, "A Vessel Licensing Fee as an Alternative Proposal for a Deep Draft Waterway User Charge," Water Resources Bulletin, April 1984.

(5) Firms enter and exit the market freely and capacity moves between specific markets (routes and freight).

(6) Continuous information on charters and rates is available from Telex subscription services and other sources.

Given that the tramp shipping industry approaches the perfectly competitive model, the right of free entry and exit will belong to any firm with the necessary resources to compete. The only exception is the special right given to U.S. flag vessels to carry at least one-half of all nonmilitary, government cargoes, which includes P.L. 480 grain cargoes. Relative to the total volume of grain shipments, this right to carry P.L. 480 grain does not amount to a large benefit for U.S. flag vessels. It basically gives them a chance to participate in what otherwise might be a closed market. Without this special right, the costs of operating a U.S. flag ship (including wages for U.S. crew members) would almost always be prohitively high compared to other flag vessels.

3.2.4 Rights of Commerce on the Shoreline

While the federal government has been responsible for maintaining all major ship channels at authorized depths, state and local governments have provided and maintained shoreside cargo-handling facilities through their own general revenues. Usually these services are provided through cooperation with local port authorities, and there is no federal mandate that requires these services to be provided. The amount of money spent by nonfederal port interests for shoreside facilities has been estimated at $4,864,636,000 for the period 1946-1978. This money has been generated from a combination of state, local, and private sources and is very close in magnitude to the total amount that the federal government has spent in developing and maintaining the navigation channels.[6]

With respect to bulk commodities such as grain, terminals are generally privately owned. The grain exporting industry, which owns most of these elevators, is a relatively concentrated industry. In 1974-75 (the latest years for which these figures are available), the eight largest exporting firms handled 81.7 percent of all wheat exports, 63.8 percent of all corn exports, and 63.7 percent of all soybean exports. For the four largest firms, those figures are 61 percent, 42 percent, and 40.5 percent, respectively.[7] Most of the port grain elevators are owned by a relatively few number of companies. Therefore, while the ocean shipping industry has a large number of firms, and the inland transportation system has a large number of firms, the buyers of grain using both of these transportation systems are highly concentrated. Nevertheless, these large grain companies appear to compete heavily with one another and the only barrier to entry is the high capital cost associated with a successful port elevator.

The large grain exporting firms are granted no special rights, but their market power and political power can be used to influence policy decisions with respect to ports and waterways. In the debates over

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[6] J. Ronald Brinson, Testimony before the Committee on Environment and Public Works, U.S. Senate, in <u>Water Resource Policy Issues</u>, No. 97-H14, p. 695.

[7] Charles Conklin, <u>An Economic Analysis of Pricing Efficiency and Market Organization of the U.S. Grain Export System</u>, General Accounting Office, GAO/CED-82-615, 1982.

alternative user fee proposals, the varying industry views have been important considerations.[8]

3.2.5 Environmental Rights

Another set of rights which need to be considered here are the environmental rights of the U.S. public. Since federal funds are used for port and channel projects, an environmental impact statement must be completed before a project can be approved. The total procedure necessary for Congressional authorization of channel deepening involves 19 steps and often takes over 20 years. The agencies involved in the dredging permit process include the Corps of Engineers, the Environmental Protection Agency, the Departments of Commerce and Transportation, the Coast Guard, the Fisheries and Wildlife Service, and state and local agencies.[9] Most of the concern over the dredging projects is centered on the discovery of toxic wastes which have settled into the dredge material. Public Law 92-500 requires that a permit be obtained to dispose of dredge materials in any given location. The criterion for denying a permit is the determination that discharge of the dredge materials "will have an unacceptable adverse effect on municipal water supplies, shellfish beds, and fishery areas (including spawning and breeding areas), wildlife, or recreational areas."[10] When toxic materials are

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[8]Nancy Berini, ed., Maritime User Fees: Perspectives on the Upper Great Lakes, Conference Highlights, Minnesota Sea Grant Extension Program, University of Minnesota, Duluth, 1983.

[9]R. Bruce Schulte, 1983, p. 4.

[10]Water Pollution Control Federation (Publishers), P.L. 92-500, Section 12071-8, Federal Water Pollution Control Act Amendments of 1972, KU 55, Vol. 86, Washington, D.C., 1973, p. 69.

found to be present in dredge material, it is necessary to build a confinement area for the sediments, since no location in the water will pass the requirements of the Clean Water Act. The process of disposing of dredge materials can become a very expensive one, but one that is necessary to protect the environmental rights of the public.

3.3 Impact of Alternative Proposals

The initial distribution of property rights described above refers to the structure of rights at the present time. This structure has changed over time, and it will continue to change, especially if user fee legislation is enacted. In the following sections, three alternative user fee proposals will be analyzed with respect to their impact on the above structure of rights.

3.3.1 S. 809 - Reagan Administration Bill

The initial effort by the Reagan administration to impose user fees was submitted as a Senate bill in February of 1981. The proposed legislation was extreme in its intent to place deep draft navigation entirely in the private sector. It called for 100 percent cost recovery for all Corps of Engineers' expenses, both operations and maintenance, and new construction. The user fee was to be port specific, where the local authorities would have full responsibility for imposing and collecting whatever fees were necessary to cover their own port's expenses. All fees collected were to go back into the general treasury and there were no provisions for a deep draft trust fund. While the St. Lawrence Seaway was to be excluded from this legislation, there was no provision for eliminating or forgiving the Seaway debt. Finally, there were no "fast-tracking" provisions where the process for obtaining permits would be streamlined.[11]

3.3.2 S. 970 - The Moynihan Bill

The "National Harbor Improvement and Maintenance Act of 1983" was introduced by Senator Daniel Patrick Moynihan, D-New York, on April 5, 1983. In contrast to the administration's bill, S. 970 only calls for partial cost recovery of federal expenses. With respect to operations and maintenance expenditures, the bill specifies a 50:50 split between local and federal responsibility. There is a five-year phase-in period for the user fees, starting at a 30 percent local share and increasing steadily to 50 percent. The bill specifies that the fees are to be levied on a tonnage basis, with a uniform fee for the entire national system. However, if in any year a particular port collects an amount greater than its average annual operations and maintenance costs, the excess collected can be credited toward the port's new construction costs. The credits accumulated by a port may not exceed $90,000,000 in any one year. Anything in excess of this amount would go back into the general treasury.

The Moynihan Bill has two levels of federal cost sharing for new construction, depending on the depth of the channel or port. The local-federal split is 60:40 for projects between 20 and 45 feet, and 75:25 for project depths greater than 45 feet. Fifty percent of the local share of new construction costs must be paid during the construction

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[11]Steve Thorp, Great Lakes Legislative Update and News Clipping, Great Lakes Commission, Ann Arbor, Michigan, June 1983.

period, with the remaining 50 percent due within 30 years after the project becomes available.

In order to speed up the study and authorization process for a new project, the local interest can provide "up to 50 percent of the cost to carry out the appropriate preconstruction planning and design work."[12] The bill also provides for "fast-tracking" by requiring that all "applicable statutory requirements[13] shall be completed on an expedited basis pursuant to schedules, established by the Secretary."[14]

Finally, the Moynihan Bill has two provisions which relate to the Great Lakes - St. Lawrence Seaway system. Under this Act, Seaway tolls would be reduced by 50 percent and user fees would be collected for use of the Seaway system instead. In other words, the Seaway system would be at least partially incorporated into the total U.S. deep draft system. The bill also provides that all Great Lakes connecting channels will be operated and maintained completely by federal funds. Great Lakes ports will be subjected to the same user fees as other ports.

3.3.3 S. 865 - The Hatfield Bill

Senators Hatfield (R-Oregon), Byrd (D-West Virginia), and Warner (R-Virginia) introduced the Deep Draft Navigation Act of 1983 on March 3, 1983. This proposed legislation differs from the Moynihan and Administration Bills in a number of ways. The Act calls for the

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[12]Daniel Patrick Moynihan, "National Harbor Improvement and Maintenance Act of 1983," S. 970, 98th Congress, 1st Session, 1983, p. 11.

[13]These include compliance with the National Environmental Policy Act of 1969, the Clean Water Act, and the Fisheries and Wildlife Coordination Act.

[14]Moynihan, 1983, p. 16.

establishment of a deep draft navigation trust fund which would include accounts for both operations and maintenance, and new construction (see Figure 3.1). The nonfederal share of operations and maintenance expenses would be 40 percent, with a three-year phase-in period. User fees and state vessel taxes[15] would go into the operations and maintenance account of the trust fund, along with other Congressional appropriations. The user fee specified in this bill is an ad valorem tax of $.0006 per dollar of value of the commodities being shipped. It would be levied on a nationally uniform basis.

The Hatfield Bill also has a special credit account where ports whose user fee contributions exceed their operations and maintenance charges can gain port credits to offset the local share of improvements. The local-federal split on new construction varies with port depth according to the schedule in Table 3.3.

The federal share of improvement projects comes out of the navigation improvement account of the trust fund. This account is financed by excess funds from the operations and maintenance and special credit accounts, as well as by customs revenues and other Congressional appropriations. The customs revenues contribution is specified to equal 95 percent of the receipts from user fees and will be diverted from the general fund that normally receives customs fees.

The Hatfield Bill includes procedures for Congressional authorization of new projects and would "fast-track" environmental permits for

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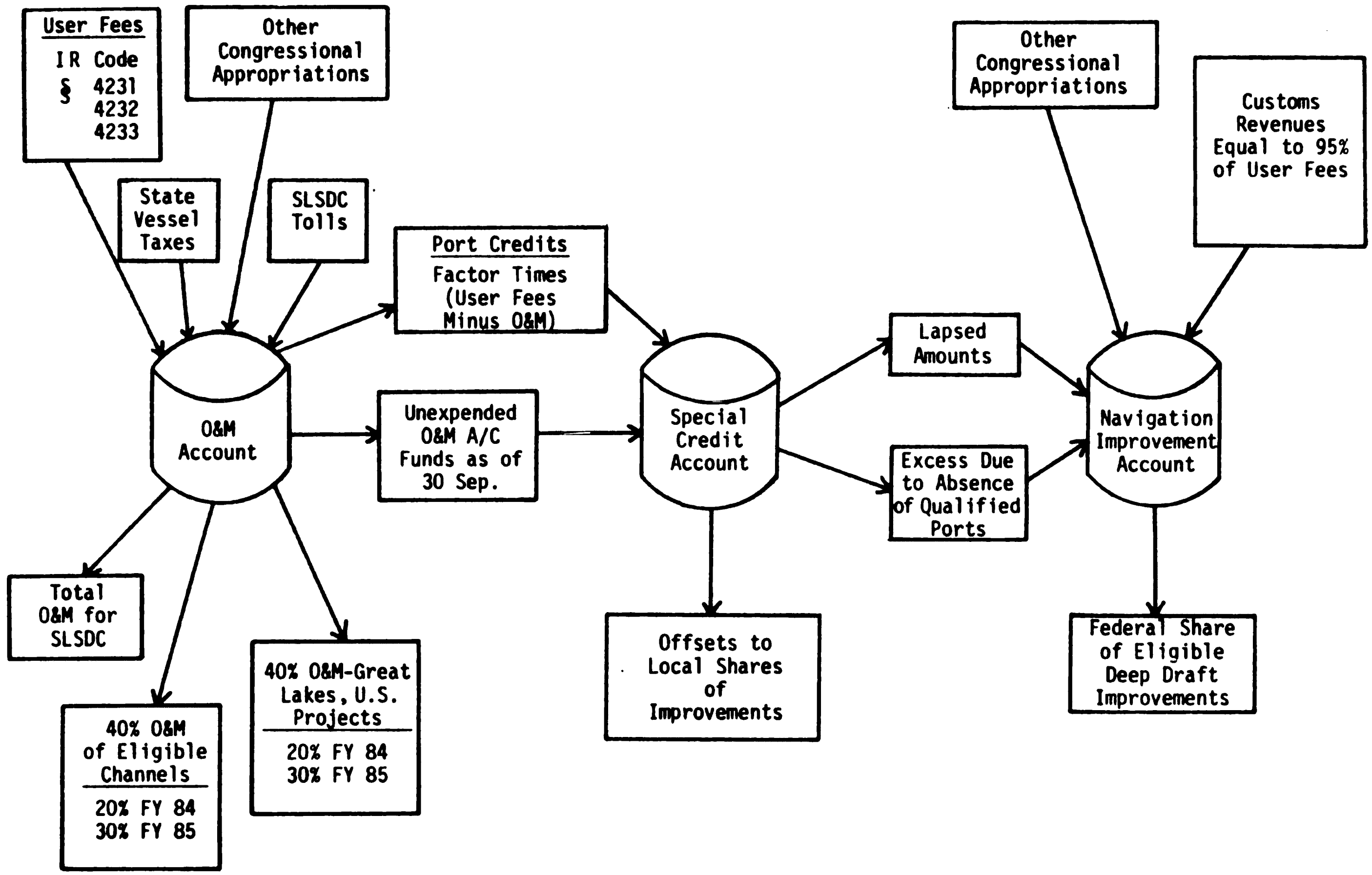
[15]The Hatfield Bill excludes exports from user fees in order to avoid any possible violation of the General Agreement on Trade and Tariffs. However, it authorizes and encourages states to levy state vessel taxes on exports for the same purposes as the user fees.



Source: John O'Doherty, Michigan Department of Transportation, 1983.

Figure 3.1

S. 865 Deep Draft Navigation Trust Fund (Hatfield)

Table 3.3

Local Share of New Construction Costs Under the Hatfield Bill

For Deepening to:	Local Share is:
24 - 35 feet	20 percent
35 - 40 feet	25 percent
40 - 45 feet	25 percent plus 1 percent of total project cost for each foot over 40
45 - 50 feet	30 percent plus 2 percent for each foot over 45
50 - 55 feet	40 percent plus 3 percent for each foot over 50
55 - 60 feet	55 percent plus 4 percent for each foot over 55
Over 60 feet	75 percent

Source: Robert M. Schnapp and Byung Doo Hong, Port Deepening and User Fees: Impact on U.S. Local Exports, Energy Information Administration, DOE/EIA-0400, May 1983, p. 35.

this purpose. The objective of the new authorization process would be to significantly reduce the time necessary to approve proposed projects.

With respect to the Great Lakes - St. Lawrence Seaway system, the Hatfield proposal calls for 100 percent reduction in U.S. tolls for vessels subject to the user fees. In effect, the Seaway operations and maintenance would get folded into the national deep draft program entirely. The connecting channels and Great Lakes ports would be treated the same as the rest of the deep draft system.

Figure 3.2 summarizes the three major user fee proposals, and outlines their provisions for cost sharing, fast-tracking, and treatment of the Great Lakes - St. Lawrence Seaway system.

Legislation	Cost Recovery Level: O&M	Cost Recovery Level: New Const.	Recovery Mechanism	Seaway Tolls Provision	"Fast-Tracking"	Other
S.809 Administration	100:0 local/ federal	100:0 local/ federal	Port and project specific user fees; local responsibility for implementation; fees collected go to federal general fund	St. Lawrence Seaway excluded from legislation; debt not relieved	No change from current review process; Congressional authorization process same	No impact study called for
S. 970 Moynihan (NY) and Stafford (VT), 4-5-83	50:50 local/ federal share 30-50%, 5-year phase-in	60-75% local-federal share 20'-45' - 75% 50% local share to be paid during construction remainder over 30 years	Uniform cargo tonnage fee 8¢/ton to 16¢/ over 5 years. Non-federal interests authorized to collect such fees	Elimination of one-half of U.S. Seaway O&M (Fold into deep-draft system); presumption: 50% reduction in U.S. tolls	Fast-tracking for authorization process to expedite completion of studies - locals can assist in funding	Great Lakes Connecting Channels O&M - 100% federal financial responsibility harbors of refuge exempt as well as commercial ports without significant traffic
S. 865 Hatfield (OR) et al., 3-21-83	40:60 local/ federal 20-40%, 3-year phase-in	20-75% increasing local share based on depth, e.g., <35'-20% 40'-25% >60'-75%	TRUST FUND (3 ACCOUNTS) Exports excluded 1. Uniform ad valorem tax \$.0006/dollar of value, avg. \$.0025-\$.003 2. Portion of customs revenues for new construction (95% of receipts from 1.) 3. Portion of uniform tax to offset local contribution where O&M exceeds tax State vessel taxes authorized (for export shipments)	Elimination of U.S. Seaway O&M (fold into deep-draft program); presumption: 100% reduction in U.S. tolls for vessels subject to ad valorem	Sets procedure for Congressional authorization of new projects Fast-tracking of environmental permits	NO IMPACT STUDY Penalties for unlawful diversion to port outside of U.S. to avoid fee obligation

Source: Steve Thorp, 1981 and 1983.

Figure 3.2

Summary of Alternative User Fee Proposals

3.3.4 Impact of the Proposals on the Distribution of Property Rights

3.3.4.1 Ownership and Development Rights

The passage of any of the three user fee bills mentioned here would not change the ownership rights of the deep draft waterway system. The federal government would still own all rights-of-way along navigable deep draft waters. The development rights to these resources also would remain intact. Congressional authorization would still be required for all projects and the Corps of Engineers would still have the responsibility for carrying out authorized projects.

The provision in the Moynihan Bill which allows a local authority to pay up to one-half of the costs of the feasibility study (and, therefore, speed up the authorization process) gives those local areas with extra financial resources access to a special right. While that right is available to all areas, the ability to pay, not necessarily willingness to pay, determines access to the right.

It should be stressed that although all of the proposals require at least partial cost recovery, none of them turn the development decision over to those who will be paying. The Congressional authorization process remains intact, although it is "expedited" in two of the proposals. The most extreme case of separation between those holding the right to develop and those paying the costs of development is S. 809, which requires 100 percent cost recovery and no changes in the authorization process. The deep draft shipping industry would not be unique if S. 809 were to pass. Highway users currently pay for interstate highway development, yet the federal government has all development rights to those highways. To decentralize the investment decision for something so widely used as an interstate highway system, however, would be very difficult. In the case of harbors and port areas, there are fewer users and a local port authority already exists which could make investment decisions representing the users.

The transportation industries are similar to many other U.S. industries which have a mix of public and private involvement in development decisions. It is not accurate to say that governmental decision making is more "correct" for some industries than others. The decision process simply takes into account a different set of preferences and, therefore, assumes a different distribution of rights. It is clearly wrong, however, to say that 100 percent cost recovery user fees will place deep draft navigation "in the marketplace," when development rights remain with the federal government.

3.3.4.2 Right to "Free" Navigation

The administration's bill, S. 809, removes all rights to general taxpayer-financed navigation, usually referred to as "free" navigation rights. Under this proposal, local authorities would have to reimburse the Corps of Engineers for all work done on their port area, including operations, maintenance, and new construction. There would be no subsidization across ports since the user fees would be port specific.

The Hatfield and Moynihan Bills require only partial reimbursement to the federal government for operations, maintenance, and new construction costs. Therefore, local interests will have lost their right to general taxpayer-financed navigation to a lesser extent than under S. 809. An exception to this is contained in the Moynihan Bill, however, which states that Great Lakes connecting channels would remain 100 percent federally financed. The users of the Great Lakes system would retain a right to "free" navigation that the other port users would not enjoy.

It has been noted in the previous chapter that the St. Lawrence Seaway users have been denied the right to "free" navigation since tolls were instituted in 1959. The Hatfield proposal would put the Seaway users on the same basis as other port users, since it would place the Great Lakes - St. Lawrence Seaway system into the overall deep draft system and reduce tolls by 100 percent of the operations and maintenance costs. The Moynihan Bill would also fold the Seaway into the overall deep draft system, but it only provides for a 50 percent reduction in Seaway tolls. Therefore, the users of this system still wouldn't have the same set of rights as the users of other port areas. Presumably, the remaining tolls would go to cover the costs of Great Lakes connecting channels, although this is not explicitly stated.

3.3.4.3 Right to Charge User Fees

The administration's proposal grants a specific right to local port authorities to impose user fees in whatever form they deem appropriate. The fees are to cover 100 percent of the costs of operations, maintenance, and any new construction costs. This new right for local authorities is of particular concern to the Great Lakes ports. Since the route to the ocean from all Great Lakes ports requires the passage through national (and international) waterways, it is not clear which local authorities would have the right to charge a user fee for the operations and maintenance on these connecting channels. A representative of Great Lakes port expressed this concern:

> The chaos of locally and independently imposed user fees over a waterway system encompassing multiple states or regional public entities should be self-evident. We would have eight

> independent states in control of vital passageways such as the Detroit River and the St. Lawrence River, who frequently have conflicting economic and social objectives.... It is inconceivable that a local system of channel user fees would be implemented without serious interstate dispute.[16]

A similar problem arises with respect to Canadian vessels that pass through the entire Great Lakes - St. Lawrence Seaway system. They also may be subjected to local U.S. user fees at each connecting channel.

The Moynihan proposal avoids the problem of allocating the right to collect fees for the use of Great Lakes connecting channels, since these channels are 100 percent federally funded. The Hatfield Bill, however, requires the Great Lakes connecting channels to be part of the overall deep draft system. This means that user fees for operations, maintenance, and development of the connecting channels will have to be collected. Individual localities will not have the right to charge for this purpose, however, as they would under S. 809, since the user fees are nationally uniform. This means that the U.S. costs of the Great Lakes - St. Lawrence Seaway system go into a pool with the rest of the nation's deep draft system, and a schedule of commodity-specific, but nationally uniform, user fees are levied to cover 40 percent of the total cost. It is clear that the high cost port areas are gaining a right to subsidization by the low cost areas under this scheme. The benefits from this right are likely to be much less than the benefits which were previously received under the right of general taxpayer-financing.

The Hatfield and Moynihan Bills set out alternative mechanisms for the collection of user fees. Under the Moynihan proposal, user fees for

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[16]Ray Hoffman, Testimony before the Committee on Environment and Public Works, U.S. Senate, in Water Resource Policy Issues, No. 97-414, 1981, p. 837.

operation and maintenance costs will be set by the Secretary of the Army and will be in the form of a uniform cargo tonnage fee. However, non-federal public bodies are also authorized to collect fees for the use of a project in order to meet the obligations of the local share of new construction costs. These fees may include cargo or vessel fees, tolls, or harbor user charges. This leaves some discretion for local authorities to decide who will pay, and in what relative amounts, for new construction projects. However, the Act also states that any such fee "shall reflect to the maximum extent practical the service and benefits provided to each commercial vessel or cargo laden therein."[17] A public hearing must be held which would give the beneficiaries a chance to influence the relative burdens each would pay. Nevertheless, the language of the Act is sufficiently ambiguous to give the local authority the right to determine the incidence of at least part of the costs of any project.

3.3.4.4 Environmental Rights

The alternative user fee bills have implications for the environmental rights currently in place. Since the administration's bill does not allow for "fast-tracking" or any other changes in the authorization process for new projects, the environmental rights would remain the same under this proposal. Those who prefer to keep the environment in the present state have the right to do so. Anyone who wishes to modify the environment by construction of a navigation project must prove, through the submission of an environmental impact statement and acquisition of

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[17] Daniel Patrick Moynihan, 1983, p. 20.

appropriate permits, that they will not seriously harm the present state of the environment.

Under the Hatfield and Moynihan proposals, the process for obtaining Congressional authorization would be extremely cut back, from 20 years to around two and one-half years. While neither proposal will supercede the National Environmental Policy Act, the Clean Water Act, or other environmental statutes, they do provide for completion of statutory requirements on an expedited basis. This is of concern to environmentalists who feel that the consequences of construction at a particular port area cannot be completely known in two and one-half years. A spokesperson for the Environmental Defense Fund expressed the concern as follows:

> "...if we go to fast-tracking, this means we will be shunting aside, in order to capture some international trade, some very important concerns. This is to say that we ought to know the answer as to what harbor deepening will do to shellfish. We don't have all the answers; we don't know, for example, what harbor deepening in Norfolk and up and down the bay will do....[18]

By setting time limits for completion of environmental regulatory requirements, the right to ensure that the environment is not harmed has been diminished. At the same time, as acknowledged in the statement above, those engaged in overseas commerce have gained the right to improve their port facilities in a much shorter period of time and, therefore, earn more profits than they otherwise would have. As is always the case, the loss of a right for one party results in another party's gain.

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[18]Brent Blackwelder, Testimony before the Committee on Environment and Public Works, U.S. Senate, in <u>Water Resource Policy Issues</u>, No. 97-H14, 1981, p. 727.

3.3.5 Alternative Bases for Defining Efficiency

In neoclassical economics, efficiency is defined in terms of minimizing the value of input used for a given value of output produced. With respect to navigation services, this would mean minimizing the cost of a navigation facility which would provide a given value of navigation services. Following such an efficiency rule implies that a facility would never be built if the value of the services provided by the facility did not equal or exceed the cost of the facility. The proponents of port specific, 100 percent cost recovery user fees, such as S. 809 would impose, argue that only the users can effectively compare these costs and benefits and make efficient choices for construction and maintenance of navigation facilities. In other words, a facility would have to pass a "market test" where the costs would be paid for by the users or else the facility would not be provided.

A Senate committee report stated this view as follows:

> The new policy to require local interests to finance all future harbor improvements recognizes that any decision to expand a particular harbor is essentially a commercial decision. Therefore, the marketplace should be utilized to determine future actions. Harbor construction dredging projects will be achieved in a more timely and economical fashion when the decision is made by the interested parties, rather than the federal government.[19]

The reasoning is very appealing at first glance. However, as Schmid points out:

> It is one step to minimize a set of costs and another to determine what effects to include in that calculation. Contrary to the suggestion of neoclassical theory, costs do not

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[19]Committee on Environmental and Public Works, Report on "National Harbors Improvement and Maintenance Act of 1981," Report No. 97-301, December 15, 1981, p. 8.

> simply exist in nature, but are selected by the public choice of property rights.[20]

The changes in property rights which would result from the passage of the alternative bills has been analyzed. The implications of those changes for defining efficiency can now be assessed.

3.3.5.1 Change in Benefit and Cost Allocation Procedures

S. 809 implies a complete redefinition of the beneficiaries of deep draft navigation. As it was previously stated, the administrative viewpoint is that economic efficiency is achieved when the beneficiaries of a project are required to pay all costs of that project. Since S. 809 requires local responsibility for all costs of deep draft navigation, the administration must feel that all beneficiaries are also local. It was pointed out in the last chapter, however, that the deep draft navigation system has benefits to people other than those directly involved in the shipping industry. The benefits to national defense and the balance of trade have to be allocated to all U.S. inhabitants. The benefits to those involved in the export commerce itself, including the initial producers, can be narrowed down and identified somewhat more easily. These beneficiaries pay for the service of transportation, and if the user fee is instituted in the form of higher transportation charges, then these beneficiaries will be paying for the services they receive. For this reimbursement to be exact, however, would require commodity specific and port specific user charges. Only then would it be assured that the beneficiaries of grain transportation through the Gulf, for instance, would not be paying a part of the costs of moving general cargo out of

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[20] A. Allan Schmid, Property, Power and Public Choice: An Inquiry Into Law and Economics, Praeger, New York, 1978, p. 241.

New York. The provision in S. 809 to leave the institution of user fees up to the local authorities, requires a careful analysis by these local authorities to identify beneficiaries and allocate costs among them. Even with this, the general benefits in terms of national defense and balance of trade will be subsidized by those paying the user fees.

The provisions of the Hatfield and Moynihan Bills are much different from S. 809. Both of these bills call for nationally uniform user fees, which means that all costs of the Corps of Engineers for deep draft navigation in the U.S. will be pooled. The Moynihan Bill then allocates 50 percent of this total cost to all users, based on the tonnage of cargo that they carry. This implies that a vessel carrying a heavy bulk commodity, such as iron ore, is responsible for more of the costs of the navigation facility than a vessel carrying containerized cargo, which is generally lighter. The Hatfield Bill, which proposes ad valorem user fees, implies that a vessel carrying a high-valued commodity, such as containerized cargo, is responsible for more of the costs of the facility than a vessel carrying a low-value (usually bulk) commodity. It is easy to see why interest groups have lined up behind one or the other of these bills. Each of them clearly allocates costs differently, and the type of commodity being shipped will determine the difference. Since almost all Great Lakes cargoes are low-value bulk commodities, there is an incentive for Great Lakes port interests to back the Hatfield proposal over the Moynihan Bill. Other port areas with high-value commodity shipments will have opposite incentives. To say that either cost allocation procedure is the "correct" one, however, would be meaningless. They merely imply different sets of property rights for different types of shippers.

The arguments over whether tonnage or ad valorem user fees are appropriate is very similar to the arguments over whether the railroads should have rates based on value of service or cost of service. The argument for value of service rates would be the same as that for ad valorem user fees. If the demand for transportation is strictly a derived demand, then high-valued commodities should be willing to pay a higher transportation charge than low-valued commodities for the same transportation service. For a profit maximizing firm in a competitive market, the derived demand for transportation is:

$$T_j = d_j(p, r_i, r_j) \qquad (1)$$

where:

p = final product price;

r_i = variable production input price;

r_j = transportation input price[21]

The coefficient on p could be estimated econometrically, but from economic theory, it can be shown to be positive. In a perfectly competitive market, a firm will use a marginal unit of input (e.g., transportation) if the value of the marginal product (VMP) of that unit of input exceeds the price of the input. Further, the downward sloping part of the VMP curve for that input, over the range of units, is the demand curve for the input (see Figure 3.3). The VMP equals the price of the output, p, times the marginal physical product of the input. Clearly, for two products with different output prices but identical marginal products for the transportation input, the VMP curves, and therefore

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[21]Marc A. Johnson, "Estimating the Influence of Service Quality on Transportation Demand," American Journal of Agricultural Economics, Vol. 58, No. 3, August 1976, p. 498.

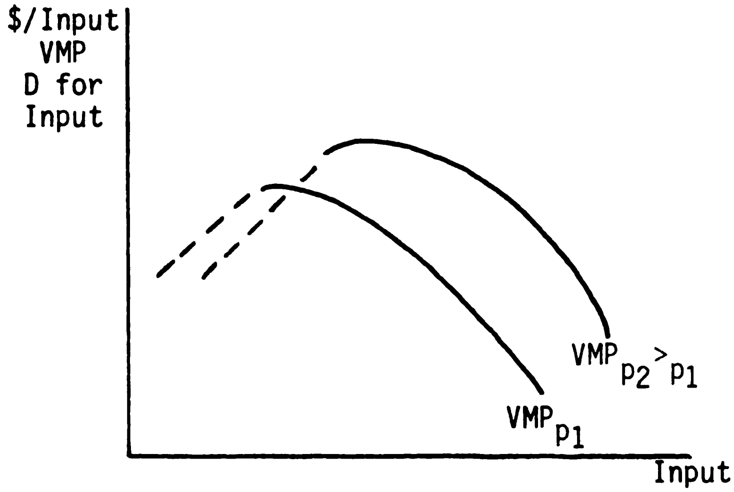


Figure 3.3

Value of the Marginal Product Under Different Output Prices and Identical Marginal Products

the willingness to pay for transportation services, differ. The only thing left to debate is whether the MP of a grain transportation service is different for a high-valued commodity than for a low-valued commodity. The transportation input does not add to the amount of product, but rather gives the product time and space utility by moving the product to the location of demand. From a purely physical standpoint, the transportation service gives the same time and location attribute to a high-valued commodity as it does to a low-valued commodity. The conclusion is, therefore, that the VMP of a given transportation service is higher for a high-valued commodity than for a low-valued commodity.

The next thing to consider is the cost of providing a given transportation service. Assuming that the high-valued commodity does not need any different service than the low-valued commodity, the cost of transporting either should be the same. (The usual case is that the cost of transporting certain high-value commodities, such as perishables or fragile items, is higher than that of low-value bulk commodities, but not as high as the value of service, defined above.) If the transportation industry were perfectly competitive, especially with respect to free entry of new firms, then the rate charged for a service would always be driven down to the cost of providing the service, regardless of the value of the service. If a particular firm would try to charge a value of service rate for a high-value commodity, there would be an economic incentive for a new firm to enter the market and charge a lower rate, as long as the rate is above the minimum of long-run marginal cost. This would continue until all firms based their rates on cost of service. It is clear that the railroad industry is far from a "perfectly competitive" industry and, therefore, cost of service rates may or may not be appropriate. In particular, there have been regulations which have forced railroads to maintain branch lines which were not economically viable. This gives customers on those branch lines a property right that they wouldn't enjoy under the "free" market. However, the railroads have to be allowed to make at least a normal return, so they must charge other customers higher rates, or else be subsidized by the government. Charging value of service rates allows the shippers of high-value commodities to (willingly or not) subsidize those operations which otherwise would not be available. This is just one of many ways that the government redistributes property rights to achieve certain social goals.

The ad valorem user fees would have the same type of effect as value of service railroad rates. That is, high-value commodity shipments would be subsidizing low-value shipments, assuming that the two types of commodities don't need different services. With respect to the deep draft channels and harbors, there is no reason to believe that high-value commodities need deeper, or wider, or better maintained facilities than low-value commodities. The on-shore facilities are different, but those would not be paid for by user fees.

It would also be true that high cost ports would be subsidized by lower cost ports, since all costs are to be pooled and then divided evenly through the nationally uniform user fees. The arguments for the uniform fee are very similar to those regarding subsidization of railroad branch lines. For national defense purposes, as well as for maintaining competition in the port system, there appears to be a desire to avoid the bankruptcy and, therefore, closure of any major ports. Toward this end, the cross-subsidization among ports has been deemed acceptable by most port interests. Once again, this represents an alternative distribution of property rights in order to achieve certain goals. The different set of rights means that costs will be allocated differently.

3.3.6 Changes in Port Relationships Induced by User Fee Policy

The efficiency rule that was discussed earlier assumes a particular starting point and measures the benefits and costs produced by adding a marginal unit. There are two problems with this assumption with respect to navigation facilities. The first is that different port areas are not at the same starting point in regard to level of development already in place. The second is that any major navigation improvement is not a marginal change from the starting point. The "market" test would not be whether to spend the next dollar, but rather to spend the next million dollars. The investments necessarily come in lumps.

The fact that different port areas are at different stages of development raises some equity questions if any of the user fee proposals are enacted. The legislation would require any new investment to pass a "market" test, as described earlier, where beneficiaries would have to be willing to pay for the costs of new construction. In the case of navigation improvements, it might seem simple to determine the costs of a project. However, these costs are dependent on a number of factors which will almost certainly be different for all port areas. For example, if a port has previously been maintained (with federal funds) to a depth of 40 feet, it will cost less to improve it to 45 feet than it would if it started at a 20-foot depth. There is a large amount of variability in the maturity of different port areas in the U.S. For instance, the Great Lakes - St. Lawrence Seaway system has only been open since 1959. It has a system-wide draft of only 26 feet, as well as having length and beam restrictions on ships passing through the locks. Putting a proposed improvement for the Seaway to the "market test" now, ignores decisions which were made previously by nonusers. The Great Lakes - St. Lawrence system would be starting from a base of 24 years of federal improvements, much of which has already been paid for by users through the St. Lawrence Seaway tolls. The "market test" would then be applied which would ask whether an improvement can be paid for by the users. The Atlantic area, on the other hand, would be starting from a 159-year base of federal investment. When deciding whether the benefits of a facility would exceed the costs, only the "new" costs (post-user fee enactment) would have to be considered by both of these port areas, without regard for the amount of past investment.

There is another aspect of the Great Lakes - St. Lawrence Seaway system that distinguishes it from the other port areas in terms of its market base. Each Great Lakes port is dependent on a whole system of locks and channels to move any cargo out to the ocean. An improvement at a given port then, may do nothing to enhance the system's capability. Even if the users of the port of Duluth/Superior, for instance, were willing to pay for a channel deepening to 40 feet, it would not finance the enlargement of the whole system to 40 feet. Therefore, the entire Great Lakes - St. Lawrence Seaway has to be treated as one port area, and allocating costs and benefits within that port area becomes very difficult, as mentioned previously. Most other port areas have ports which can be treated individually with respect to investment criteria for new projects. Their base from which to determine efficiency is much different than that for any Great Lakes port. Placing all ports in a "free" market arena at this point in time is a clear political choice of which costs to include in the efficiency calculation for any new port construction.

The second problem of nonmarginal investments will also have an impact on relative port competitiveness. An investment of millions of dollars at any one port area could make that area more attractive to shippers. Of course, the shippers will have to pay the additional user fees for the improvements, but the economies of scale from the use of larger ships may be greater than the increased user fees. If this were to happen under S. 809, a vicious cycle of higher user fees and, therefore, less traffic will occur at the other port areas. Traffic will be drawn to the deeper port, thereby lowering the user fee there (by spreading the costs over more users) while the decrease in traffic at other ports causes their user fees to increase which, in turn, causes more traffic to divert, and so on. The nonmarginal investment in one area causes severe price and volume effects throughout the whole system. The efficiency rule, however, assumes that prices remain constant across the system when determining whether or not to invest.

Under the Hatfield and Moynihan proposals, the nationally uniform user fee for operations and maintenance would prevent the cycle above from being so severe, since user fees for operations and maintenance, at least, wouldn't vary between port areas. However, a large investment in one area could still lend to traffic diversions and will almost surely change the structure of shipping rates. Again, the efficiency calculation won't incorporate the new equilibrium situation which will exist after the nonmarginal investment.

3.4 Summary

This chapter has described the alternative user fee proposals and their impact on the distribution of property rights within the system. It cannot be argued that any of the three proposals are "better" than the others. They simply allocate rights differently and, therefore, give weight to different people's preferences. The alternative structures of rights result in different considerations of costs to include in any efficiency calculation. Therefore, it can't be said that any proposal leads to a more efficient deep draft system than another. The efficiency calculations would just be made from different bases and with different accounts of costs and benefits.

CHAPTER 4

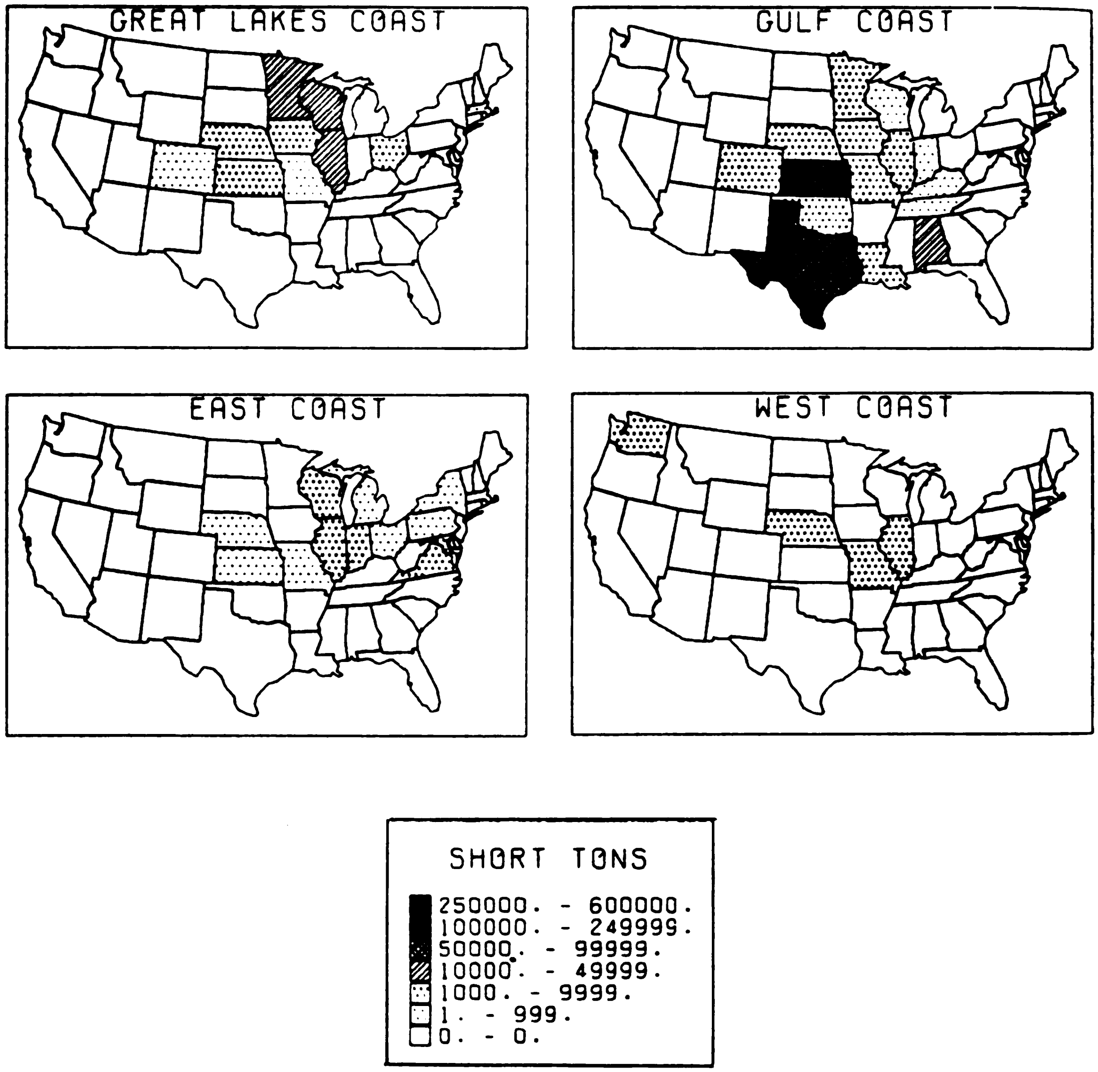
A MODEL OF THE INLAND TRANSPORTATION SYSTEM FOR EXPORT GRAIN

4.1 The Study Area

The focus of this research is on the Great Lakes - St. Lawrence Seaway transportation system. In order to analyze the impact of user fees on this system, it is necessary to define the hinterland of the Great Lakes. A hinterland can be defined in a number of ways, but in this case, the interest is in the economic hinterland for export grain shipments that move through the Great Lakes ports. This hinterland will change over time as relative grain prices, transportation rates, and transportation infrastructure change.

Figures 4.1 and 4.2 show the Great Lakes hinterland for export food and feed grains in 1970. The hinterland for food grains extended as far West as Colorado at that time, and yet did not include either Michigan or Indiana. The nonrepresentation of Michigan and Indiana may be due to the small sample size,[1] but it is possible that these states did not export any food grain through the Great Lakes ports during 1970. The majority of Michigan's wheat production involves soft winter wheat which is most often used domestically. Indiana may have taken advantage of the

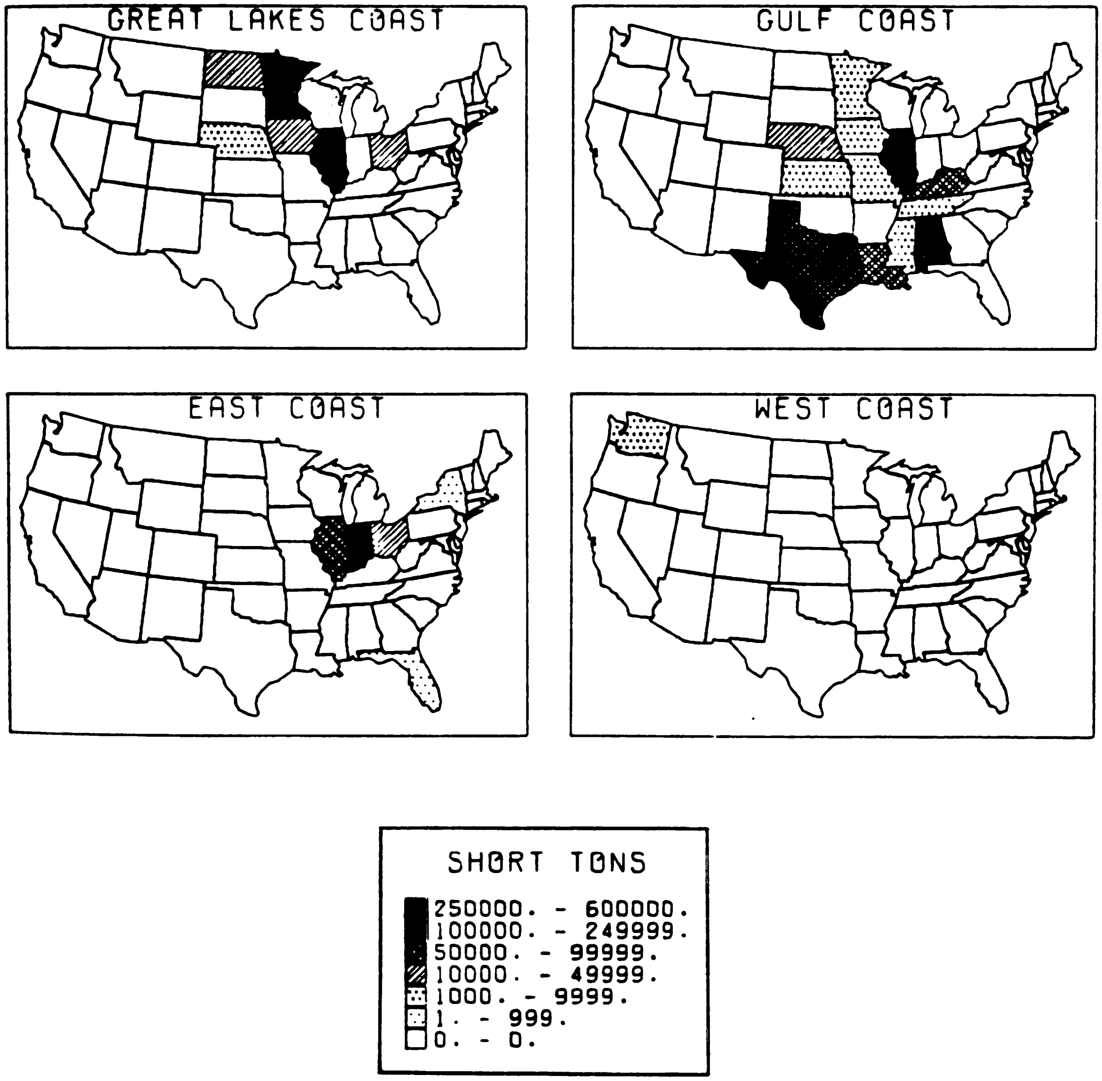
[1]For a brief description of the sample and method of analysis, see: Eric Schenker, Harold M. Mayer and Harry C. Brockel, The Great Lakes Transportation System, University of Wisconsin Sea Grant College Program, Technical Report No. 230, January 1976, pp. 137-138.



Source: <u>Analysis of International Great Lakes Shipping and Hinterland</u>, Special Report No. 23, April 1975, Center for Great Lakes Studies, Map 3, p. II-13.

Figure 4.1

Place of Acquisition of Great Lakes Related Exports of Cereal Preparations (SBR 4)



Source: Analysis of International Great Lakes Shipping and Hinterland, Special Report No. 23, April 1975, Center for Great Lakes Studies, Map 4, p. II-19.

Figure 4.2

Place of Acquisition of Great Lakes Related Exports of Feeding Stuff for Animals (SBR 8)

Ohio-Mississippi River route to the Gulf, as well as the rail route to the Atlantic.

Figure 4.2 shows the 1970 Great Lakes hinterland for feed grains. Michigan and Indiana are still not included, but the Western edge is at Nebraska and North Dakota in this case. A possible explanation for the lack of feed grain exports from Michigan could be the relative rail rate advantage that Michigan has to the New England feeder areas. It is often more profitable to ship feed grains there than to export them. Again, the small sample size of this particular study should be emphasized.

Since 1970, there have been a number of changes in the grain transportation system which have resulted in changes in the Great Lakes hinterland. Of recent interest is the extension of the Pacific hinterland as far East as western Iowa and Minnesota. The Great Lakes ports now compete within the ports of Seattle and Portland for grain produced in Iowa, Minnesota, and North Dakota. The increasing importance of the Pacific ports in the Midwest grain export market can be attributed to both favorable destination prices at the ports and favorable unit train rates from the Midwest.[2] In addition, the number of subterminal elevators capable of loading unit trains has increased in the states of Iowa and Minnesota.[3]

Competitive unit train rates have also developed to the Gulf and Atlantic ports for grain coming out of the Midwest. These rail rates

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[2]Acres Consulting Services, Ltd., and Data Resources, Inc., Seaway Commodity Flow Forecast, 1980-2000, February 1982, pp. 3-163.

[3]Chuck Eldridge, Jerry Fruin and Mike Alley, Minnesota's Grain Movement, 1981, University of Minnesota Agricultural Experiment Station Bulletin No. 475, 1983, May.

are competing with both barge rates on the Mississippi River and truck rates to Great Lakes ports. This highly competitive system has resulted in a less clear definition of the Great Lakes hinterland. Some of the states which shipped through the Great Lakes in 1970 are clearly not included in the hinterland today, most notably Nebraska. Those states which still use the Great Lakes ports today have a number of alternative ports to ship to, any of which can be competitive at a given time. There are virtually no areas which would be considered "captive" to the Great Lakes ports. The definition of the hinterland, therefore, can only be meaningful at a particular point in time.

The data used for this study are from a 1977 survey of grain elevators and, therefore, the 1977 Great Lakes hinterland is of interest. The definition of this hinterland is based solely on the elevators which actually shipped grain to Great Lakes ports at some time during 1977. This information is summarized in three publications done by Leath, Hill, and Fuller at the University of Illinois.[4] Figures 4.3, 4.4, and 4.5 show the patterns of grain flows to ports during 1977. The majority of grain moving through Great Lakes ports comes from the following states: North Dakota, Minnesota, Iowa, Illinois, Wisconsin, Michigan, Indiana, and Ohio. North Dakota was only involved in the wheat exports through Great Lakes ports, and much of this was durum. Unfortunately, North Dakota did not participate in the same elevator survey as the rest of

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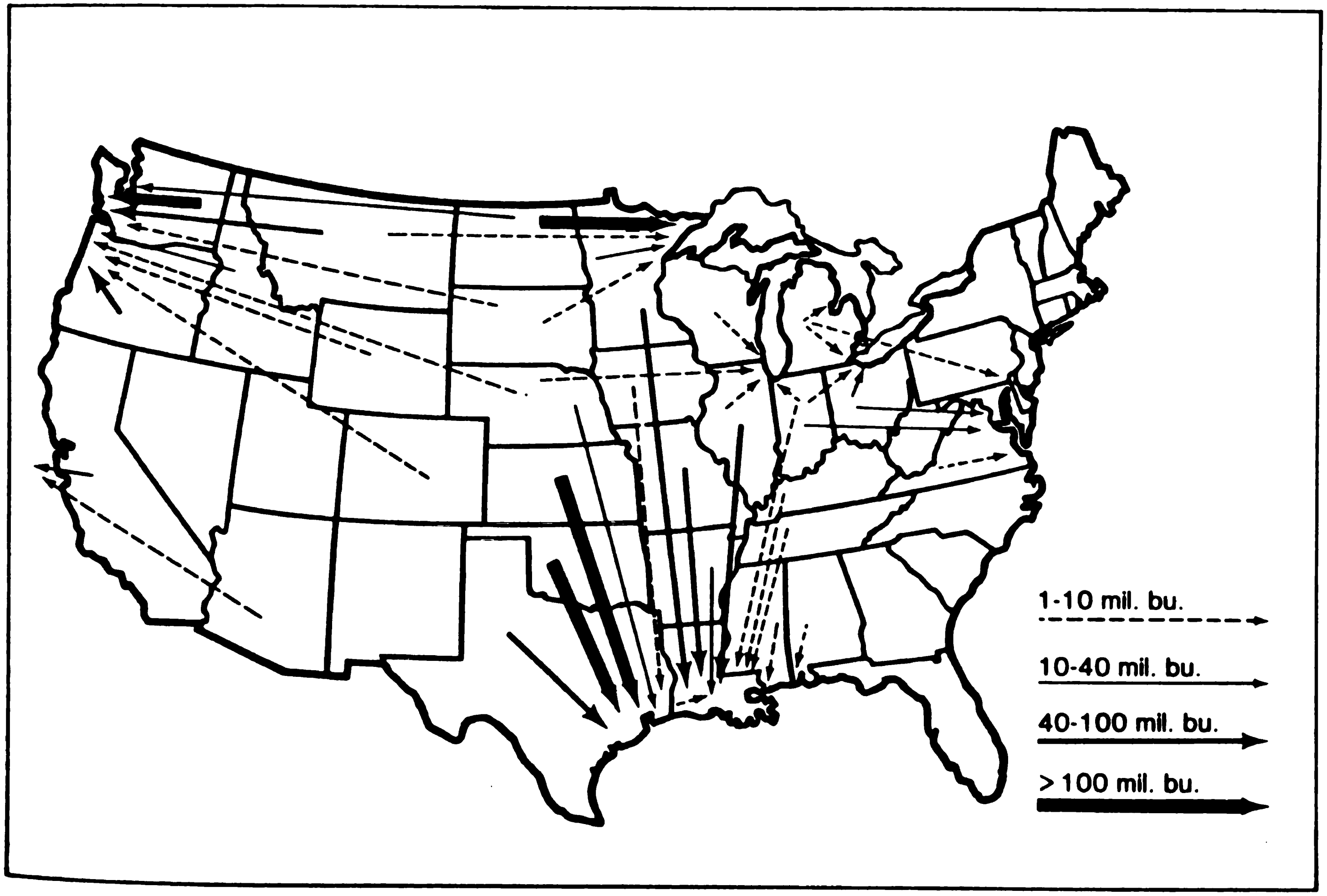
[4]Mack N. Leath, Lowell D. Hill and Stephen W. Fuller, Wheat Movements in the U.S., University of Illinois Agricultural Experiment Station Bulletin 767, January 1981.

__________, Corn Movements in the U.S., University of Illinois Agricultural Experiment Station Bulletin 768, January 1981.

__________, Soybean Movements in the U.S., University of Illinois Agricultural Experiment Station Bulletin 766, January 1981.



Source: <u>Wheat Movements in the United States, Interregional Flow Patterns and Transportation Requirements in 1977</u> (Leath, Hill and Fuller), North Central Regional Research Publication No. 274, January 1981, p. 21.

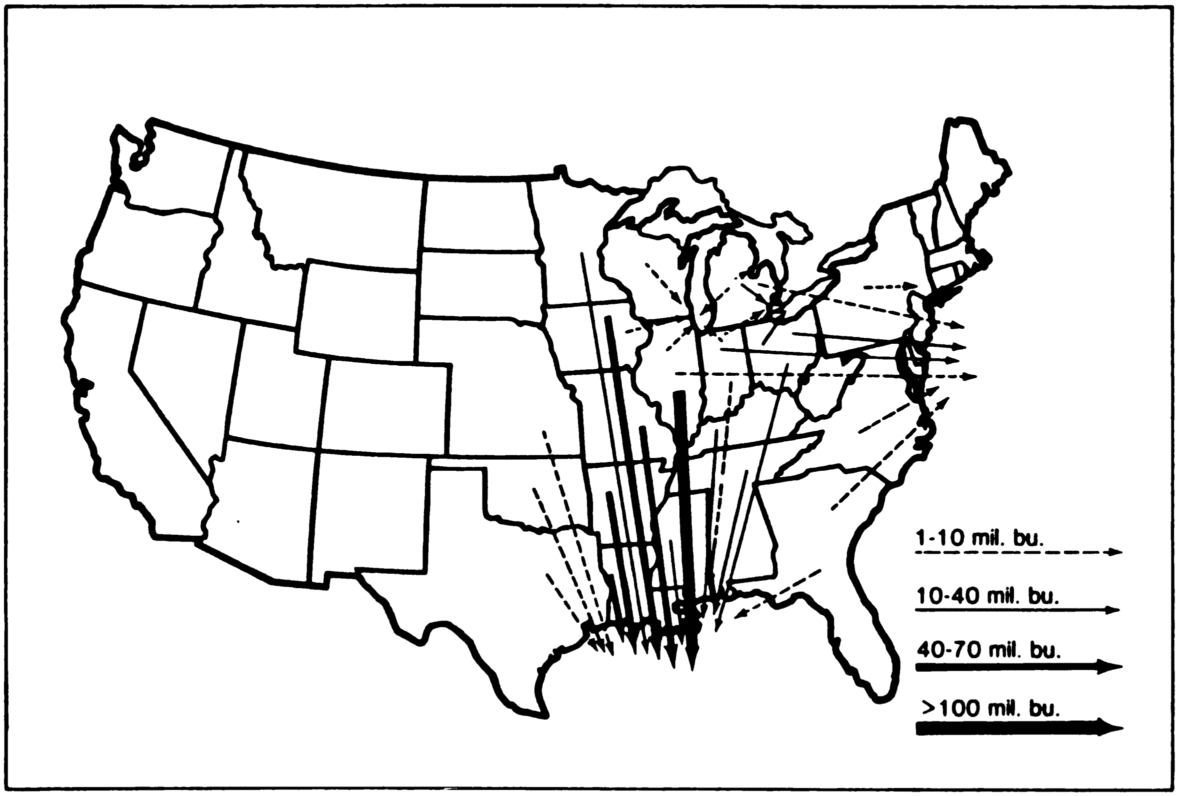
Figure 4.3

Patterns of Wheat Flows to Port Areas in 1977

Source: <u>Corn Movements in the United States, Interregional Flow Patterns and Transportation Requirements in 1977</u> (Hill, Leath and Fuller), North Central Regional Research Publication No. 275, January 1981, p. 16.

Figure 4.4

Patterns of Corn Flows to Port Areas in 1977



Source: <u>Soybean Movements in the United States, Interregional Flow Patterns and Transportation Requirements in 1977</u> (Leath, Hill and Fuller), North Central Regional Research Publication No. 273, January 1981, p. 16.

Figure 4.5

Patterns of Soybean Flows to Port Areas in 1977 the states and it was therefore impossible to include this state in the Great Lakes hinterland for the purpose of this research. In the area of wheat exports, the inclusion of North Dakota would have made the estimation of competition from Pacific ports much more reliable. This will be discussed in more detail in the next chapter.

4.1.1 Alternative Export Routes Available to the Great Lakes Hinterland

Given the Great Lakes hinterland defined in the last section (minus North Dakota), there were nine observed alternative combinations of transportation mode and destination for export grain from this area. Two of those alternatives, transporting grain by truck to the Atlantic or by truck to the Gulf, were very rare and won't be considered here as viable alternatives for exporting grain. The seven remaining alternatives are then:

(1) Moving grain by rail to the Gulf ports (Gulf by Rail).

(2) Moving grain by rail to the river terminals, then by barge to the Gulf ports (River by Rail).

(3) Moving grain by truck to the river terminals, then by barge to the Gulf ports (River by Truck).

(4) Moving grain by rail to the Atlantic ports (Atlantic by Rail).

(5) Moving grain by rail to the Great Lakes ports (Great Lakes by Rail).

(6) Moving grain by truck to the Great Lakes ports (Great Lakes by Truck).

(7) Moving grain by rail to the Pacific ports (Pacific by Rail).

The Appendix contains maps for each of these alternatives, on a state-by-state basis. When the modes are combined and only port destinations of Great Lakes grain are analyzed, the results are shown in Figures 4.6 - 4.12. These figures are based on the actual sample used in this study and may therefore differ slightly from Figures 4.3 - 4.5. What is immediately apparent from these figures is the large drawing area of the Gulf relative to the other ports. If the Great Lakes ports are combined, however, their drawing area becomes quite large. It is also clear that although the entire Great Lakes hinterland has all seven alternatives technically available; none of the states used all seven during 1977. It is hypothesized, however, that the choice of alternative is based on a number of variables which change over time and make other alternatives feasible choices. Therefore, while it is highly unlikely that grain from Ohio will ever be exported out of Portland, there is no cost to the model in keeping this option open. It will be assumed that all seven alternatives were available to any elevator within the Great Lakes hinterland during 1977.

4.2 Alternative Ways to Model Export Grain Flows

The most important factor to consider in choosing a model for this research is the ability of the model to show the impact of user fees on export grain flows. There are a number of transportation models that have been developed which would have the ability to do this. Of secondary importance is that the model be tractable and of reasonable expense to develop. The alternative transportation models can vary enormously in this respect.

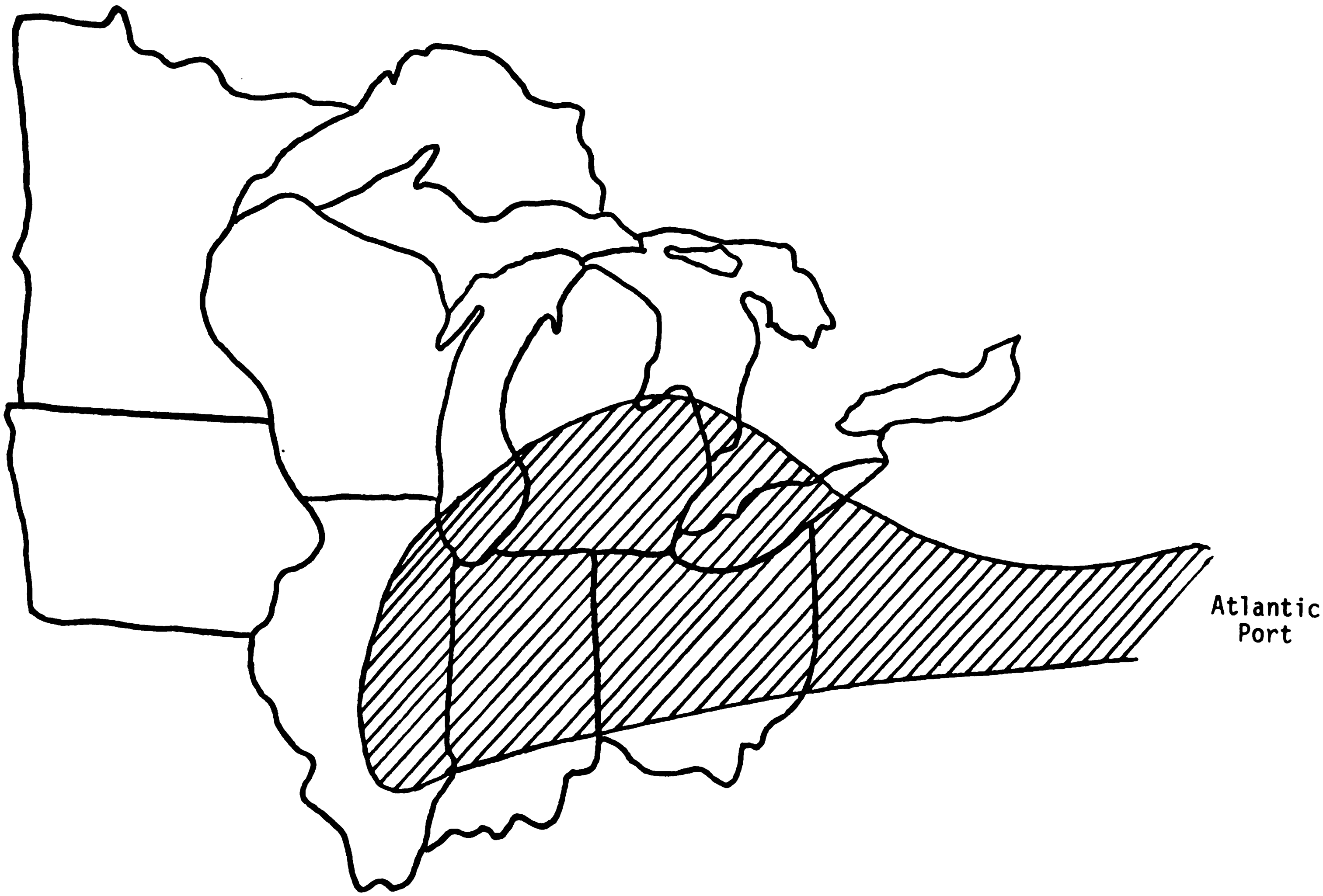


Figure 4.7

Drawing Area of the Atlantic Port of Export Grains
Based on 1977 Sample of 500 Elevators

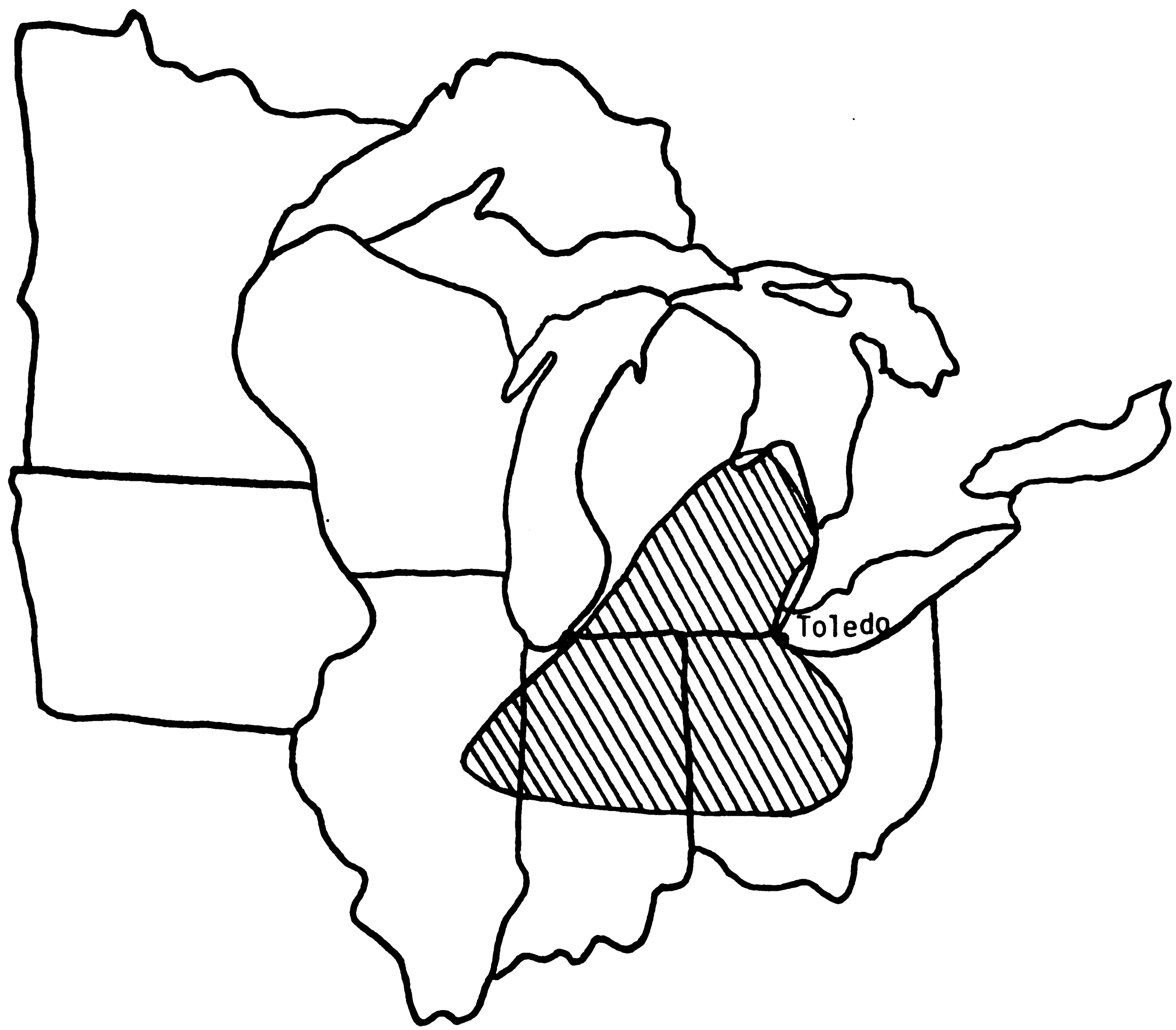


Figure 4.9

Drawing Area of the Toledo Port of Export Grains
Based on 1977 Sample of 500 Elevators

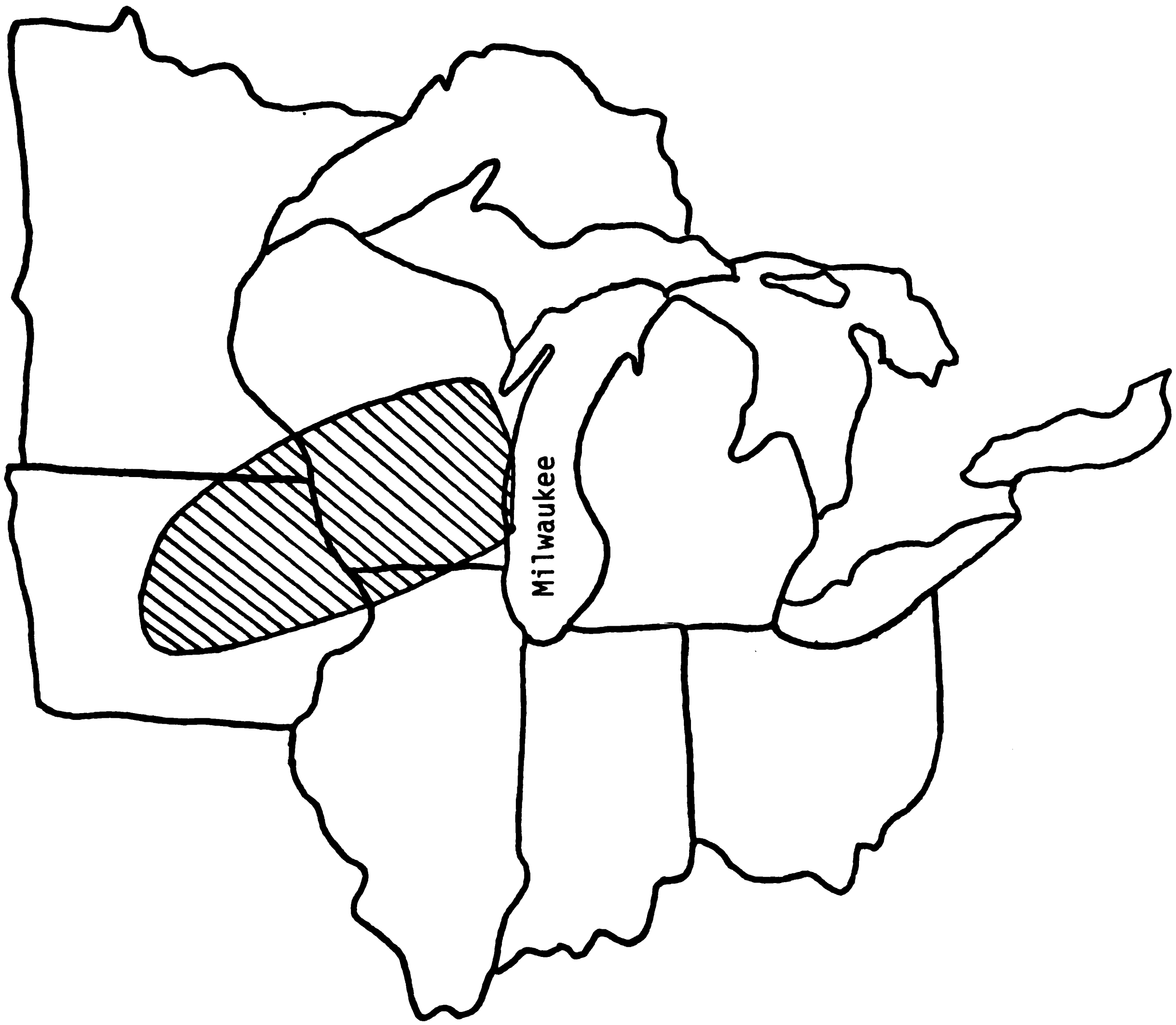


Figure 4.11

Drawing Area of the Milwaukee Port of Export Grains
Based on 1977 Sample of 500 Elevators

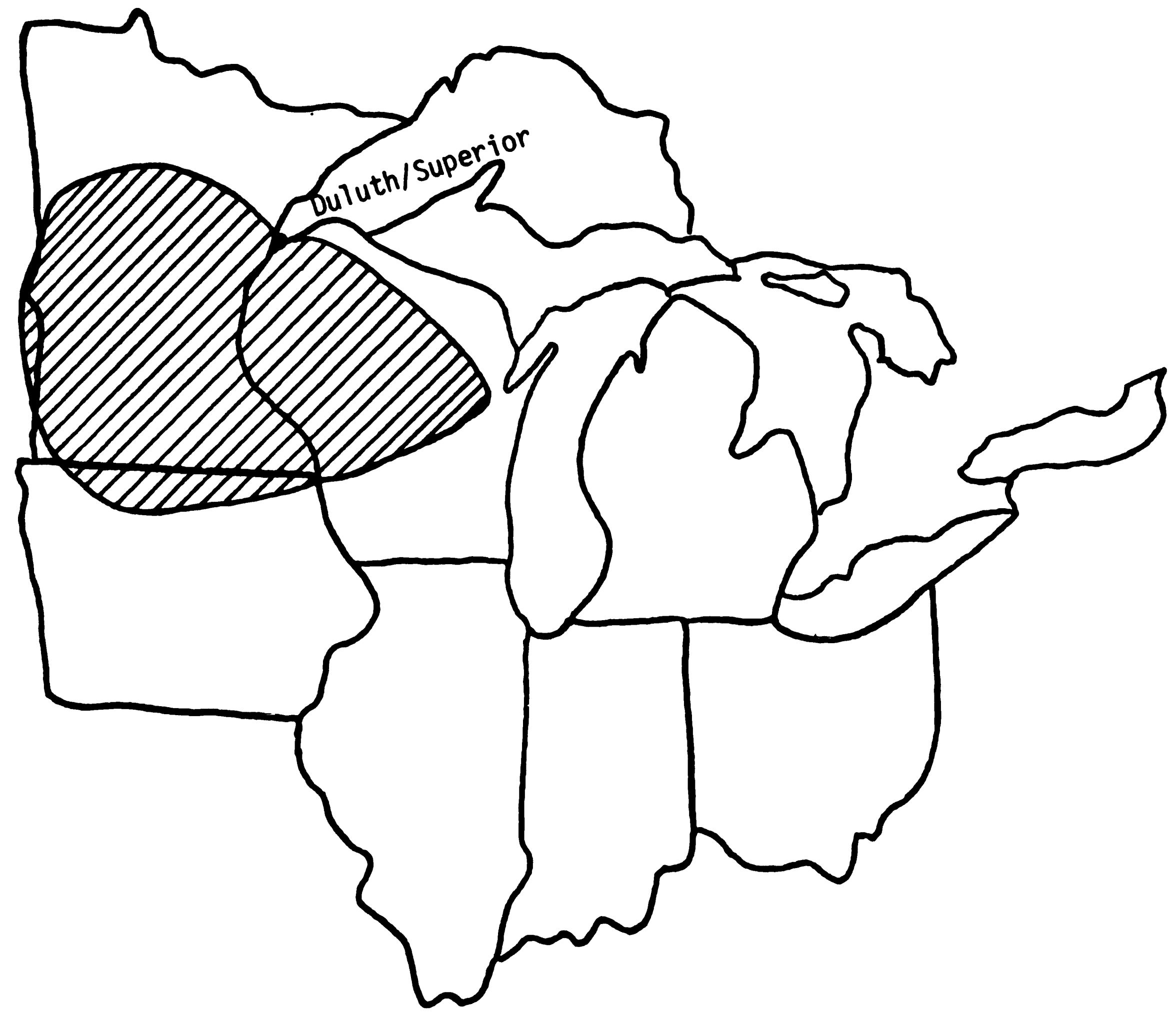


Figure 4.12

Drawing Area of the Duluth/Superior Port of Export Grains
Based on 1977 Sample of 500 Elevators

Three broad classes of models will be discussed in the following section, with particular attention to their appropriateness for this research. The model of shipper choice, which is used in this study, will be discussed in greater detail than the alternatives.

4.2.1 Linear Programming and Network Models

The use of a linear programming algorithm to minimize a transportation cost, subject to constraints, is very often found in the literature dealing with agricultural transportation.[5] In this type of model, final demand and supply for each region (both importing and exporting regions) must be specified. The surplus in some regions and the deficits in others will determine the amount of product moving in the system, and the objective function which minimizes the total cost of the system will determine the actual routes of commodity flows. Capacity constraints along any transportation route can be easily included in this type of model.

In its simplest form, the network model considers only the cost of transportation as being important in choosing a particular route. The given supplies and demands will determine exogenously how much product

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[5]For a comprehensive survey of the transportation literature, see: Clifford Winston, Conceptual Developments in the Economics of Transportation: An Interpretive Survey, Center for Transportation Studies, M.I.T., unpublished paper, 1982. For examples of the LP model relating to agriculture, see: Leonard Shabman and Joseph Havlicek, Navigation User Charges: Impact on the Transportation of Agricultural Products, Virginia Water Resources Research Center, Bulletin 121, 1979; also, Douglas Barnett, J.K. Binkley, B.A. McCarl, R.L. Thompson and J. Kennington, The Effects of U.S. Port Capacity Constraints on National and World Grain Shipments, Purdue Agricultural Experiment Station Bulletin No. 399, 1982; and Won W. Koo, "Grain Marketing and Transportation System Under the Current and Cost-Base Rate Structure," North Central Journal of Agricultural Economics, Vol. 4, No. 2, 1982.

will be moved to a particular place and the objective function will determine the origin and route chosen to meet the demand at the destination. Even in this simple form, a network model for the export of grains would be extremely large. Importing and exporting regions throughout the world would have to be defined and all feasible transportation routes between these regions would need to be defined. Then the cost of transporting a unit of commodity over these routes would have to be provided in order for the algorithm to provide a minimum cost solution. It is clear that the data needs of such a model are tremendous, yet such models have been developed. In order to analyze the impact of user fees, the costs of transportation would be modified along any routes affected by the user fees and the model could be re-solved for the new solution. The amount of grain flowing over the Great Lakes - St. Lawrence Seaway route before and after the imposition of user fees could be found directly by this method.

There are problems with the network models beyond their prohibitive cost of both development and solution. The most obvious is the reliance on cost as the only determinant of route choice. Even in the case of a bulk commodity such as agricultural products, service quality variables have been found to be important in shippers' decisions.[6] In a simple model, the route with the lowest cost would have the entire

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[6]See, for example, Kenneth D. Boyer, "Minimum Rate Regulation, Modal Split Sensitivities, and the Railroad Problem," in the Journal of Political Economy, Vol. 85, No. 3, 1977; also, Marc A. Johnson, "Market and Social Investment and Disinvestment in Railroad Branch Lines: Evaluation Procedures and Decision Criteria," unpublished Ph.D. Dissertation, Department of Agricultural Economics, Michigan State University, 1975; and Clifford Winston, "A Disaggregate Model of the Demand for Intercity Freight Transportation," in Econometrica, Vol. 49, No. 4, July 1981.

transportation flow allocated to it, regardless of whether this results in congestion and longer waiting times (service quality considerations).

The reliance on the cost variable as the sole determinant of route choice also makes the problem of determining the impact of user fees a trivial one. If a nationally uniform user fee is implemented, the cost of all export routes will go up by the same amount and the amount flowing over any given route will be unchanged. This implies that a 1 percent price increase at one port is viewed identically to a 1 percent price increase at another port. This may or may not be true, but it is assumed in the network model.

The simple network model can be expanded and made more flexible by modifying the objective function, or by imbedding the network model in a simulation model.[7] The objective function can incorporate some of the service quality variables by giving negative or positive weights to route choices with favorable service characteristics. Determining the relative importance of these variables and therefore attaching the weights, can be very difficult. In a simulation model, a number of different objective functions can be included, where one transportation decision is made first, which then impacts on later decisions. For example, traffic could start out along a least-cost route where delays from bottlenecks can be modelled when they occur. A threshold can then be imposed where traffic will divert to another route when the delay

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[7] See, for example, Robert C. Bushnell, James Low and Edward S. Pearsall, "Simulating the Impact of Changes in a Statewide Freight System," presented at the Winter Simulation Conference, Orlando, Florida, 1980; and Robert C. Bushnell, James T. Low and James B. Wiley, "The Integrated Network Model: Methodology and Description," Vol. 3 of the Final Report on "Future Transportation Systems of the Great Lakes Region: Energy and Economics," Department of Energy, Washington, D.C., 1978.

becomes too long. Designing a transportation model of this type for export grain flows would be extremely difficult and costly. Nevertheless, models of this type have been done and the methodology is available for a researcher to use.

The major drawback to all types of network models is the necessity to exogenously impose a shipper preference structure on the model. Whether it is a simple rule of cost minimization or a more complex interaction of cost and service variables that is considered, the decision rule for shipper choice must be specified a priori. In most cases, researchers have relied on shipper surveys, either formal or informal, to derive this information. Considering the importance of the specification of the objective function in mathematical programming models, the shippers' preference function that is imposed will be the determining factor in the model. Therefore, the methodology used to derive the specification of the objective function becomes extremely important. It would be preferable to estimate this function based on a large sample of data, as in econometrics, so that different variables could be tested for statistical significance. This would imply the combination of a shipper choice model, as discussed in following sections, within a network model. Most studies specify their objective functions a priori, however, based on survey data or theoretical consideration.

4.2.2 Derived Demand Models

The transportation of commodities from origin to destination can be considered an input into the production of the commodity. Transportation gives a product time and space utility by providing the good when and where it is demanded. The theory of derived demand for product inputs is well developed in microeconomic theory.[8] A simple exposition will be given here, following the work of Johnson,[9] which was introduced in the last chapter.

Let Y be the final product, in this case, grain. Then the production function for grain is:

$$Y = f\ (X_i,\ T_j \mid X_f) \tag{1}$$

where:

X_i = the quantity of variable production input i;

T_j = the quantity of transportation service of mode j;

X_f = the quantity of fixed production input.

As with other production inputs, the demand for transportation is derived from the demand for the final product. For a profit maximizing firm in a competitive market then, the demand for transportation service of mode j is:

$$T_j = d_j\ (p,\ r_i,\ r_j) \tag{2}$$

where:

p = final product price;

r_i = variable production input price;

r_j = transportation input price.

The price of transportation mode j includes more than the freight rate which is quoted. There are nonrate costs as well which are related to the quality of service characteristics of a particular mode. For example, a mode which is faster and more reliable will have lower inventory costs associated with goods in transit. These costs which

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[8]See, for example, Hal Varian, Microeconomic Analysis, W.W. Norton and Company, New York, 1978.

[9]Marc Johnson, 1975.

"constantly place their jobs on the line."[34] The attitudes of the decision makers toward risk must be accounted for in the resulting model. In this way, Winston can characterize the traffic manager as an individual maximizing utility rather than a firm minimizing cost. The possible delays which are inherent in transportation will affect the "utility" of the decision maker, since long delays are likely to jeopardize the manager's job. Since the delays are stochastic, Winston can directly relate his model to the random utility models of McFadden. For perishable agricultural commodities, this framework may be appropriate. But for grains, it is difficult, and unnecessary, to formulate the problem in this way.

Grain elevators must also be concerned with excessive delays in transportation service, but they do not risk the spoilage of their product or the shutting down of their operation (or the operation of the receiver) if a shipment must be delayed. Boyer[35] has suggested that it is precisely the nonperishable agricultural commodities which are least sensitive to the quality-of-service characteristics of a transportation mode. Because of this, and the fact that individual decision makers across elevators are likely to vary in their "job security," the utility maximization framework will not be followed here. A more general choice index will be applied instead.

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[34] Ibid., p. 984.

[35] Kenneth Boyer, "The Price Sensitivity of Shippers' Mode of Transport Selection and the Intermodal Allocation of Freight Transport," Ph.D. Dissertation, University of Michigan, 1975.

are related to different service quality characteristics of any mode can be denoted (r_{jq}, $q = 1, \ldots, s$). Each characteristic will affect the nonrate cost and, therefore, transport price can be rewritten as:

$$r_j = r_{jp} + r_{jq} \left(q_{j1}, \ldots, q_{js}\right) \tag{3}$$

Substituting (3) into (2), the derived demand for transportation becomes:

$$T_j = d_j \left[p, r_i, r_j \left(r_{jp}, q_{j1}, \ldots, q_{js}\right)\right] \tag{4}$$

Elasticities with respect to both prices and levels of service quality characteristics can be derived from equation (4).

The above framework is consistent with the theory of derived demand for inputs, but it is not clear that the choice of transportation modes should be treated as a demand for a production input. The demand for transportation itself is certainly a derived demand, but the choice of which kind of transportation to use is a choice between substitutes, not complements, in the production process. As Boyer[10] points out, in classical derived demand theory, the production function is assumed to have a convex region where the marginal products of inputs are positive. If the two inputs are two modes of transportation, then it is assumed that one mode can be substituted for the other mode in varying proportions, but that both modes are always used except at the corners of the production function. In fact, for any given shipment at a point in time, only one mode of transport will be used by a firm. This implies that the firm would always be at a corner solution with respect to the optimal input use. Classical derived demand theory, however, requires that the

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[10] See: Kenneth Boyer, "The Price Sensitivity of Shippers' Mode of Transport Selection and the Intermodal Allocation of Freight Transport," Ph.D. Dissertation, University of Michigan, 1975, pp. 55-58.

optimal solution point be internal. As Varian states, "the condition characterizing profit maximization and cost minimization...need to be modified when the maximization or minimization solution is not interior, i.e., when some factor is not used."[11] When the price of one transport mode increases and causes a shift to the alternative mode, the firm is moving from one corner point to another in its input allocations. The implications of this are that the demand for a particular transportation mode is not uniquely derived from the demand for the final product, although the demand for transportation services in general may be.

Boyer (1975) points out other reasons why the classical derived demand theory may not be useful for measuring the demand for alternative modes. Nevertheless, this type of model has been used to estimate demand elasticities for transportation modes,[12] which should be compared to the results from alternative models to see the direction of bias.

4.2.2.1 Models of Discrete Shipper Choice

An alternative way of interpreting the idea of a corner solution is to view the firm as having thresholds with respect to alternative transportation modes. If the combination of rate and service quality costs of a particular mode reach a certain threshold, the firm switches to an alternative mode. For any given shipment at a point in time, the firm will choose only one transportation mode, depending on the relationship of the rate and service characteristics of each alternative to the firm's threshold. The threshold levels are not directly observed by the researcher, only the decision of which mode is actually chosen is observed.

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[11] Hal Varian, Microeconomic Analysis, 1978, pp. 12-13.

[12] Winston, 1982, p. 18, reviews some of these studies.

However, if the researcher assumes a particular distribution for the thresholds among firms (e.g., normal, logistic), then the observations of discrete choice can be used to construct a model of probabilistic choice.[13]

There are a number of choice models in the literature and Winston (1982) has divided these into two categories, aggregate and disaggregate models. In the aggregate models, the modal split between two types of transportation is generally specified as:

$$\log \frac{S_i}{S_j} = a_0 + a_1 (P_i - P_j) + \sum_{k=2}^{k} a_k (X_{ik} - X_{jk}) \qquad (5)$$

where:

$\frac{S_i}{S_j}$ = ratio of the market share (S) of mode i to the share of mode j;

$P_i - P_j$ = the price difference between the modes;

$X_{ik} - X_{jk}$ = the difference of service quality-type variables.[14]

Boyer (1976) used a framework similar to this in his study on railroad regulation.

An alternative to the aggregate approach is to specify an individual (or disaggregate) choice function which represents the choice structure of the decision maker each time a shipment is made. Therefore, individual shipments are the relevant observation, rather than an aggregate share of many shipments.

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[13]See: Takeshi Amemiya, "Qualitative Response Models: A Survey," in The Journal of Economic Literature, Vol. XIX, No. 4, December 1981; also, Oral Capps, Qualitative and Censored Response Models, paper presented at the AAEA Meetings, Summer 1983.

[14]Winston, 1982, pp. 17-18.

There are many examples in the literature of individual choice models.[15] The majority of these are concerned with individual consumer choice, where utility maximization is the given decision rule. There are a number of studies of this type regarding commuters' choice of transportation mode. Domencich and McFadden's 1975 study[16] is the classic example of this methodology. Hausman and Wise[17] analyze a similar type of problem using a different functional form, while Train[18] combines the choices of auto ownership and alternative mode in a nested model.

Winston[19] uses a framework of utility maximization to explain the transportation mode choice of a firm's distribution manager. His contention is that the risks involved in transportation delays cause the manager to behave in a way that will maximize the manager's utility, rather than strictly minimize costs of the firm.

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[15]Surveys of this literature include: Takeshi Amemiya, 1981; Oral Capps, 1983; and Daniel McFadden, "Quantal Choice Analysis: A Survey," in Annals of Economic and Social Measurement, Vol. 5, No. 4, 1976, pp. 363-390.

[16]T. Domencich and D. McFadden, Urban Travel Demand: A Behavioral Analysis, North Holland Publishing Company, Amsterdam, 1975.

[17]Jerry A. Hausman and David A. Wise, "A Conditional Probit Model for Qualitative Choice: Discrete Decisions Recognizing Interdependence and Heterogeneous Preferences," in Econometrica, Vol. 46, No. 2, March 1978, pp. 403-426.

[18]Kenneth Train, "A Structured Logit Model of Auto Ownership and Mode Choice," in Review of Economic Studies, Vol. XLVII, 1980, pp. 357-370.

[19]Clifford Winston, "A Disaggregate Model of the Demand for Intensity Freight Transportation," in Econometrica, Vol. 49, No. 4, July 1981.

The utility maximization theory that underlies these models is very intuitive.[20] Using the example of consumer choice between two alternative transportation modes, the utility functions for each mode can be specified as:

$$U_{i0} = \alpha_0 + Z_{i0}' \beta + \omega_i' \gamma_0 + \varepsilon_{i0} \tag{6}$$

$$U_{i1} = \alpha_1 + Z_{i1}' \beta + \omega_i' \gamma_1 + \varepsilon_{i1} \tag{7}$$

where:

i = referencing the individual;

j = referencing the mode, and is 0 for transit and 1 for car;

Z_{ij}' = vector of mode attributes;

ω_i' = vector of the individual's characteristics.

Notice that in the specification of (6) and (7), the β vector of parameters is the same for both modes. This is what McFadden calls the absence of alternative-specific effects. For example, if an element of Z_{i0}' is the time involved in using a particular mode of travel, then a constant β implies that it shouldn't matter whether the time is spent on a bus or in a car. A person's utility is affected by how much time is spent on an alternative, not by what the alternative is called. Using the terminology of Lancaster's[21] activity analysis, it is the combination of characteristics of an alternative that are important, not the

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[20] See any of the above references for alternative specifications of this theory, and see: Amemiya (1981), and Daniel McFadden, "Conditional Logit Analysis of Qualitative Choice Behavior," in P. Zarembka (ed.), Frontiers in Econometrics, Academic Press, New York, 1973, pp. 105-143, for general derivations of choice models from utility theory.

[21] K.J. Lancaster, "A New Approach to Consumer Theory," in the Journal of Political Economy, Vol. 74, 1966, pp. 132-157.

label of the alternative. Unfortunately, the researcher cannot always specify and measure all of the characteristics of a good that affect the consumer's utility. For instance, there may be status associated with the driving of an automobile that is not present when the commuter takes a bus. If a variable called "status" can't be measured in a relative way for the two alternatives, then it is necessary to include an alternative-specific variable (dummy variable) to account for a "pure auto preference" effect.[22] The inclusion of alternative-specific variables does not present a problem for estimation of the model. However, it does take away one of the advantages of the Lancaster-type framework. If all alternatives could be described only by their characteristics (what McFadden calls "generic variables"), then the effect of a policy change on any alternative (whether it was included in the original estimation or not) could be calculated by using the β parameters and the <u>characteristics</u> of the new alternative. Whether this is an advantage to the researcher depends totally on the nature of the problem being investigated.

The second thing to notice about equations (6) and (7) is that the γ_j vector is different between the two alternatives. This means that an individual (described by the same ω_i' vector in both equations) can derive different utilities from the alternative modes, which is what we would expect.

Finally, notice that equations (6) and (7) include error terms. These are the stochastic elements of the utility functions, while the first three elements of the functions are assumed to be nonstochastic.

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[22]Domencich and McFadden, 1975, p. 117.

McFadden interprets the nonstochastic part of the utility function as reflecting the "representative tastes of the population," and the error term reflecting "the idiosyncrasies of this individual in tasts for the alternative with attributes (Z_{ij}')."[23]

Given the two utility functions, U_{i0} and U_{i1}, and a decision rule of utility maximization, it is clear that the commuter will choose the car alternative if $U_{i1} > U_{i0}$. Define the random (0, 1) variable y_i to correspond to the event that the car alternative is chosen. Then $y_i = 1$ with the i^{th} person drives a car. The probability that the i^{th} person will drive a car is therefore the probability that the utility from the car alternative is greater than the utility from the transit alternative:

$$P\ (y_i = 1) = P\ (U_{i1} > U_{i0})$$

substituting (6) and (7),

$$= P\ (\alpha_1 + Z_{i1}'\ \beta + \omega_i'\ \gamma_1 + \varepsilon_{i1} > \alpha_0 + Z_{i0}'\ \beta + \omega_i'\ \gamma_0 + \varepsilon_{i0}) \qquad (8)$$

rearranging terms:

$$= P\ [\varepsilon_{i0} - \varepsilon_{i1} < \alpha_1 - \alpha_0 + (Z_{i1}' - Z_{i0}')\ \beta + \omega_i'\ (\gamma_1 - \gamma_0)]$$

By specifying a particular distribution function, F, for the $(\varepsilon_{i0} - \varepsilon_{i1})$'s the probability that $y_i = 1$ becomes:

$$P\ (y_1 = 1) = F\ [(\alpha_1 - \alpha_0) + (Z_{i1}' - Z_{i0}')\ \beta + \omega_i'\ (\gamma_1 - \gamma_0)] \qquad (9)^{24}$$

[23] D. McFadden, 1973, p. 108.

[24] Note that a "cumulative probability function is defined as having as its value the probability that an observed value of a variable X will be less than or equal to a particular X." (R. Pindych and D. Rubinfeld, Econometric Models and Economic Forecasting, McGraw-Hill Book Company, New York, 1981.)

The three most common choices for F are:[25]

Linear Probability Model $F(\omega) = \omega$

Probit Model $F(\omega) = \Theta(\omega) = \int_{-\infty}^{\omega} \frac{1}{\sqrt{2\pi}} e^{-t^2/2} dt$

Logit Model $F(\omega) = L(\omega) = \frac{e^{\omega}}{1 + e^{\omega}}$

Notice that in equation (9), the parameters γ_1 and γ_0 appear only as a difference, $(\gamma_1 - \gamma_0)$. This means that if the coefficient on a socioeconomic variable does not vary between alternatives, then that variable should not be included in the final formulation of the model. This makes intuitive sense because we are trying to explain the choice among alternatives. If an independent variable does not have an effect on which alternatives are chosen, it will not be explaining anything in the equation. An example from Kohn, et al.,[26] which investigates the choice among colleges by students, is helpful. Write the utility function as:

$$U_{ij} = V_1 (Z_{ij}, \omega_i) \cdot \theta_1 + V_2 (\omega_i) \cdot \theta_2 + \varepsilon_{ij} \qquad (10)$$

where the first term encompasses the utility functions of (6) and (7) (i.e., the general function $V_1 (Z_{ij}, \omega_i) \cdot \theta_1$ can be specified as $\alpha_j + Z_{ij}' \beta + \omega_i \gamma_j$). This first term represents the utility derived from the attributes of each particular college under consideration. The second term of (1) represents "the utility derived from college in general by individual i in a way that does not depend on the qualities of a

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[25] Amemiya, 1981, p. 1486.

[26] Meir G. Kohn, Charles F. Manski and David S. Mundel, "An Empirical Investigation of Factors Which Influence College-Going Behavior," in Annals of Economic and Social Measurement, Vol. 5, No. 4, 1976, pp. 391-419.

given college."[27] In other words, there is nothing in this term that will vary between colleges (note that there is no j subscript in this term). Therefore, when the utility differences between any two alternatives are being calculated (e.g., $U_{i1} - U_{i2}$), the second term drops out of the equation to be estimated. The implications of this are that all independent variables must be interacted with the alternatives when the equation is estimated. This will be discussed further in the next chapter.

4.2.3 Modelling Choice Without Reference to Utility Maximization

McFadden's derivation of a probability model from utility maximization theory makes the analysis formally complete for some types of problems. However, as Amemiya[28] points out, the link to utility maximization is not necessary, and may not even be desirable for some types of problems. A more straightforward approach is to specify a functional form for the probability function which makes sense in terms of the concept of probability. Generally, the probability of an event occurring [i.e., $P\ (y_i = 1)$] can be written as some function of independent variables which affect the probability:

$$P\ (y_i = 1) = F\ (X_i\ \beta) \qquad (11)$$

In specifying the functional form for F, it is convenient to use a cumulative distribution function, which provides a transformation that constrains the dependent variable to be between 0 and 1. It is also desirable to specify a continuous function so that it would not have to be truncated at the 0 and 1 boundaries.

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[27]Ibid., p. 395.

[28]Amemiya, 1981, p. 1492.

Finally, there is empirical evidence[29] that suggests the function should be S-shaped, and asymptotic to the 0 and 1 values. The two most common functional forms for this type of curve are the logistic and probit forms (see Figure 4.13). There have been studies done using the uniform cumulative distribution function, which leads to the linear probability model. However, the shortcomings of this approach are well-documented[30] and, therefore, should only be used in special cases.

In a dichotomous choice model, there are few criteria to use to choose between the logit or probit forms. Their distributions only vary at the tails and the difference is small. However, in the multiple choice or multinomial models, there are more significant differences between the two models. These differences and their implications for the problem being studied will be discussed more fully in the section on estimation. As a practical matter, the logit model is a much simpler model to estimate, since the probit model requires the evaluation of integrals. However, the properties of the normal distribution (particularly its derivation from the Central Limit Theorem) upon which the probit model is based, make it appealing for problems when the appropriate underlying distribution is not known.

There is yet another way to arrive at a probability or choice model without reference to utility maximization. The logic is similar to that used by McFadden, but it is a more general approach. Instead of using

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[29]Eric Hanushek and John Jackson, Statistical Methods for Social Scientists, Academic Press, New York, 1977, p. 183.

[30]See, for example: Janushek and Jackson, 1977, pp. 181-186; also, R. Pindyck and D. Rubinfeld, Econometric Models and Economic Forecasting, McGraw-Hill Book Company, New York, 1981; and A. Goldberger, Econometric Theory, John Wiley & Sons, New York, 1964.

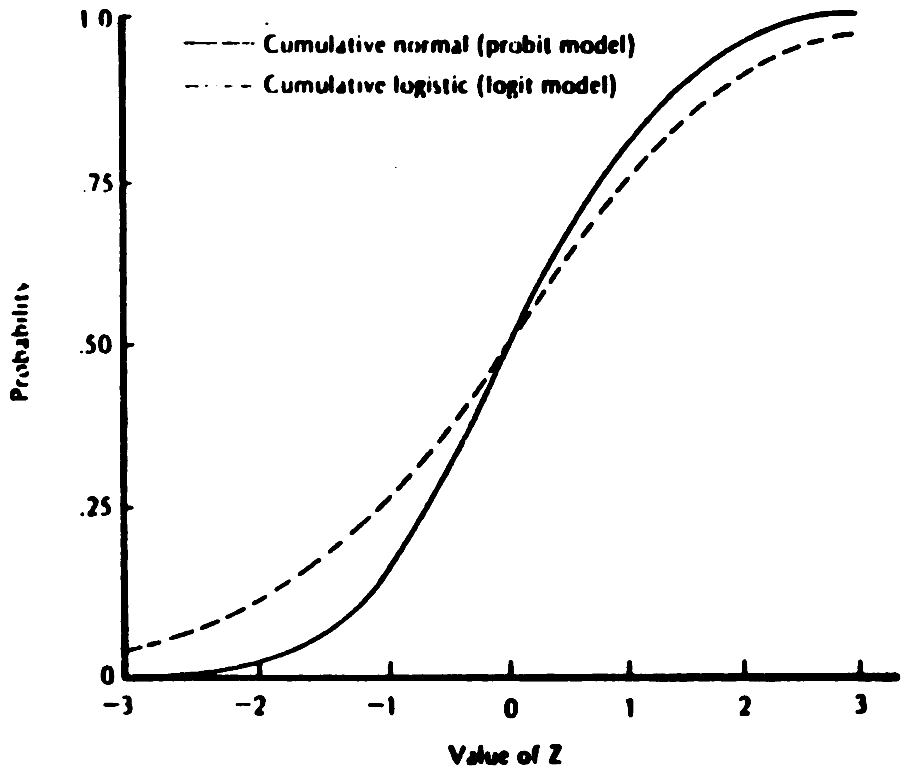

Figure 4.13

Comparison of Logit and Probit
Cumulative Distributions

utility functions, the choice is characterized by a function called a decision index.[31] The decision index simply relates the choice of an alternative to a set of independent variables that are hypothesized to affect that choice. There is also a stochastic element:

$$C_{ij} = C\ (Z_{ij}, \omega_i) + \varepsilon_{ij} \qquad (12)$$

If the choice is among inputs for a firm, this index could be called a cost function and the firm would choose alternative j if:

$$C\ (Z_{ij}, \omega_i) + \varepsilon_{ij} < C\ (Z_{i\ell}, \omega_i) + \varepsilon_{i\ell}, \text{ for all } \ell \neq j \qquad (13)$$

where Z_{ij} is a vector of the costs of the input, and ω_i is a vector of characteristics of the firm.

Following the same steps as equation (8), the probability that a firm will choose alternative j is:

$$P_{ij} = P\ [\varepsilon_{ij} - \varepsilon_{i\ell} < C\ (Z_{i\ell}, \omega_i) - C\ (Z_{ij}, \omega_i)], \text{ for all } \ell \neq j \qquad (14)$$

Again, by specifying a distribution for the $(\varepsilon_{ij} - \varepsilon_{i\ell})$'s, a particular model can be estimated (e.g., linear probability, probit, or logit model).

It should be clear that the probability or choice models that are estimated are the same, regardless of whether they are based on utility maximization, cost minimization, or just some unnamed function that characterizes the decision process. It is possible, however, that the choice among models (e.g., logit vs. probit) will depend on the underlying structure of the probability function.

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[31]See, for example: Paul L. Jaskow and Frederic S. Mishkin, "Electric Utility Fuel Choice Behavior in the United States," in International Economic Review, Vol. 18, No. 3, October 1977; and Michale LeBlanc, "Estimating Input Cost Shares for Agriculture Using a Multinomial Logit Framework," in Agricultural Economic Review, Vol. 34, No. 4, October 1982.

4.3 Specifying the Transportation Choice Function

In this study, the interest is in the choice among ports by elevators shipping export grain. Since the elevator also has a choice of modes of transportation to move the grain to any given port, there is actually a joint choice that must be estimated. By specifying every combination of this joint choice that is available to an elevator in the study area, we can model the situation as a multiple choice problem between all combinations of modes and destinations. Fortunately, for this case, there are only seven choices that need to be specified in this manner and, therefore, the problem is still manageable. Alternative methodologies have been developed to handle cases with a larger number of joint choices.[32]

4.3.1 The Decision Maker and the Choice Setting

The inland grain elevators that were included in this study ranged from small country elevators to large terminal elevators. It is difficult, therefore, to say anything about the characteristics of an individual decision maker that would be present in all the elevators. Only the larger elevators would have a "traffic manager" or someone whose only responsibility is to make transportation decisions.

In those cases where a traffic manager exists, the framework used by Winston[33] might be suggested. In this framework, the decision makers are seen as operating in a world of uncertainty where they

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[32]Problems which involve joint choices are usually called "multivariate" problems in the literature (see, Capps, 1983, p. 15), but the terminology is not always consistent. For an example of an alternative way to model the joint choice case, see Kenneth Train, "A Structured Logit Model of Auto Ownership and Mode Choice," in Review of Economics Studies, Vol. XLVII, 1980, pp. 357-370.

[33]Clifford Winston, 1981.

4.3.2 Identification of Variables

A choice index, as described above, is simply an expression that relates the choice of an alternative to some set of independent variables:

$$C = C\ (Z_{ij},\ \omega_i) + \varepsilon_{ij} \tag{15}$$

The function in equation (15) will have a value at any given levels of variables and parameters. It is necessary to know the functional form involved, as well as whether a higher value of (15) makes the choice more probable or less probable. In the case of utility maximization, the higher the index for a given alternative, the more likely the alternative would be chosen. In the case of cost minimization, a lower value for the index would make the alternative more likely. In the problem under consideration here, neither utility maximization nor cost minimization will be strictly applied. Instead, it will be hypothesized that the elevator wishes to maximize a type of "net profit" variable, subject to certain technological constraints of the facilities. This net profit variable is the difference between the destination price for the grain and the cost of transporting the grain to that destination. This does not presume that these are the only two factors involved in the net profit calculation of the elevator. They are hypothesized as being the most important when deciding on the combination of destination and transportation mode.

The technological constraints of the elevator are similar to the characteristics of the individual variables, ω_i, in the utility maximization model. A number of these types of variables were hypothesized as being relevant to the transportation choice. The total storage capacity (CAPACITY) of the elevator is the usual determinant of "size" of the elevator. In general, large elevators would be more likely to have good rail facilities available, and would therefore be more likely to use the rail mode. However, the rail facilities can be measured more directly by the maximum number of cars that can be loaded at one time (MAXCARS) and the loading rate per hour for rail cars (RRLOAD). The trucking facilities of the elevator can be similarly characterized by the truck loading rate, in bushels per hour, (TRLOAD). Finally, the ability of the rail tracks to accept 100 ton hopper cars (HOPPERS) can also influence the choice between rail and truck transportation.

In addition to the characteristics of the elevator, there are characteristics of the shipment that are important in determining destination and mode. The volume of a shipment (VOLUME) will determine whether the elevator can take advantage of multiple car rail rates. The type of grain being shipped (TYPE) may have an influence in choice of destination, since not all ports have equal demands for certain types of grain. Perhaps most important, the time of year that the shipment takes place (SEASON) will have an effect on whether the seasonal routes (Great Lakes and upper Mississippi River) are chosen.

The net profit variable of destination price minus transportation cost (NETPFT) is a variable whose value varies by alternative. These are the Z_{ij} variables of equation (15). These price and cost variables could have been included separately in the equation, but it was believed that this would not describe the actual decision process as well.[36] The

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[36]This was tried in a separate run, to be sure that the empirical results supported the hypothesis. There were numerous wrong signs on coefficients and insignificant t-ratios, almost certainly due to the obvious multicollinearity between the two variables.

variables are most likely not considered independently from each other when a transportation decision is made.

The form of the function, $C\ (Z_{ij},\ \omega_i)$, was assumed to be linear in parameters. Various interactions between variables can still be included, as is the case with ordinary regression analysis. For lack of any a priori reason to interact variables, the resulting equation entered all the variables separately:

$$\begin{aligned} C_{ij} = {} & \beta_{1ij}\ \text{CAPACITY}_i + \beta_{2ij}\ \text{MAXCARS}_i + \beta_{3ij}\ \text{RRLOAD}_i + \\ & \beta_{4ij}\ \text{TRLOAD}_i + \beta_{5ij}\ \text{HOPPERS}_i + \beta_{6ij}\ \text{VOLUME}_i + \\ & \beta_{7ij}\ \text{TYPE}_i + \beta_{8ij}\ \text{SEASON}_i + \beta_{9ij}\ \text{NETPFT}_{ij} \end{aligned} \qquad (16)$$

The elevator's preference for any given alternative j is assumed to be represented by this decision index. The elevator will choose alternative j if $C_{ij} > C_{i\ell}$, or:

$$\begin{aligned} P_j &= P\ [C\ (Z_{ij}, \omega_i) + \varepsilon_{ij} > C\ (Z_{i\ell}, \omega_i) + \varepsilon_{i\ell}] \\ &\quad \text{for all } \ell \neq j \\ &= P\ [(\varepsilon_{i\ell} - \varepsilon_{ij}) < C\ (Z_{ij}, \omega_i) - C\ (Z_{i\ell}, \omega_i)] \\ &\quad \text{for all } \ell \neq j \end{aligned} \qquad (17)$$

where the Z_{ij} and ω_i variables are as defined above. The procedure involved in estimating P_j is described in the next chapter.

4.4 Methodology for Analyzing the Impact of User Fees

The imposition of user fees must have an effect on one or more of the variables in (16) in order for this model to be useful. Since user fees are an untried policy, some assumptions will need to be made about who will ultimately pay the cost. The structure of the markets involved will determine how this cost is passed along and, therefore, some theoretical conclusions based on market structure can be proposed.

The immediate application of the user fee will be to the ships that use a port. Whether the fee is based on weight or value of the commodity, the ship entering or leaving the port will have to pay the fee. As previously stated, the transportation ship industry that serves the grain export market is a very competitive one. In a competitive industry, the supply curve is likely to be relatively elastic. A small increase in the price shippers are willing to pay at a particular port will draw a large number of ships to that port area.

The demanders in this market are the port elevators. The demand for transportation ships by grain elevators is relatively inelastic, at least in the short-run. The port elevator has contracts on both sides of the market. It usually forward contracts with inland elevators for the grain to be delivered and it contracts with the overseas buyer ahead of the delivery time as well. Since storage capacity is limited, the ocean transportation link must be provided at specified times, regardless of what the rate is at that time. Of course, if the elevator expects high ocean rates at a particular port, there are sometimes alternative ports which can be used. This depends on whether a particular grain company has elevators in more than one port, and whether the ocean rates vary between ports. When rates are high at all ports, the shippers have no alternative to paying them except to hold their grain. The ability to do this is severely constrained by the limits of storage and available capital. In the longer run, the combination of high ocean rates and low margins for export sales could make the demand for ocean transportation more elastic. The short-run situation is more likely to look like Figure 4.14.

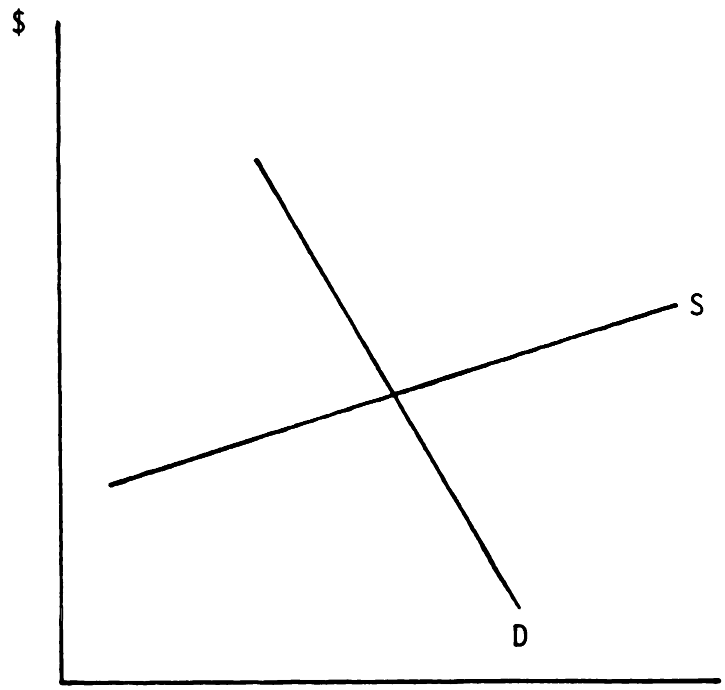

Figure 4.14

The Short-Run Market for Ocean Transportation Services

Figure 4.15 shows what the imposition of a user fee will do to this market. The net result is that quantity has decreased somewhat, sellers are accepting a slightly lower price (P_N) and, most noticeable, the buyers are paying most of the user fee (P_1 - P_0). The relative elasticities of the supply and demand curves determine completely who pays the user fee in a competitive market. It is not the purpose here to attempt a complete analysis of the market structure and relative elasticities, but the general conclusions drawn above will hold for a range of market conditions. If the presence of an alternative market structure is hypothesized, then the effects of that can be easily included in the final analysis.

The fact that the port elevators pay most of the user fee initially does not mean that they can't also pass it along to the inland grain sellers, and eventually, back to the farmer. The way that the user fee is distributed through the market can be analyzed through a marketing margin or marketing spread (MS) framework. Isolating transportation as the only marketing service, the market for this service is the one described in Figures 4.14 and 4.15. The marketing spread is what is paid for the marketing service, or (P_0 - 0) before user fees and (P_1 - 0) after user fees (see Figure 4.16). Therefore, the MS has increased from the imposition of user fees.

The market for grain can be described by Figure 4.17, where D_E is the demand for grain overseas, and D_P is the derived demand at the port elevator. The intersection of supply and demand gives the prices for grain at the two places. The difference in these prices is the marketing spread, or what is spent on marketing services (in this case, transportation). When the MS increases from the imposition of user fees, the

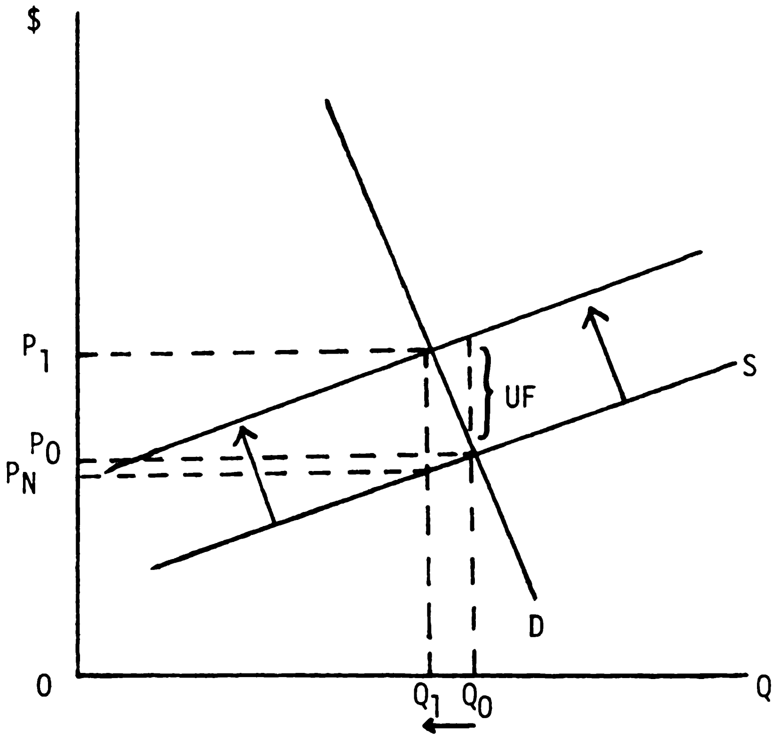

Figure 4.15

The Effect of a User Fee on the Ocean Transportation Market

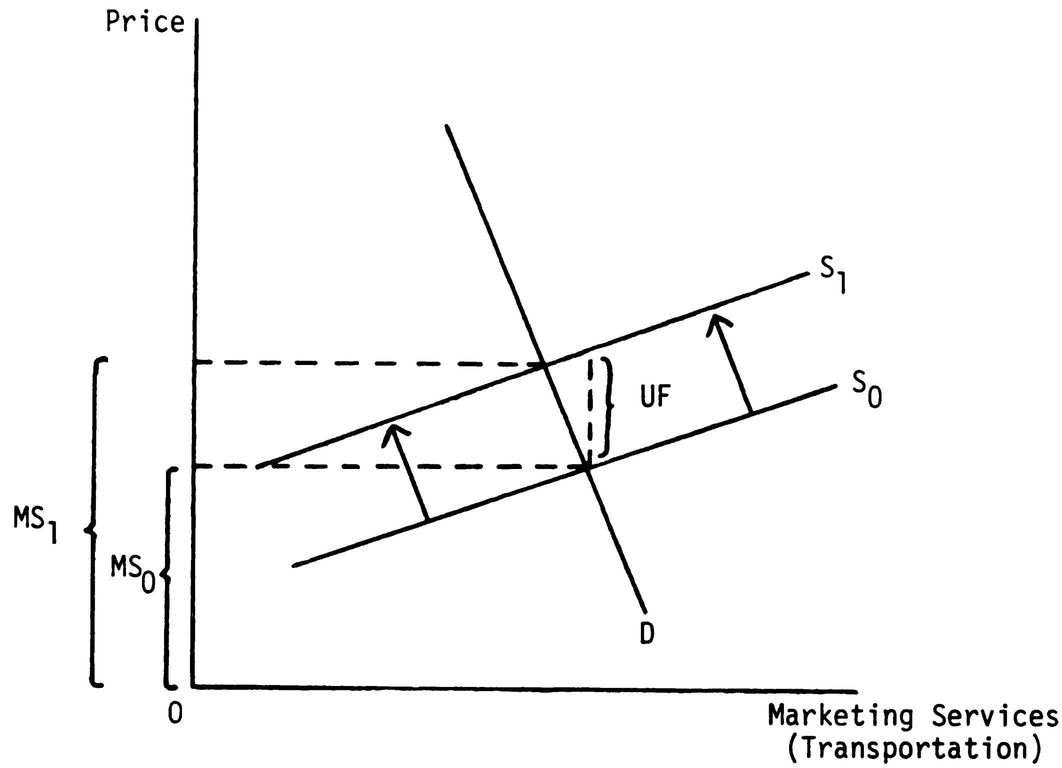

Figure 4.16

The Effect of a User Fee (UF) on the Market for Marketing Services (Transportation)

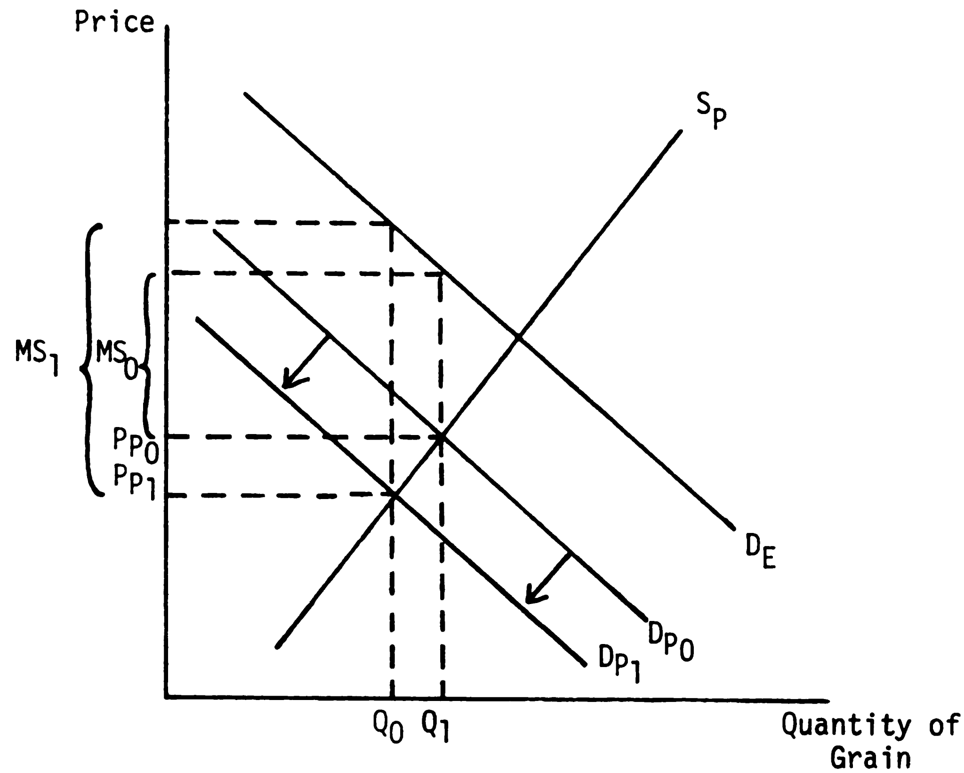

Figure 4.17

The Effect of a User Fee on the Market for Export Grain derived demand for grain at the port elevators shifts back by the amount needed to cover the increase in transportation cost (i.e., the port elevators offer a lower price for any given quantity).

The demand at inland elevators is also derived from the demand at port elevators, as depicted in Figure 4.18. When D_P shifts back, D_I will also shift back, since there has been no change in the MS for this market (i.e., the inland transportation rates are assumed to remain the same). Finally, the demand at the farm is derived from the demand at the inland elevators, and this must also shift back, resulting in a lower price paid to farmers (Figure 4.19).

By using this framework, the effect of alternative user fee scenarios can be analyzed. The effect of a user fee on the price offered at the port (P_P) can be translated into the effect on grain movements to the port by using the equation developed in the last section. (Recall that price offered at a port minus the inland transportation cost was one of the independent variables.) Under some user fee proposals, the charge levied at different ports may vary according to the costs of maintaining the ports. Under this scenario, the MS increase will be different at different ports and, therefore, the post-user fee price change at ports will vary. Under the alternative of a nationally uniform user fee, the increase in the MS would be the same at all ports. However, it is possible that shippers will view this increase differently at different ports. In other words, it is possible that shippers have different elasticities of supply for different port areas. For example, it is often asserted that the Great Lakes - St. Lawrence Seaway route is a "residual" transportation route for grain exports. The hypothesis then, is that the elasticity of shipper choice with respect to

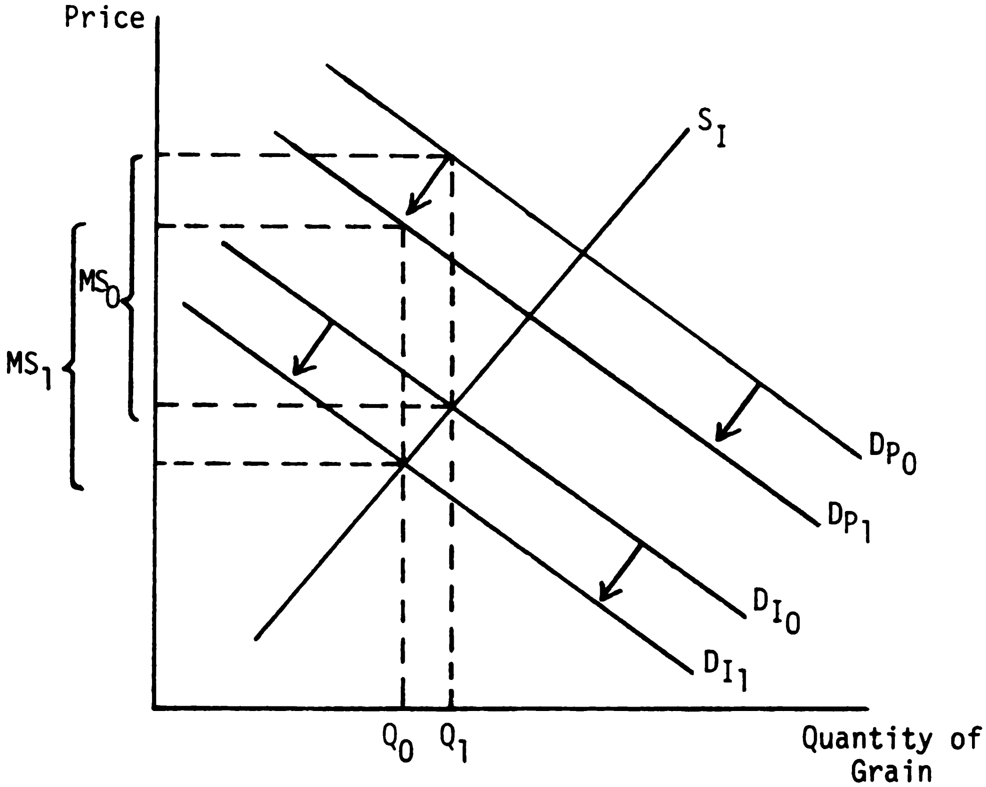

Figure 4.18

The Effect of a User Fee on the Market for Inland Grain

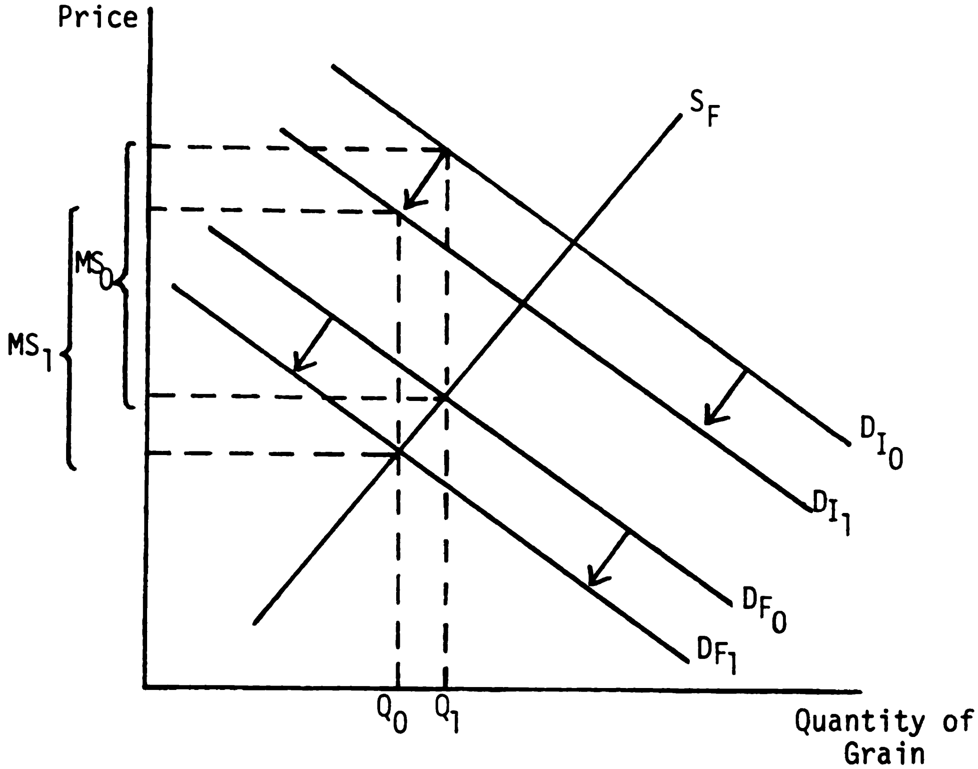

Figure 4.19

The Effect of a User Fee on the Market for Farm Grain destination price is greater at Great Lakes ports than at other port areas. This hypothesis can be tested using the shipper choice model described previously. The coefficients of the estimated equation will allow an analysis of the impact of user fees on alternative port areas.

CHAPTER 5

ESTIMATION OF THE SHIPPER CHOICE MODEL

5.1 Measurement of Variables and Data Sources

The major data source for this study was a 1977 survey of grain shippers and receivers nationwide. The survey was coordinated by Lowell D. Hill at the University of Illinois, and was implemented with the cooperation of universities and Agricultural Experiment Stations throughout the country. It is a unique data source, in that information of this kind is not available anywhere else. The original surveys were used in this study so that individual shipper information could be obtained for the disaggregated shipper choice model. Summary statistics of the grain flow data on a state-by-state basis are available in published form,[1] but this source would not allow the characteristics of elevators to be matched with their destination choice.

The elevators that were surveyed provided information on their volume of monthly shipments of grain by type, mode, and destination. This provided the value of the dependent variable (equal to one for the chosen mode - destination pair, zero otherwise) as well as the independent variable of VOLUME (in bushels). It was not possible to absolutely

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[1]Summaries of the data collected are presented in three volumes by Lowell D. Hill, Mack N. Leath and Stephen W. Fuller, Corn Movements in the United States, North Central Regional Research Bulletin 275, 1977; Wheat Movements in the United States, North Central Regional Research Bulletin 274, 1977; and Soybean Movements in the United States, North Central Regional Research Bulletin 273, 1977, Agricultural Experiment Station, College of Agriculture, University of Illinois, Urbana, Illinois.

conclude that the volume shipped in a month represented one shipment or more than one shipment. However, there were data on the type of rail shipment used by each elevator (i.e., what percent of rail shipments were single-car, 3-car, 10-car, or unit train). If an elevator responded that it shipped 100 percent by unit train and the volume shipped in a month was the equivalent of two train loads, then it was concluded that the elevator made two shipments that month. Similarly for truck shipments, the number of shipments could be easily ascertained in this way. There were only a few cases where an elevator would use a mix of train rates for a given grain type and, in those cases, judgment had to be used as to the most likely number of shipments for the stated volume.

The types of grain that were included for this study were wheat, corn, and soybeans. It is true that other grains are important for the Great Lakes - St. Lawrence Seaway, especially sunflower seeds, but these three grains represent the largest volumes produced in the Great Lakes hinterland, as defined here. The variable TYPE could be included in the equation as a series of dummy variables for each grain. However, it was decided that a separate equation should be estimated for each type of grain. The results reported here are only for the equation on corn shipments, since the most comprehensive data were available for this commodity. The equations for the other two types of grain can be readily estimated from available data. This may be a part of future research on this subject.

The monthly nature of the data provided a natural way to include the SEASON variable as the month of shipment. This would require the inclusion of 11 dummy variables, however, and would strain the capacity of the computer program. Since the interest is really in whether or not the shipment took place during the winter months, a single dummy variable called WINTER was used.

The survey responses provided all the information that was used for describing the characteristics of the elevator. The variable MAXCARS was reported as the maximum number of cars that could be spotted for loading on the elevator's tracks at one time. The HOPPERS variable was simply a dummy set equal to one if the elevator could rail a 100-ton car onto its tracks, and zero otherwise. The CAPACITY variable was specified as the total permanent storage of the elevator, which was reported on the questionnaire. The load rate variables, RRLOAD and TRLOAD, were the normal hourly load out capacity for rail cars and trucks, respectively, in bushels per hour.

The NETPFT variable, equal to the difference between destination price and transportation cost for a given shipment, was not available from the questionnaires. Secondary data sources had to be used to estimate what this variable would have been for any given shipment. Ideally, the actual rate charged and price offered for each shipment would be supplied by the elevator. Unfortunately, the competitiveness of both the grain market and the transportation market make this information unavailable to anyone not working directly with the elevators. Even if the firms were willing to share this information, it would be impossible to match all of the shipments from the 1977 survey with the records of each elevator.

The data for destination prices were taken from the Grain Market News.[2] Since the data from the surveys were monthly, monthly average grain prices were used for this variable as well. The prices offered

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[2]U.S. Department of Agriculture, Grain Market News, 1978.

at the various ports were easily matched up with the destinations of the actual shipments. The prices offered at river elevators were not always available, however. The river destinations of Minneapolis, St. Louis, and Louisville had monthly average prices reported, but the prices offered along the Illinois River had to be estimated using the north central and south central Illinois prices.

5.1.1 Rates vs. Costs

Empirical studies of transportation problems inevitably face the question of whether rates or costs should be used for data. Rates are the actual charges paid by the shipper for a given service and can be quite different from the cost to the transportation firm of providing that service. There are numerous studies of the pricing policies of transportation firms and the diversions of rates from costs.[3] In this study, no attempt is made to analyze pricing policies or to make a case for either cost or value of shipment pricing. The important factor here is to choose the most appropriate variable for explaining shipper choice. It is clear that the shipper responds to the actual rate charged and not to any estimate of cost from the transportation firm's point of view. Therefore, the appropriate variable for this study is the rate (per bushel) that either the trucking company or the railroad charged for a given shipment in 1977.

5.1.2 Estimation of Rates

The transportation rate had to be estimated for each shipment included from the surveys. For the corn equation, this involved rates

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[3]See Winston, 1982 for a review of many of these; also, Boyer, 1977, addresses these issues.

for 470 shipments, many of which were from very small towns. The only rail rate data available for grain shipments were from selected, usually large, elevators to about 40 various destinations[4] (not all destinations were included for every origin). Although the rates which were available were not comprehensive, they did represent a unique data source for information which is traditionally very hard to find. These rates were used to estimate rate functions which could supply the needed information for all the shipments in the study.

The rate functions for rail transportation were specified as:

$$\text{Rate} = f\ (\text{distance, number of cars, destination}) \qquad (1)$$

The rate data were divided into single-car, 3-car, 10-car, and unit train shipments. In addition, there were rates called "export proportional" rates available in 1978, which gave a price break to shipments which moved to the coasts for export. (The Great Lakes ports were not considered export ports for this purpose.) The latter two factors in equation (1) were accounted for by estimating six separate equations for each of the three grain types.

$$\text{Rate}_{ijk} = f\ (\text{distance}) \qquad (2)$$

where:

i = index of the grain type (corn, wheat, or soybeans);

j = index of the number of cars in the shipment (single, 3-car, 10-car, or unit train);

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[4]These data were supplied by W.J. Free from, Shipping Rates: Corn, Wheat, and Soybeans from TVA for 1978 and 1980 in Cents Per Bushel, a notebook of compiled data sheets. It is impossible that the 1 percent waybills kept by the Interstate Commerce Commission could have supplied more rate data, but these were unavailable when requested.

k = index of the destination (coast or noncoast).[5]

The equations for 10-car and unit train shipments were for export-proportional rates only, since none of the data on these types of shipments had noncoast destinations.

Two alternative forms of equation (2) were estimated. In the first, distance and distance squared were both included as independent variables, allowing the increase in rates to diminish as distance got very large. Since the railroad industry is characterized by high fixed costs, this would make sense theoretically. The empirical results, however, showed a much better fit for all equations when only distance was used as the independent variable. It is possible that the separate estimation of the alternative equations took into account some of the same factors that the squared distance term would have measured if all the data were combined. The 18 resulting equations are presented in Table 5.1. The 10-car and unit train equations should be applied with

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[5]The hypothesis that rates differed depending on destination was tested statistically. A "constrained" model was estimated with all of the rate data included in one equation (i.e., the parameters were constrained to be the same for both coast and noncoast shipments). The "unconstrained" model consisted of the separate equation for coast and noncoast shipments. A Chow test was then applied which tests whether the SSE when all parameters are constrained to be the same is significantly higher than the sum of the SSE's when the parameters are allowed to vary. The values of $F = \frac{(SSE_c - SSE_u)/K}{(SSE_u)\ (T_1 + T_2 - 2K)}$, where K is the number of parameters, T_1 is the number of observations in the first equation, and T_2 is the number of observations in the second equation, were as follows:

Single Car			3-Car		
Corn	Wheat	Soybeans	Corn	Wheat	Soybeans
33.24	23.30	35.83	29.93	16.97	9.00

All of these reject the hypothesis that the coefficients are the same for both equations, at the .05 significance level.

(In: Peter Kennedy, A Guide to Econometrics, The MIT Press, Cambridge, Massachusetts, 1980, p. 70).

Table 5.1

Estimated Rate Equations

Dependent Variable	Constant	Distance (Miles)	R^2	F
Single-Car Corn Rate, Coast	4.928 (.054)	4.369 (.005)	.740	93.713
Single-Car Corn Rate, Noncoast	14.178 (.057)	1.724 (.003)	.837	375.537
Single-Car Wheat Rate, Coast	1.027 (.062)	6.893 (.008)	.657	57.342
Single-Car Wheat Rate, Noncoast	18.291 (.072)	3.841 (.007)	.649	122.259
Single-Car Soybean Rate, Coast	4.327 (.056)	7.041 (.008)	.580	46.872
Single-Car Soybean Rate, Noncoast	16.282 (.076)	3.315 (.006)	.724	178.817
3-Car Corn Rate, Coast	3.313 (.040)	6.911 (.009)	.543	20.232
3-Car Corn Rate, Noncoast	10.934 (.054)	1.990 (.003)	.809	258.337
3-Car Wheat Rate, Coast	19.154 (.017)	2.731 (.004)	.611	18.815
3-Car Wheat Rate, Noncoast	8.098 (.062)	5.171 (.008)	.660	56.398
3-Car Soybean Rate, Coast	8.454 (.043)	8.500 (.011)	.611	14.146
3-Car Soybean Rate, Noncoast	9.407 (.068)	5.750 (.009)	.665	59.469
10-Car Corn Rate	1.938 (.042)	5.100 (.006)	.838	51.813
10-Car Wheat Rate	4.233 (.041)	7.299 (.009)	.718	20.380
10-Car Soybean Rate	13.728 (.032)	5.303 (.006)	.636	24.430
Unit Train Corn Rate	2.989 (.032)	6.183 (.007)	.803	20.439
Unit Train Wheat Rate	7.264 (.028)	10.878 (.014)	.560	3.816
Unit Train Soybean Rate	13.046 (.025)	9.276 (.010)	.491	5.789

Numbers in parentheses are standard errors.

care, since they were estimated from a small number of observations. The strength of these results is that they are based on actual rates charged for grain shipments from elevators in the Great Lakes hinterland.

Rail rates for each origin-destination pair in the study were estimated using the equations of Table 5.1. The resulting rate was deflated from 1978 to 1977 prices using the Rail Freight Rate Index for Farm Products.[6]

Truck rates for grain shipments were estimated on the basis of a truck rate function developed by Free, Stone, and Baldwin.[7] The function for corn shipments was based on a 56 pound bushel of corn, which could be adjusted for wheat and soybeans by considering 60 pound bushels.

The equation for corn is:

$$\text{Truck Rate for Corn } (¢/\text{bu.}) = 4.985 + .1001 \text{ (Distance)} \quad (3)$$

The transportation rates had to be calculated for the alternative that was chosen by each elevator, and also for the six alternatives which were not chosen. For example, an elevator in central Illinois might have made a shipment to the Illinois River by truck. The truck rate for this shipment was estimated using the equations above. In addition, a rate for trucking the grain to the nearest Great Lakes port was calculated. The functions in Table 5.1 were then used to calculate the rates that would have been charged if the elevator had railed the shipment to any of the following: the Illinois River destination that was actually chosen; the nearest Great Lakes port; the port of Baltimore;

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[6] U.S. Department of Agriculture, Agricultural Outlook, Economics, Statistics, and Cooperatives Service, AO-50, December 1979.

[7] W.J. Free, L.E. Stone and Dean Baldwin, Transportation Rates for Corn, Wheat, and Soybeans, Southern Cooperative Regional Series No. 227, Bulletin Y-124, TVA, February 1978.

the port of Portland; and the nearest Gulf port. This resulted in 3,290 observations for the corn equation. This type of information on all of the available alternatives is necessary for the shipper choice model, since the value of the index for each alternative must be compared to every other alternative. The rates calculated from the relevant equations were subtracted from the destination prices for each of the 3,290 observations to obtain the NETPFT variable.

5.2 Maximum Likelihood Estimation of the Shipper Choice Model

5.2.1 Derivation of the Probability Formula

The shipper choice model developed in the preceding chapter was of the following form:

$$P_{ij} = P\ (C_j > C_\ell),\ \text{for all}\ \ell \neq j \qquad (4)$$

where:

$C_j = c\ (Z_{ij},\ \omega_i) + \varepsilon_j$ is a decision index;

i references the individual elevator;

j references the alternative mode-destination combinations.

Equation (4) can be rewritten as:

$$P_{ij} = P\ [\varepsilon_\ell - \varepsilon_{ij} < c\ (Z_{ij},\ \omega_i) - c\ (Z_{i\ell},\ \omega_i)] \quad \text{for all}\ \ell \neq j \qquad (5)$$

If we define the joint cumulative distribution of the ε's as F $(\varepsilon_1, \ldots, \varepsilon_j)$, then the derivative of F with respect to its j^{th} argument, ε_j, can be denoted as F_j (which will be the density function of ε_j associated with the cumulative distribution function F). By supressing the i subscript and letting $c_j = c\ (Z_{ij},\ \omega_i)$, McFadden[8] rewrites (5) as:

[8]Daniel McFadden, 1973, p. 108.

$$P_j = \int_{-\infty}^{+\infty} F_j \; (\varepsilon + c_j - c_1, \ldots, \varepsilon + c_j - c_\ell) \; d\varepsilon \qquad (6)$$ [9]

At this point, a particular joint distribution function must be specified for F so that equation (6) can be solved for the resulting probabilities. McFadden has shown that the use of the Weibull, or extreme value, distribution will lead to the multinomial logit model where:

$$P_j = \frac{e^{c} \; (Z_{ij}, \omega_i)}{\sum_{j=1}^{J} e^{c} \; (Z_{ij}, \omega_i)} \qquad (7)$$ [10]

The Weibull distribution function is defined as:

$$P \; [\varepsilon \; (Z_{ij}, \omega_i) \leq \varepsilon] = e^{-e^{-\varepsilon}} \qquad (8)$$

and the associated frequency function is therefore $(e^{-\varepsilon} \; e^{-e^{-\varepsilon}})$. The similarity between this frequency function and the normal frequency function is shown in Figure 5.1. The logit model, which is derived from the assumption of a Weibull distribution for the error terms, is much simpler computationally than the probit model, which arises from an assumption of a joint normal distribution. There is a drawback to the multinomial logit model, however, which involves the assumption of "independence of irrelevant alternatives."[11] This assumption can be demonstrated by noting that the form of the probability equation above [equation (7)] is used to derive the odds of choosing one alternative

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[9]Note that as an intermediate step, (5) can be rewritten as:
$P_j = P \; (\varepsilon_\ell < \varepsilon_j + c_j - c_\ell)$, for all $\ell \neq j$

[10]Daniel McFadden, 1973, p. 108.

[11]Ibid., pp. 110-111.

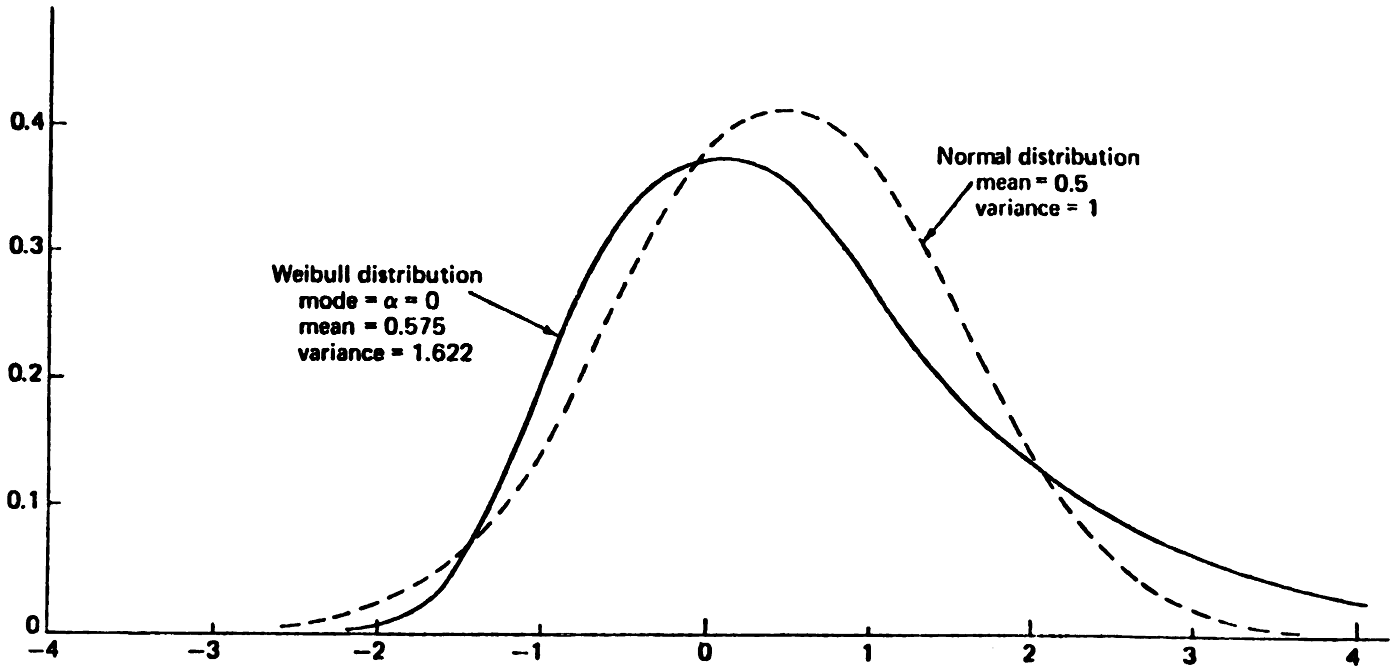

Figure 5.1

Frequency Functions of Normal and Weibull Distributions over another, P_j / P_ℓ. Expressed as the "log odds" of alternative j over alternative ℓ, this is:

$$\log \left(\frac{P_j}{P_\ell}\right) = c\ (Z_{ij}, \omega_i) - c\ (Z_{i\ell}, \omega_i) \qquad (9)$$

which shows that the relative odds of these two alternatives is "independent of presence or absence of third alternatives."[12] The implications of this can be seen when a third alternative is added to the model which is very similar to one of the first two alternatives.

Suppose that alternative A was chosen over alternative B with probability $\frac{2}{3}$,[13] and that a new alternative C is introduced which is very similar to B. It would make sense that a decision maker would view B and C the same when comparing either of them to A. There is no reason to believe that the probability of choosing A would change from $\frac{2}{3}$ after the introduction of C. The probability of choosing either B or C would then be $\frac{1}{6}$. This violates the assumption of irrelevant alternatives, because the relative odds of choosing A over B has now changed with the introduction of C.

The application of the multinomial logit model described by (7) and, therefore, the acceptance of the independence of irrelevant alternatives assumption, should be "limited to multiple choice situations where the alternatives can plausibly be assumed to be distinct and independent in the eyes of the decision maker."[14] It is argued here that the seven mode-destination alternatives facing each elevator are, in fact, distinct

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[12]Ibid., p. 69.

[13]This example follows that of Domincich and McFadden, 1975, pp. 77-78.

[14]Ibid., p. 78.

and independent alternatives. There is no reason to believe that a shipper doesn't consider each of these alternatives independently when making a choice.[15]

5.2.2 The Likelihood Function

Equation (7) can be written for the shipper choice model developed in the preceding chapter as:

$$P_{ij} = \frac{e^{\beta_j Z_{ij}' + \gamma_j \omega_i'}}{\sum_{j=1}^{J} e^{\beta_j Z_{ij}' + \gamma_j \omega_i'}} \qquad (10)$$

where β and γ are unknown parameters, allowed to vary by alternative (i.e., no generic variables are used); Z_{ij}' is a vector of attributes of the j^{th} alternative, in this case, NETPFT; ω_i' is a vector of characteristics of the elevator and the shipment, which includes the variables WINTER, VOLUME, CAPACITY, RRLOAD, TRLOAD, MAXCARS, and HOPPERS. This formula for probability is then used to define the likelihood function.

The likelihood function, L, is an expression that represents the likelihood of observing the pattern of dependent variables (Y_{ij} = 1 or 0) that is present in the sample of data. "If all observations are obtained independently, as is reasonable in cross-sectional analysis, the likelihood of obtaining the given sample is found from the product of the probabilities of the individual observations having the observed outcomes."[16] Algebraically, this is:

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[15]Only elevators which had both rail and truck facilities were included in this study, which makes the independence assumption more plausible than if elevators with only one type of facility were included.

[16]Hanushek and Jackson, 1977, p. 201.

$$L = \prod_{i=1}^{N} P_{i1}^{\ f_{i1}} P_{i2}^{\ f_{i2}} \ldots P_{ij}^{\ f_{ij}} \qquad (11)$$

where f_{ij} is a binary variable which equals 1 if the i^{th} shipper (elevator) chooses alternative j and equals 0 otherwise.[17]

The log of this expression, called the log-likelihood function, is:

$$\log L = \sum_{i=1}^{N} \sum_{j=1}^{J} f_{ij} \log P_{ij} \qquad (12)$$

Substituting (10) into (12) yields:

$$\log L = \sum_{i=1}^{N} \sum_{j=1}^{J} f_{ij} \log \left(\frac{e^{\beta_j Z_{ij}' + \gamma_j \omega_i'}}{\sum_{j=1}^{J} e^{\beta_j Z_{ij}' + \gamma_j \omega_i'}} \right) \qquad (13)$$

Equation (13) shows that the value of log L depends upon the unknown parameters β and γ. The maximum likelihood technique seeks to find the values of the unknown parameters which maximize the likelihood function.[18] This can be done by taking the partial derivatives of log L and setting them equal to zero. Let θ be the vector of β and γ parameters for any alternative j, and X be the independent variables. Then, equation (13) becomes:

$$\log L = \sum_{i=1}^{N} \sum_{j=1}^{J} f_{ij} \log \left(\frac{e^{\theta' X_{ij}}}{\sum_{\ell=1}^{J} e^{\theta' X_{i\ell}}} \right) \qquad (14)$$

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[17] Oral Capps, 1983, p. 27.

[18] A set of parameters which maximize the likelihood function will also maximize the log-likelihood function, since the logarithmic function is a monotonic transformation.

$$= - \sum_{i=1}^{N} \sum_{j=1}^{J} f_{ij} \log \left[\sum_{\ell=1}^{J} e^{\theta' (X_{i\ell} - X_{ij})} \right] \qquad \text{(14-- cont.)}$$ [19]

The partial derivative of log L with respect to θ is:

$$\frac{\partial \log L}{\partial \theta} = \sum_{i=1}^{N} \left[\sum_{j=1}^{J} (f_{ij} - P_{ij}) X_{ij} \right] \qquad (15)$$ [20]

where $P_{ij} = \frac{}{\sum_{\ell=1}^{J} e^{\theta' X_{i\ell}}}$.

Equation (15) must be set equal to zero to find the maximum. There will be a system of k of these equations, where k equals the number of exogenous variables, which can be solved using an iterative search technique for solving nonlinear systems. A statistical package called

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[19]Equation (14) can be derived as follows:

$$P_{ij} = \frac{e^{\theta' X_{ij}}}{\sum_{\ell=1}^{J} e^{\theta' X_{i\ell}}}$$

Multiply numerator and denominator by $e^{-\theta' X_{ij}}$:

$$= \frac{1}{\left(\sum_{\ell=1}^{J} e^{\theta' X_{i\ell}}\right) \cdot e^{-\theta' X_{ij}}}$$

$$\frac{1}{\sum_{\ell=1}^{J} e^{\theta' (X_{i\ell} - X_{ij})}}$$

Then: $\log L = \sum_{i=1}^{N} \sum_{j=1}^{J} f_{ij} \log \left[\frac{1}{\sum_{\ell=1}^{J} e^{\theta' (X_{i\ell} - X_{ij})}} \right]$

$$= \sum_{i} \sum_{j} f_{ij} \left[\log(1) - \log \left[\sum_{\ell=1}^{J} e^{\theta' (X_{i\ell} - X_{ij})} \right] \right]$$

$$= -\sum_{i} \sum_{j} f_{ij} \log \left[\sum_{\ell=1}^{J} e^{\theta' (X_{i\ell} - X_{ij})} \right]$$

[20]Domencich and McFadden, 1975, p. 121.

QUAIL[21] was used to perform the maximum likelihood estimation for the model developed here.

5.3 Results of the Estimation

5.3.1 Specification of the Probability Equation

Many of the independent variables specified in the preceding chapter did not turn out to be statistically significant in the estimation of shipper choice. This is not surprising, since most of the characteristics of the elevators are related to the size of the elevator. It is likely that the larger elevators, in terms of CAPACITY, will have better facilities for loading rail cars and trucks (i.e., the values of RRLOAD, TRLOAD, HOPPERS, and MAXCARS will be higher). This introduces multicollinearity into the model and can lead to parameter estimates that are not significantly different from zero.

There is also a correlation between the variables VOLUME and NETPFT. This was introduced when the rate calculations were based on the number of cars being used for a given shipment. It is clear that VOLUME and NETPFT will be positively correlated for this reason.

Since the statistical results were unsatisfactory when all the variables were included, a decision based on the hypothesized behavior of the shipper was made. It has been proposed elsewhere[22] that the ability of an elevator to load a unit train is the major factor in the decision to ship longer distances (i.e., ship directly to a salt-water coast). The MAXCARS variable is the best measure of this ability to load unit

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[21] QUAIL stands for Qualitative, Intermittant, and Limited Dependent Variable Statistical Program, and was developed at the University of California, Berkeley.

[22] C. Eldridge, J. Fruin and M. Alley, 1983.

trains and, therefore, this is the variable that was included in the estimation. The VOLUME variable was dropped out, since its effect would be included in the coefficient on NETPFT. Unfortunately, this does not allow the measurement of the effect of VOLUME independently from its effect on NETPFT.

The final equation that was estimated included the WINTER and MAX-CARS variables, as well as the NETPFT variable for each alternative. The presence of alternative specific effects from the NETPFT variable was tested for by running two separate equations. In the first, NETPFT was entered "generically," constraining the coefficient on this variable to be the same for all alternatives. The interpretation of this specification is that a one-unit change in the value of NETPFT for alternative j will have the same effect as a one-unit change in NETPFT for alternative $\ell \neq j$. The second equation was "unconstrained" in that the coefficient of NETPFT was allowed to vary by alternative. This would be consistent with the hypothesis that the Great Lakes ports are viewed differently by shippers, and are treated as a "residual" transportation route.

The appropriate test for the significance of alternative specific variables is:

Choose the unconstrained model if:

$$2\,[\log L\,(\hat{\beta}_{ML}) - \log L\,(\hat{\beta}_{CML})] > \alpha\,\%\text{ critical value of } \chi_q^2 \qquad (16)^{23}$$

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[23] Amemiya, 1981, p. 1496.

where:

$\log L(\hat{\beta}_{ML})$ = the value of the log-likelihood function at convergence for the unconstrained model;

$\log L(\hat{\beta}_{UML})$ = the value of the log-likelihood function at convergence for the constrained model; and

q = the number of constraints being tested for.

In this case, the unconstrained model should be chosen if:

$$2\,(\log L_7 - \log L_1) > \chi_6^{\;2} \qquad (17)$$

The value of the statistic was 68.6 which is greater than $\chi_6^{\;2}$ at the .005 significance level (18.55).

The final model which was estimated had the following formula for the probability of the j^{th} alternative:

$$P_{ij} = \frac{e^{\beta_j \text{ WINTER} + \beta_j \text{ MAXCARS} + \sum_{j=1}^{7} \beta_j \text{ NETPFT}_j}}{\sum_{j=1}^{7} e^{\beta_j \text{ WINTER} + \beta_j \text{ MAXCARS} + \sum_{j=1}^{7} \beta_j \text{ NETPFT}_j}} \qquad (18)$$

5.3.2 Parameter Estimates and Elasticities

Table 5.2 shows the estimated coefficients for equation (18). There are two wrong signs, both on the MAXCARS variable. If MAXCARS increases, the probability of using any of the rail alternatives should also increase. The results in Table 5.2 show that the coefficient on MAXCARS is negative for alternative 2 and 7, both which involve rail movements. Neither of these coefficients are significantly different from zero, however, and the overall estimation was improved by leaving the MAXCARS variable in.

The results show that if a shipment is made in winter (December-March), the probability of choosing alternatives 1, 4, or 7 increases.

Table 5.2

Estimated Coefficients of the Shipper Choice Model

Alternative j	β_j, WINTER	β_j, MAXCARS	β_j, $NETPFT_1$	β_j, $NETPFT_2$	β_j, $NETPFT_3$	β_j, $NETPFT_4$	β_j, $NETPFT_5$	β_j, $NETPFT_6$	β_j, $NETPFT_7$
(1) Gulf by Rail	.4864 (.2750)	.0447* (.0054)	.0733* (.0068)						
(2) River by Rail, Barge to Gulf	-.1717 (.2915)	-.0010 (.0075)		.0814* (.0071)					
(3) River by Truck, Barge to Gulf	-.5463 (.2952)	-.0074 (.0088)			.0813* (.0070)				
(4) Atlantic by Rail	.0640 (.2457)	.0329* (.0053)				.0760* (.0065)			
(5) Great Lakes by Rail	-.1154 (.2734)	.0057 (.0064)					.0795* (.0068)		
(6) Great Lakes by Truck	-.5650 (.3170)	-.0498* (.0164)						.0851* (.0068)	
(7) Pacific by Rail	.8480 (.4480)	-.0251 (.0141)							.0775* (.0073)

	At Convergence	At Zero
Log Likelihood	-703.8	-914.6
Percent Correctly Predicted. .	41.70	14.29

$$\text{Likelihood Ratio Index} = 1 - \left(\frac{\log L \text{ at Convergence}}{\log L \text{ at Zero}}\right) = .2305$$

Numbers in parentheses are standard errors.
*Significant at the .01 level.

Conversely, the probability of choosing any of the River or Great Lakes routes decreases, which is expected since portions of these routes are frozen during the winter months.

The coefficients on the NETPFT variables are all positive and all highly significant. The interpretation of the magnitude of these coefficients is difficult, since they don't affect the P_{ij}'s in the usual linear manner. However, elasticities can be calculated from these results, which show the percentage change in the probability of choosing alternative j induced by a 1 percent change in any of the independent variables.

5.3.3 Elasticity of Shipper Choice[24]

Recall that the probability of an elevator i choosing alternative j is:

$$P_{ij} = \frac{e^{\theta_j' X_{ij}}}{\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}}} \tag{19}$$

This probability can be interpreted as the expected choice of alternative j by elevator i. If there were a number of elevators of type i, with the same characteristics and facing identical price and rate vectors, then the expected choice of alternative j by type i elevators would by $N_i\ P_{ij}$.[25] In this problem, however, there are no

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[24]The terminology "elasticity of shipper choice" is used here instead of "elasticity of demand" to avoid comparisons with previous studies of demand for transportation modes. The choice that the shipper makes in this study is a combination of mode and destination. In addition, the NETPFT variable is a combination of destination prices and mode rates. Therefore, the elasticity of choice with respect to NETPFT is a very different calculation than the price elasticity of demand for a particular transportation mode.

[25]Domenich and McFadden, p. 84.

elevators that are of an identical type, so $N_i = 1$ for all cases. With respect to elasticity of choice then, each elevator will have its own elasticity for each alternative. The elasticity for alternative j can be described both with respect to its own independent variable, X_{kij}, and with respect to a "cross" variable, $X_{ki\ell}$ (i.e., one in the set of independent variables for alternative $1 \neq j$).

To find the change in expected choice of alternative j from a one-unit change in X_{kij}, differentiate (19) with respect to X_{kij}:

$$\frac{\partial P_{ij}}{\partial X_{kij}} = \frac{(\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}})\, \theta_{jk}\, e^{\theta_j' X_{ij}} - e^{\theta_j' X_{ij}} (\theta_{jk}\, e^{\theta_j' X_{ij}})}{(\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}})^2}$$

Rearranging terms:

$$= \frac{\theta_{jk}\, e^{\theta_j' X_{ij}} (\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}} - e^{\theta_j' X_{ij}})}{(\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}})^2}$$

Substituting (19):

$$= \frac{\theta_{jk}\, P_{ij} (\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}} - e^{\theta_j' X_{ij}})}{(\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}})}$$

Multiplying by:

$$\frac{(\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}})^{-1}}{(\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}})^{-1}}$$

And substituting (19) again:

$$= \theta_{jk}\, P_{ij}\, (1 - P_{ij}) \qquad (20)$$

Equation (20) would be multiplied by N_i to find the change in expected choice if there were N elevators of type i.

The change in expected choice of alternative j with respect to a cross variable, $X_{ki\ell}$, $l \neq j$, can be found in a similar way to be:

$$\frac{\partial P_{ij}}{\partial X_{ki\ell}} = \theta_{\ell k} P_{ij} P_{i\ell}, \ \ell \neq j \qquad (21)^{26}$$

Following Domencich and McFadden,[27] expressions (20) and (21) can be converted to elasticities as follows:

$$E_{ij}(j,k) \equiv \frac{X_{kij}}{P_{ij}} \frac{\partial P_{ij}}{\partial X_{kij}} = \theta_{jk} X_{kij} (1 - P_{ij}) \qquad (22)$$

$$E_{ij}(\ell,k) \equiv \frac{X_{kij}}{P_{ij}} \frac{\partial P_{ij}}{\partial X_{ki\ell}} = \theta_{\ell k} X_{ki\ell} P_{i\ell} \qquad (23)$$

It is clear from these expressions that the elasticity of shipper choice will be neither constant across alternatives for a given elevator, nor constant across elevators for a given alternative. It is therefore necessary to know something about the population of elevators within a study area (their individual characteristics and locations) in order to forecast the effect of a change in one of the independent variables.

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[26]

$$\frac{\partial P_{ij}}{\partial X_{ki\ell}} = \frac{(\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}}) \cdot 0 - e^{\theta_j' X_{ij}} (\theta_{\ell k} e^{\theta_\ell X_{i\ell}})}{(\sum_{\ell=1}^{J} e^{\theta_\ell' X_{i\ell}})^2}$$

Substituting (19) twice results in:

$$= -\theta_{\ell k} P_{ij} P_{i\ell}, \ \ell \neq j$$

[27] Domencich and McFadden, p. 84.

Although complete information of this kind is not available for this study area, it is possible to analyze the effects of a policy change on a number of "representative" elevator types. It is also possible to evaluate these individual elasticities at the means of the independent variables. This will be done in the next section.

Domencich and McFadden also show how to derive a "market" elasticity of choice for the population being studied. If $N_i\ P_{ij}$ is the expected demand for alternative j by type i elevators, then:

$$\sum_i N_i\ P_{ij} = C_j \tag{24}$$

is the market choice of alternative j. In the QUAIL statistical package, this market choice is divided by N (the total number of cases) to derive the "probability share" for alternative j, which is shown in Table 5.3. These probability shares would thus be multiplied by N to get the market choice of each alternative j. To find the elasticity of this market choice, assume that a uniform percentage change in an independent variable is defined by:

$$X_{ki\ell} = t\ \bar{X}_{ki\ell} \tag{25}$$

where t is a scalar and $\bar{X}_{ki\ell}$ is an initial value. The elasticity of market choice is then defined as the elasticity with respect to t, evaluated at t = 1. Using this definition,

$$\begin{aligned} E_j\,(j,k) &\equiv \frac{t}{C_j}\ \frac{\partial\, C_j}{\partial\, t}\Big|_{t=1} = \Big[\frac{t}{\sum_i N_i\ P_{ij}} \sum_i \frac{\partial\,(N_i P_{ij})}{\partial\,(\bar{X}_{kij}\ t)} \\ &\qquad \frac{\partial\,(\bar{X}_{kij}\ t)}{\partial\, t}\Big]\Big|_{t=1} \\ &= \sum_i \omega_i\ \frac{\partial\,(N_i\ P_{ij})}{\partial\,(X_{kij}\ t)}\Big|_{t=1}\ \frac{\bar{X}_{kij}}{N_i\ P_{ij}} \\ &= \sum_i \omega_i\ E_{ij}\,(j,k) \end{aligned} \tag{26}$$

Table 5.3

Probability Shares for Each Alternative

Alternative	Probability Shares
(1) Gulf by Rail	.2045
(2) River by Rail	.1174
(3) River by Truck	.1378
(4) Atlantic by Rail	.2156
(5) Great Lakes by Rail	.1467
(6) Great Lakes by Truck	.1315
(7) Pacific by Rail	.0465

where:

$$\omega_i = N_i \; P_{ij} / \sum_i N_i \; P_{ij}$$

"is a weight giving the proportion of the total demand for alternative j originating from individuals of type i."[28] Using the same reasoning, the elasticity of market demand with respect to a cross variable, $Z_{ki\ell}$, $1 \neq j$, is:

$$E_j(\ell, k) = \sum_i \omega_i \; E_{ij}(\ell, k) \qquad (27)$$

In this case, where N = 1, the market choice elasticity for alternative j is simply the average of all the individual elasticities of choice

[28]Domencich and McFadden, p. 85.

for alternative j. As Domencich and McFadden point out, this average can be misleading. If the market is comprised of a large number of elevators with a clear-cut preference for alternative j (i.e., a small elasticity of choice), and a small number of elevators with a choice that is very sensitive to a change in the independent variable (i.e., a high elasticity of choice), then the market elasticity will be necessarily small. The large group's contribution to the market elasticity will be small because of their low elasticity of choice, while the small group's contribution will be small because of their small number of individuals. The result is a market elasticity "which is typically smaller in magnitude than the value of the individual elasticity formula evaluated at the population mean of the independent variable."[29]

It is clear from equation (22) that the elasticity of shipper response must be evaluated at some "point" (i.e., at some values of the independent variables). A common practice would be to calculate the elasticity at the means of the independent variables. The first step is to calculate P_{ij} at the means of the independent variables. Table 5.4 shows the probability of an "average" elevator shipping by each of the alternatives during winter. The probability of shipping to the Great Lakes by rail (alternative 5) is somewhat higher in Table 5.4 than would be expected. This is partially a result of the characteristics of the "average" elevator in this sample, however, and should be compared to results from elevators of different sizes. The "average" elevator in this sample was one which could load 29 cars at one time (i.e., $\overline{\text{MAXCARS}}$ = 29), which is a relatively large capacity for an elevator. There were

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[29] Domencich and McFadden, p. 85.

Table 5.4

Probabilities of Shipping by Each Alternative, for an Average Elevator in Winter

	Alternative j						
	1	2	3	4	5	6	7
P_j, mean, winter	.2731	.1262	.0715	.2603	.1817	.0335	.0538

numerous elevators in the sample with MAXCAR values less than 10, but the larger elevators had the ability to load greater than 50 cars, leading to a higher average value for this variable. This points out the importance of applying the estimated coefficients to individual data, as well as average data. Both will be done here to show the potential differences.

Table 5.5 shows the elasticities of shipper choice, calculated at average values of the independent variables, with WINTER = 1. The elasticities in this table are with respect to the NETPFT variables. The "own-NETPFT" elasticities are on the diagonal, with the "cross-NETPFT" elasticities off the diagonal. For example, the elasticity of shipper choice for alternative 1 (Gulf by Rail) with respect to the NETPFT for this alternative is 10.645. The elasticity for this same choice with respect to the NETPFT for alternative 5 (Great Lakes by Rail) is -6.231.

Table 5.5

Elasticities of Shipper Choice With Respect to the NETPFT of Each Alternative

Alternative j	$E^j_{NETPFT_1}$	$E^j_{NETPFT_2}$	$E^j_{NETPFT_3}$	$E^j_{NETPFT_4}$	$E^j_{NETPFT_5}$	$E^j_{NETPFT_6}$	$E^j_{NETPFT_7}$
(1) Gulf by Rail	10.645	-6.181	-6.180	-5.993	-6.231	-6.369	-5.724
(2) River by Rail, Barge to Gulf	-.971	13.849	-1.050	-1.008	-1.059	-1.082	-.973
(3) River by Truck, Barge to Gulf	-.266	-.288	14.707	-.279	-.290	-.297	-.267
(4) Atlantic by Rail	-5.201	-5.628	-5.627	11.362	-5.674	-5.799	-5.212
(5) Great Lakes by Rail	-2.306	-2.495	-2.495	-2.419	13.064	-2.571	-2.310
(6) Great Lakes by Truck	-.046	-.050	-.050	-.049	-.051	15.776	-.047
(7) Pacific by Rail	-.138	-.149	-.149	-.144	-.150	-.153	13.882

The own-NETPFT elasticities are quite high, showing that a small percentage increase in the NETPFT variable can lead to a large increase in the probability of shipping by that alternative. This is a plausible result for an "average" elevator, since they shouldn't be locked into any one alternative for shipping their grain. The high number of alternatives available, and the importance of the NETPFT variable relative to any quality of service considerations, make this result somewhat expected. Unfortunately, these results can't be compared with any of the research done on elasticities of shipper mode choice with respect to transportation rates, since the rates are combined with destination prices in this study.

The results presented above are for a particular elevator facing particular NETPFT values for each alternative. Those values are the average values for the sample used in 1977. An alternative analysis can be done by calculating a "market" elasticity in the form of a weighted average of individual elasticities. For this purpose, the sample was divided into classes of elevators based on the value of the MAXCARS variable. Class I was for MAXCARS = 1-9, Class II for MAXCARS = 10-19, Class III for MAXCARS = 20-49, and Class IV for MAXCARS = 50+.[30] Table 5.6 shows the elasticities for each of these classes (using the mean values of NETPFT), as well as the market elasticity, which is the weighted average of the four class elasticities. The market elasticities are only slightly lower in Table 5.6 than the individual elasticities calculated at the mean of the independent variables. The

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[30] The sample could have been divided into more classes, but there is no natural division based on this variable (MAXCARS). Four classes serve to point out some of the differences between classes.

Table 5.6

Market Elasticities for Each Alternative

	Class I E_j ($NETPFT_j$)	Class II E_j ($NETPFT_j$)	Class III E_j ($NETPFT_j$)	Class IV E_j ($NETPFT_j$)	Market E_j ($NETPFT_j$)
(1) Gulf by Rail	12.91	12.05	10.52	6.28	9.39
(2) River by Rail, Barge to Gulf	13.27	13.41	13.89	15.34	13.55
(3) River by Truck, Barge to Gulf	14.14	14.33	14.74	15.63	14.37
(4) Atlantic by Rail	13.06	12.30	11.29	10.51	10.66
(5) Great Lakes by Rail	12.77	12.74	13.11	14.96	13.00
(6) Great Lakes by Truck	14.07	15.01	15.82	16.31	14.49
(7) Pacific by Rail	12.86	13.33	13.92	14.61	13.18

elasticities across classes, however, differ substantially. These differences are only from changing the MAXCARS' value for each class. If the NETPFT values were to change as well, the differences would be even greater. In the next chapter, the model will be applied to 21 hypothetical elevators, using updated data, to show how the calculated probabilities and elasticities can differ.

5.3.4 Goodness of Fit Statistics

There are a number of scalar criteria which can be used to measure the goodness of fit of the estimated equation.[31] There are drawbacks to some of these, however, especially when comparing the results of separate equations with different independent variables included. Careful attention must be given to the appropriate adjustments for degrees of freedom in these cases. The choice of scalar criteria to use is not straightforward. Capps and Amemiya suggest that since no single criterion is appropriate for every case, that two or three criteria should be selected for comparing results.

In Table 5.2, three goodness of fit statistics were given for the estimated equation. The value of the log likelihood is reported "at convergence" and "at zero." The value at convergence (-703.8) is the log of the likelihood function evaluated at the maximum likelihood parameters in Table 5.2. The value at zero assumes all parameter estimates are equal to zero. The same criteria used to test for alternative specific effects can be used here to test whether the estimated equation is significantly different than an equation with all parameters

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[31]For detailed definitions and discussion of scalar criteria, see Amemiya, 1981; McFadden, 1976; Capps, 1983; McFadden, 1973; and Domincich and McFadden, 1975.

constrained to be zero. Equation (16) was used for this test and the null hypothesis that all coefficients are zero was rejected at the .005 significance level.

A second criterion which can be used is the likelihood ratio index. McFadden states that this measure provides "a convenient basis for defining an index of 'proportion of variance explained'."[32] It is similar in concept to the R^2 measure in ordinary regression analysis. The value of the likelihood ratio index for the estimated equation is .2305. This criterion was used to choose between equations with different independent variables, taking into account any changes in degrees of freedom.

The third statistic listed in Table 5.2 is the percent of actual choices that would have been correctly predicted by the estimated model. If all coefficients were constrained to equal zero, 14.29 percent would be correctly predicted, while under the maximum likelihood coefficients, 41.70 would be correctly predicted. This statistic can be somewhat misleading because of the "all-or-none" character of the prediction. For example, two alternatives could be very close in probability under the estimated model, yet the one with the slightly higher probability value will be "predicted" under this criteria. If, in fact, the other alternative was chosen, the model would have an incorrect prediction. When the model is used for policy analysis, however, probabilities which are very close are likely to be viewed similarly. A prediction of only one of the alternatives is not likely to happen under those circumstances. There is nothing wrong with reporting that two alternatives have about equal probabilities of being chosen, without being forced to predict a single outcome.

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[32] McFadden, 1976, p. 377.

5.4 Summary

An equation representing shipper choice was estimated using the multinomial logit methodology developed by McFadden and others. The results were consistent with hypothesized behavior except for two wrong signs on coefficients, neither of which were significantly different from zero. The hypothesis that the elasticity of shipper choice is higher for Great Lakes destinations than others is only true for certain comparisons. The elasticity for the choice of Great Lakes by truck is higher than all of the other alternatives. The elasticity for the choice of Great Lakes by rail is higher than the nonseasonal routes of Atlantic by rail and Gulf by rail, but slightly lower than the other alternatives. All of the elasticities are quite high, which is to be expected in this type of model.[33] The calculations are sensitive to the values of the independent variables, and the application of the model is best suited to individual analysis. For policy purposes, however, both individual and market elasticities should be considered.

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[33] The elasticities of electric utility fuel choice reported by Jackson, et al. (1977) are also relatively high compared to price elasticities of demand which are usually reported.

CHAPTER 6

APPLICATION OF USER FEE ALTERNATIVES TO THE ESTIMATED MODEL

6.1 Updating the Independent Variables

The analysis of the last chapter showed clearly that probabilities and elasticities of shipper choice will vary by elevator. The model is, after all, a model of individual choice, the individual in this case being the elevator operator. Since location alone can affect transportation rates and therefore NETPFT, each elevator will face a different set of independent variables. By the definition of elasticity for this model then, each elevator can have a different elasticity.

The estimated model will allow an examination of the elasticity of choice for an "average" elevator facing average values of independent variables (see Table 5.5). It also allows for the calculation of an average of individual elasticities. For a large number of elevators, however, this becomes a large task. The grouping of elevators into classes makes that task somewhat more manageable (see Table 5.6). The analysis still requires the use of an average value for the NETPFT variables, since the locations of the elevators in a class will vary greatly.

One final methodology will be used in this section, in addition to the two previous calculations of elasticities, for the purpose of policy analysis. A midpoint in each of the states included in this study will be used as a hypothetical location for three different sized elevators. Probabilities and elasticities will be calculated using 1983 values for the NETPFT variables. The application of a user fee will then be represented as a decrease in the price offered at the port, thereby lowering each of the NETPFT variables. The change in the probabilities from the change in the independent variables can be directly calculated. The previous calculation of "average" elasticities can also be used to calculate the impact of the percentage change in NETPFT resulting from the imposition of the user fees.

6.1.1 Measurement of the Variables for the Hypothetical Elevators

The three sizes of the elevators are defined as: MAXCARS=5, MAXCARS=25, and MAXCARS=75. The months of January, June, and September of 1983 were chosen as the months when the hypothetical shipments would take place. Destination prices were taken from the monthly averages reported in Grain Market News and transportation rates were calculated from rail and truck cost functions. Cost functions, instead of rate functions, were used for this part of the analysis because of the changing structure of the railroad industry since deregulation. Theoretically, deregulation should lead to more competition within the railroad industry, and rates should therefore reflect costs. Whether the Staggers Act will indeed lead to this competitive structure is undetermined as yet. Under these circumstances, the best estimate of rail rates in the absence of actual data on rates is derived from a cost function. There is reason to believe that actual rate data will be more available in the future under the Staggers Act, which would provide a better information base for analysis.

Truck and rail costs for this analysis were estimated using the functions developed by Koo and Thompson.[1] The truck cost function is for a semi tractor-trailer, which would be the likely vehicle for movements to river and port elevators. Koo and Thompson considered fixed, variable, and transfer costs for grain trucks and expressed the average cost per hundredweight as a function of distance, as:

(1) Truck cost = 2.224 + 0.24d

The values calculated from this function were converted to ¢/bu. and adjusted to current prices using a price index for transportation of agricultural commodities.[2]

Rail costs are estimated in Koo and Thompson for four different types of shipments; single car, 25 car, 50 car, and 75 car. These equations are also expressed as functions of distance as follows:

(2) Rail cost (single) = 14.1049 + 0.04668d

(3) Rail cost (25-car) = 8.1578 + 0.04640d

(4) Rail cost (50-car) = 8.1561 + 0.04506d

(5) Rail cost (75-car) = 8.0849 + 0.04141d

These cost values were also adjusted to ¢/bu. and current (1983) prices using the rail freight rate index for grains.[3]

The locations of the hypothetical elevators are as follows:

(A) Grand Ledge, Michigan

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[1]Won W. Koo and Sarahelan Thompson, An Economic Analysis of U.S. Grain Marketing and Transportation System, North Dakota State University Agricultural Experiment Station, Bulletin No. 89, June 1982.

[2]U.S. Department of Agriculture, Food Consumption, Prices, and Expenditures, 1962-82, ERS, Statistical Bulletin 702, 1982, p. 102.

[3]U.S. Department of Agriculture, Agricultural Outlook, 1983.

(B) Columbus, Ohio

(C) Indianapolis, Indiana

(D) Decatur, Illinois

(E) Baraboo, Wisconsin

(F) Des Moines, Iowa

(G) New Ulm, Minnesota

6.1.2 Updated Results of the Model for Seven Hypothetical Elevators

Tables 6.1-6.7 show the estimated choice probabilities and elasticities associated with each of the elevators at the three different times of the year. Since prices and, therefore, NETPFTs are higher in June and September than in January, the elasticities are also higher (recall the formula for elasticity, equation 5-22). Of most interest, however, is the comparison across alternatives during any given month, and how that comparison changes between elevators and at different times of the year.

The Michigan elevator (see Table 6.1) that could load to a maximum of five cars at one time would be most likely to ship to a river elevator by rail during January, and to Toledo by truck during June and September. If the elevator could load 25 cars at one time, it would probably ship to the Atlantic by rail during January, and to the river by rail during either June or September. The choice of Toledo by rail is the second option during these two months.

The Michigan elevator that can load 75 cars at one time is most likely to ship to the Atlantic by rail at all three times of the year. This choice is highly likely during both January and September, while

Table 6.1

Estimated Choice Probabilities and Elasticities for a Hypothetical Elevator in Grand Ledge, Michigan

	Month of Shipment →	January			June			September		
MAXCARS	Alternative$_j$	$NETPFT_j$	P_{ij}	$E_j(NETPFT_j)$	$NETPFT_j$	P_{ij}	$E_j(NETPFT_j)$	$NETPFT_j$	P_{ij}	$E_j(NETPFT)_j$
5	1	199.84	.023	14.31	268.84	.004	19.63	300.84	.003	22.00
	2	220.69	.260	13.30	295.69	.241	18.27	328.69	.224	20.76
	3	193.97	.034	15.79	268.97	.058	21.36	301.97	.059	23.95
	4	227.44	.198	13.87	289.44	.036	21.21	330.44	.051	32.82
	5	219.94	.176	14.41	297.94	.170	19.66	330.94	.148	22.41
	6	216.00	.209	14.55	294.00	.488	12.80	327.00	.513	13.55
	7	207.95	.101	14.49	254.95	.003	19.70	281.95	.001	21.82
25	1	207.10	.054	14.36	276.10	.014	19.95	308.10	.010	22.37
	2	227.69	.256	13.79	302.69	.374	15.43	335.69	.353	17.68
	3	193.97	.017	16.08	268.97	.045	21.66	301.97	.046	24.28
	4	234.55	.372	11.19	296.55	.107	20.13	337.55	.155	21.68
	5	226.89	.195	14.53	304.89	.296	17.06	337.89	.263	19.81
	6	216.00	.044	17.58	294.00	.161	20.98	327.00	.172	23.04
	7	215.63	.063	15.66	262.63	.003	20.30	289.63	.001	22.41
75	1	208.76	.179	12.56	277.76	.097	18.38	309.76	.060	21.35
	2	228.12	.079	17.10	303.12	.236	18.84	336.12	.204	21.79
	3	193.97	.004	16.29	268.97	.020	22.23	301.97	.019	24.98
	4	235.47	.648	6.31	297.47	.381	14.00	338.41	.502	12.81
	5	227.08	.082	16.57	305.08	.257	18.03	338.04	.207	21.31
	6	216.00	.001	18.36	294.00	.009	24.80	327.00	.008	27.59
	7	219.33	.007	16.87	266.33	.001	20.63	293.33	.000	22.73

Table 6.2

Estimated Choice Probabilities and Elasticities for a Hypothetical Elevator in Columbus, Ohio

MAXCARS	Month of Shipment → / Alternative$_j$	January			June			September		
		$NETPFT_j$	P_{ij}	$E_j(NETPFT_j)$	$NETPFT_j$	P_{ij}	$E_j(NETPFT_j)$	$NETPFT_j$	P_{ij}	$E_j(NETPFT_j)$
5	1	207.27	.020	14.89	276.27	.003	20.19	308.27	.002	22.55
	2	229.70	.271	13.63	304.70	.233	19.01	337.70	.215	21.57
	3	227.86	.301	13.43	302.86	.468	13.57	335.86	.476	14.85
	4	237.05	.205	14.31	299.05	.035	21.94	340.05	.049	24.57
	5	219.29	.084	15.97	297.29	.075	21.86	330.29	.065	24.55
	6	213.55	.085	16.63	291.55	.184	20.24	324.55	.192	22.31
	7	203.12	.035	15.20	250.12	.001	19.37	277.12	.000	21.47
25	1	214.49	.048	14.97	283.49	.011	20.55	315.49	.007	22.96
	2	236.64	.272	14.03	311.64	.350	16.48	344.64	.323	19.00
	3	227.86	.151	16.31	302.86	.352	16.56	335.86	.356	18.22
	4	244.09	.394	11.24	306.09	.100	20.94	347.09	.141	22.66
	5	226.24	.095	16.28	304.24	.127	21.11	337.24	.110	23.86
	6	213.55	.018	17.84	291.55	.059	23.34	324.55	.062	25.91
	7	210.83	.022	15.98	257.83	.001	19.96	284.83	.000	22.06
75	1	215.93	.158	13.33	284.93	.082	19.17	316.93	.049	22.10
	2	236.82	.083	17.67	311.82	.239	19.32	344.82	.200	22.45
	3	227.86	.033	18.57	302.86	.171	21.15	335.86	.158	23.83
	4	244.74	.682	5.92	306.74	.383	14.39	347.74	.494	13.38
	5	226.46	.041	17.27	304.45	.121	21.27	337.45	.096	24.26
	6	213.55	.000	18.16	291.55	.003	24.72	324.55	.003	27.53
	7	214.67	.003	16.59	261.67	.000	20.27	288.67	.000	22.37

Table 6.3

Estimated Choice Probabilities and Elasticities for a Hypothetical Elevator in Indianapolis, Indiana

MAXCARS	Month of Shipment → Alter-native$_j$	January			June			September		
		NETPFT$_j$	P_{ij}	E_j(NETPFT$_j$)	NETPFT$_j$	P_{ij}	E_j(NETPFT$_j$)	NETPFT$_j$	P_{ij}	E_j(NETPFT$_j$)
5	1	212.75	.030	15.13	281.75	.005	20.55	313.75	.004	22.91
	2	229.43	.269	13.66	304.43	.247	18.65	337.43	.268	20.09
	3	226.83	.279	13.78	301.83	.465	13.61	334.83	.556	12.54
	4	226.79	.095	15.59	288.79	.017	21.57	329.79	.029	24.34
	5	227.52	.163	15.14	301.52	.114	21.24	325.52	.057	24.41
	6	214.14	.090	16.58	288.14	.149	20.86	312.14	.085	24.30
	7	212.61	.073	15.27	259.61	.002	20.08	286.61	.001	
25	1	219.93	.079	14.85	288.93	.017	20.81	320.93	.013	23.21
	2	236.37	.294	13.59	311.37	.360	16.22	344.37	.387	17.19
	3	226.83	.153	16.20	301.83	.339	16.83	334.83	.400	16.93
	4	233.90	.201	14.21	295.90	.048	21.40	336.90	.080	23.56
	5	234.49	.202	14.88	308.49	.187	19.93	332.49	.092	23.99
	6	214.14	.021	17.84	288.14	.047	23.38	312.14	.026	25.86
	7	220.27	.051	16.20	267.27	.002	20.67	294.27	.001	22.78
75	1	221.22	.309	11.20	290.22	.139	18.31	322.22	.101	21.23
	2	236.55	.109	17.16	311.55	.270	18.52	344.55	.275	20.34
	3	226.83	.040	18.35	301.83	.181	20.83	334.83	.203	22.48
	4	234.84	.428	10.21	296.84	.208	17.86	337.84	.326	17.30
	5	234.78	.105	16.70	308.78	.198	19.69	332.78	.093	24.01
	6	214.14	.001	18.21	288.14	.003	24.45	312.14	.002	26.52
	7	223.83	.007	17.22	270.83	.001	20.98	297.83	.000	23.07

Table 6.4

Estimated Choice Probabilities and Elasticities for a Hypothetical Elevator in Decatur, Illinois

MAXCARS	Month of Shipment → / Alternative$_j$	January			June			September		
		NETPFT$_j$	P_{ij}	E_j(NETPFT$_j$)	NETPFT$_j$	P_{ij}	E_j(NETPFT$_j$)	NETPFT$_j$	P_{ij}	E_j(NETPFT$_j$)
5	1	216.60	.033	15.35	285.60	.006	20.81	317.60	.005	23.17
	2	229.59	.230	14.40	304.59	.218	19.39	337.59	.248	20.66
	3	227.45	.248	14.41	302.45	.426	14.63	335.45	.534	13.16
	4	221.42	.054	15.93	283.42	.010	21.33	324.42	.017	24.23
	5	229.20	.157	15.35	303.20	.113	21.38	327.20	.059	24.47
	6	220.46	.131	16.31	294.46	.223	19.48	318.46	.133	23.49
	7	223.79	.147	14.79	270.79	.004	20.90	297.79	.003	23.02
25	1	223.76	.096	14.83	292.76	.022	20.99	324.76	.017	23.40
	2	236.54	.275	13.96	311.54	.339	16.75	344.54	.378	17.45
	3	227.45	.149	16.33	302.45	.332	17.04	335.45	.406	16.79
	4	228.56	.123	15.23	290.56	.030	21.42	331.56	.051	23.91
	5	236.16	.213	14.78	310.16	.199	19.75	334.16	.102	23.86
	6	220.46	.033	18.13	294.46	.074	23.20	318.46	.043	25.93
	7	231.37	.111	15.94	278.37	.004	21.48	305.37	.003	23.60
75	1	224.94	.412	9.69	293.94	.180	17.67	325.94	.139	20.57
	2	236.71	.112	17.12	311.71	.268	18.58	344.71	.292	19.88
	3	227.45	.043	18.34	302.45	.188	20.72	335.45	.225	21.93
	4	229.66	.293	12.34	291.66	.139	19.11	332.66	.231	19.45
	5	236.41	.122	16.51	310.41	.221	19.23	334.41	.110	23.65
	6	220.46	.001	18.74	294.46	.005	24.93	318.46	.003	27.02
	7	234.61	.017	17.87	281.61	.001	21.80	308.61	.001	23.90

Table 6.5

Estimated Choice Probabilities and Elasticities for a Hypothetical Elevator in Baraboo, Wisconsin

MAXCARS	Month of Shipment → / Alternative$_j$	January NETPFT$_j$	January P_{ij}	January E_j(NETPFT$_j$)	June NETPFT$_j$	June P_{ij}	June E_j(NETPFT$_j$)	September NETPFT$_j$	September P_{ij}	September E_j(NETPFT$_j$)
5	1	200.98	.014	14.52	269.98	.002	19.75	301.98	.002	22.08
	2	212.27	.074	15.99	294.27	.106	21.42	323.27	.123	23.07
	3	214.78	.113	16.05	296.78	.298	17.57	325.78	.377	17.11
	4	212.20	.035	15.56	274.20	.006	20.72	315.20	.014	23.62
	5	230.94	.240	13.95	304.94	.146	20.70	328.94	.108	23.32
	6	227.00	.302	13.48	301.00	.437	14.42	325.00	.370	17.42
	7	225.36	.220	13.62	272.36	.005	20.99	299.36	.005	23.09
25	1	208.23	.048	14.53	277.23	.009	20.13	309.23	.010	22.43
	2	219.21	.105	15.97	301.21	.199	19.64	330.21	.225	20.84
	3	214.78	.080	16.66	296.78	.279	18.03	325.78	.343	18.03
	4	219.40	.096	15.07	281.40	.020	20.95	322.40	.048	23.31
	5	237.89	.383	11.68	311.89	.310	17.11	335.89	.223	20.75
	6	227.00	.091	17.55	301.00	.176	21.11	325.00	.144	23.66
	7	232.94	.197	14.51	279.94	.006	21.56	306.94	.006	23.65
75	1	209.86	.280	11.08	278.86	.095	18.49	310.86	.095	20.62
	2	219.33	.056	16.86	301.33	.185	20.00	330.33	.186	21.87
	3	214.78	.030	17.55	296.78	.187	20.35	325.78	.205	21.84
	4	220.76	.305	11.65	282.76	.112	19.07	323.76	.242	18.66
	5	238.08	.285	13.54	312.08	.405	14.77	336.08	.260	19.77
	6	227.00	.004	19.24	301.00	.014	25.25	325.00	.010	27.37
	7	236.13	.040	17.58	283.13	.002	21.89	310.13	.002	23.99

Table 6.6

Estimated Choice Probabilities and Elasticities for a Hypothetical Elevator in Des Moines, Iowa

	Month of Shipment →	January			June			September		
MAXCARS	Alter-native$_j$	NETPFT$_j$	P_{ij}	$E_j(NETPFT_j)$	NETPFT$_j$	P_{ij}	$E_j(NETPFT_j)$	NETPFT$_j$	P_{ij}	$E_j(NETPFT_j)$
5	1	203.04	.021	14.57	272.04	.009	19.75	304.04	.010	22.07
	2	208.58	.071	15.77	290.58	.304	16.46	319.58	.324	17.59
	3	200.89	.045	16.17	282.89	.358	15.32	311.89	.414	15.40
	4	203.90	.024	15.12	265.90	.011	19.98	306.90	.026	22.72
	5	219.28	.123	15.29	293.28	.224	18.08	317.28	.152	21.39
	6	183.10	.009	15.44	257.10	.040	20.99	281.10	.031	23.17
	7	237.08	.706	5.40	284.08	.052	20.86	311.08	.043	23.08
25	1	210.28	.066	14.40	279.28	.027	19.91	311.28	.029	22.15
	2	215.54	.092	15.93	297.54	.369	15.27	326.54	.400	15.96
	3	200.89	.029	16.44	282.89	.217	18.67	311.89	.255	19.58
	4	211.15	.061	15.07	273.15	.027	20.20	314.15	.062	22.39
	5	226.30	.179	14.76	300.30	.309	16.50	324.30	.213	20.30
	6	183.10	.003	15.54	257.10	.010	21.65	281.10	.008	23.72
	7	244.58	.571	8.14	291.58	.040	21.70	318.58	.033	23.87
75	1	216.20	.429	9.05	285.20	.238	15.94	317.20	.224	18.04
	2	216.48	.043	16.87	298.48	.229	18.73	327.48	.219	20.81
	3	200.89	.009	16.78	282.89	.091	21.69	311.89	.094	23.82
	4	217.19	.224	12.80	279.19	.134	18.37	320.19	.273	17.69
	5	228.34	.126	15.86	302.34	.292	17.02	326.34	.178	21.34
	6	183.10	.000	15.58	257.10	.001	21.87	281.10	.000	23.91
	7	255.31	.169	16.45	302.31	.016	23.06	329.31	.012	25.23

Table 6.7

Estimated Choice Probabilities and Elasticities for a Hypothetical Elevator in New Ulm, Minnesota

	Month of Shipment →	January			June			September		
MAXCARS	Alternative$_j$	NETPFT$_j$	P_{ij}	$E_j(NETPFT_j)$	NETPFT$_j$	P_{ij}	$E_j(NETPFT_j)$	NETPFT$_j$	P_{ij}	$E_j(NETPFT_j)$
5	1	193.82	.003	14.16	262.82	.003	19.22	294.82	.003	21.55
	2	210.91	.027	16.71	292.91	.199	19.10	321.91	.216	20.54
	3	209.67	.029	17.16	291.67	.406	14.61	320.67	.479	14.08
	4	195.82	.004	14.82	257.82	.003	19.53	298.82	.008	22.53
	5	224.00	.055	16.83	298.00	.177	19.50	322.00	.122	22.48
	6	200.87	.013	16.87	274.87	.099	21.07	298.87	.078	23.44
	7	254.92	.869	2.60	301.92	.113	20.75	328.92	.094	23.10
25	1	201.11	.012	14.56	270.11	.009	19.62	302.11	.010	21.93
	2	217.86	.040	17.02	299.86	.282	17.53	328.86	.313	18.40
	3	209.67	.022	17.28	291.67	.287	17.53	320.67	.347	17.66
	4	203.11	.012	15.25	265.11	.009	19.96	306.11	.022	22.75
	5	230.99	.094	16.64	304.99	.283	17.38	328.99	.200	20.92
	6	200.87	.004	17.02	274.87	.030	22.69	298.87	.024	24.82
	7	262.32	.815	3.75	309.32	.100	21.58	336.32	.085	23.86
75	1	202.95	.190	12.05	271.95	.090	18.14	303.95	.095	20.16
	2	218.02	.056	16.75	300.02	.206	18.07	329.02	.279	19.31
	3	209.67	.022	17.28	291.67	.190	19.92	320.67	.222	21.04
	4	204.95	.103	13.97	266.95	.053	19.21	307.95	.121	20.57
	5	231.38	.188	14.93	305.38	.372	15.24	329.38	.254	19.53
	6	200.87	.001	17.09	274.87	.002	23.34	298.87	.002	25.39
	7	265.67	.440	11.54	311.67	.033	23.37	338.67	.027	25.54

in June the river and Toledo alternatives by rail are more competitive alternatives.

The estimated choice probabilities for the Michigan elevator are consistent with the current situation in Michigan, except for the high probabilities of shipping to the river by rail. There really isn't a likely river destination for shipments from Michigan, and the river destination of Cincinnati, Ohio was chosen only because of its proximity. It's quite possible that Michigan shippers cannot get the kind of rates to Cincinnati that are estimated here as a function of distance only.

Table 6.2 shows the results for the Columbus, Ohio elevators. Where the maximum number of rail cars is five, the river by truck alternative is most likely in all three months considered. If 25 cars can be handled at one time, the Atlantic by rail alternative becomes most probable during January, and the river by either truck or rail are most likely in the other two months. The Atlantic by rail alternative becomes highly probable when the MAXCAR value is 75.

The Great Lakes alternatives are not likely for any of the cases in Table 6.2. This is not necessarily inconsistent with the current situation in Ohio. The Great Lakes alternatives in Table 6.2 do show the highest elasticities among the alternatives and, therefore, might be able to capture some of this market under different price and rate conditions. The relative changes in NETPFT would have to be substantial for this to happen, however.

Table 6.3 shows the results for the Indianapolis elevators. The river by truck alternative is most likely for the small elevator in all three months. The medium-sized elevator would most probably ship by rail to the river in January, and by either rail or truck to the river in June and September. The elevator handling 75 cars would probably ship to the Atlantic by rail in January and September, but to the river by rail in June. Similar to the Ohio elevators, the Great Lakes are not likely destinations for an elevator in Indianapolis under the conditions represented here.

The results for Decatur, Illinois (Table 6.4) show an almost complete dominance by the river destinations. Only for the largest elevator shipping in January, where the likely alternative is the Gulf by rail, is a nonriver destination most probable. Both trucks and rail are likely to be used for the river shipments, depending on the size of the elevator. The Great Lakes by rail alternative is only competitive (second to the river by rail alternative) for the largest elevator in June.

The Wisconsin results (Table 6.5) show a more promising outlook for the Great Lakes destination, which, in this case, would be the port of Milwaukee. The Great Lakes by truck alternative is most probable for the small elevator in January and June, while in September, the Mississippi River by truck alternative is slightly more probable. The elevator able to handle 25 cars at one time is most likely to ship to the Great Lakes by rail in January and June, and to the river by rail in September. The largest elevator would be most likely to use the Atlantic by rail alternative in January, and the Great Lakes by rail alternative in June and September. Note that the use of the Great Lakes ports in January implies the storage of the grain until the Lakes open again in spring.

The results for Des Moines, Iowa (Table 6.6) show a high probability of shipping to the Pacific by rail for the small- and medium-sized elevators in January, and would probably show the same for the largest elevator if the sign of the estimated MAXCAR coefficient weren't theoretically wrong for this variable (see Table 5.2). There were relatively few observations for the Pacific alternative in the original sample (simply because not many elevators shipped there in 1977), and the model should be interpreted with care with respect to forecasts for this alternative. There is much more use of the Pacific ports now than in 1977, and current data might result in a different model as far as the Pacific alternative is concerned.

In June and September, the river alternatives are dominating for both the small- and medium-sized elevators in Des Moines. The small elevator is more likely to use trucks, while the medium-sized elevator is more likely to use rail. The largest elevator would be most likely to choose a different alternative in each month, which shows that this elevator would be particularly sensitive to price changes. In January, the most probable alternative is the Gulf by rail. In June, it is the Great Lakes by rail and in September it is the river by rail. All three of these alternatives are very close in probability in each month.

The final example is the Minnesota location (Table 6.7). The Pacific by rail alternative is highly probable for all three elevators in the month of January. This choice could certainly be plausible for many Minnesota locations in 1983, but the extremely high probabilities are mostly due to an unusually high destination price reported for January (this applies to the Iowa results as well). In June and September, the small- and medium-sized elevators are most likely to ship to the river destination by truck, in this case, Minneapolis. The largest elevator would probably choose the Great Lakes (Duluth) by rail alternative in June, and the river by rail alternative in September. The Great Lakes by rail alternative is also highly probable for this elevator in September.

6.2 Analyzing the Effects of the User Fee

Three different proposals for a user fee were analyzed in Chapter 3. The most politically feasible proposals are the Hatfield and Moynihan Bills. For the purpose of applying the alternative user fees to the estimated model, only the cents per bushel charges involved in each bill are important. However, for a complete policy analysis, the impact of each bill on the structure of rights must also be considered. The results reported here must be analyzed in conjunction with the results of Chapter 3 in order for a complete display of the impacts of each user fee proposal.

The Hatfield Bill calls for a user fee of .0006 per $1 value of the commodity being shipped. For corn at $3.50 per bushel, this amounts to .21¢ per bushel. In addition, this bill calls for a 100 percent reduction in Seaway tolls. A DRI study estimates that "a complete elimination of the U.S. toll will reduce (total) tolls by 16¢ to 18¢ per ton" for grains. This amounts to an approximate reduction of .51¢ per bushel in transportation costs of corn through the Great Lakes - St. Lawrence Seaway system. The net impact on Great Lakes transportation then is a <u>reduction</u> of .30¢ per bushel in water transportation costs. Following the logic of the marketing margin approach presented earlier, this reduction in water transportation rates results in an increase in the price offered for grain at Great Lakes ports. The NETPFT variable will therefore increase by .30¢ for the Great Lakes alternatives, and will decrease by .21¢ for the other alternatives, under the Hatfield proposal.

The Moynihan proposal is for a uniform tonnage fee of 16¢ per ton or .45¢ per bushel for corn shipments. This proposal also calls for a 50 percent reduction in Seaway tolls, which DRI estimates will decrease the transportation cost of corn by .24¢ per bushel. The net effect is to increase water transportation costs by .21¢ per bushel at Great Lakes ports and by .45¢ per bushel at all other ports.

The NETPFT variable in the updated model is likely to have a value between 200 and 350¢. The user fees calculated above only amount to a .23 percent change in this variable, at most. The impact of this level of user fee will be minimal when analyzed by the estimated model. The average elasticities calculated in Chapter 5 will be used to measure this impact of the different user fees. The updated model applied to the hypothetical elevators will also be used to assess the possible impacts.

6.2.1 Use of "Average" Elasticities to Assess Impacts

Tables 5.4 and 5.5 from the last chapter showed two alternative measures of "average" elasticities. The first is the elasticity calculated at the means of the independent variables from the original sample. Those elasticities can be applied to the percentage change in NETPFT that is likely to result from the imposition of each user fee proposal. If the price of corn were 400¢ per bushel and the NETPFT for any alternative were 350¢ per bushel (a "worst case" type of scenario for the Great Lakes alternatives), then the Hatfield Bill would result in a decrease of NETPFT by .069 percent for the non Great Lakes alternatives, and an increase in NETPFT by .077 percent for the Great Lakes alternatives. Table 6.8 shows the changes in probability that would occur from these changes in the NETPFT variables. These changes are very small and would not have any impact on the relative probabilities reported in Table 5.3.

The "market" elasticity measures from Table 5.5 can also be applied to the percentage changes in NETPFT resulting from the Hatfield Bill. Table 6.8 shows that the resulting changes in probability are even smaller, as the lower market elasticities would indicate.

The ad valorem nature of the Hatfield Bill means that higher corn prices will lead to larger impacts for shippers. The price would have to go as high as 850¢ per bushel, however, before the offsetting positive impact of 100 percent reduction in Seaway tolls would be negated. The changes in probability of choosing the Great Lakes alternatives would be zero at this point and the changes in other probabilities would be slightly smaller than those in Table 6.8.[4]

A similar analysis can be done for the Moynihan proposal. The user fee under this proposal is not tied to the value of the commodity, so changing prices will not affect the absolute amount of the change. However, the .45¢ per bushel charge will be a larger percentage of low grain prices than high prices and, therefore, can have a larger impact when prices are low. Therefore, a 200¢ per bushel value for NETPFT can be used as a "worst case" type of scenario. The change in NETPFT for the non Great Lakes alternatives will be -.255 percent. The 50 percent

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[4]Notice that although the absolute change will be much higher at 850¢ per bushel, the change is still .06 percent of the price. As long as NETPFT is close in value to the price (i.e., transportation rates stay low), the percentage change in NETPFT will be close to .06.

Table 6.8

Percentage Changes in Probabilities of Each Choice as a Result of the Hatfield Bill

Alternative_j	Percent Change in NETPFT_j	Measured by the Elasticity of the "Average" Elevator in Winter (% Change)	Measured by the "Market" Elasticity (% Change)
Gulf by Rail	-.069	-.735	-.648
River by Rail	-.069	-.956	-.935
River by Truck	-.069	-1.015	-.992
Atlantic by Rail	-.069	-.784	-.736
Great Lakes by Rail	+.077	+1.006	+1.001
Great Lakes by Truck	+.077	+1.215	+1.116
Pacific by Rail	-.069	-.958	-.909

reduction in Seaway tolls under the Moynihan proposal makes the change in NETPFT for the Great Lakes alternatives -.105 percent. Table 6.9 shows the percentage changes in probabilities which result from these changes in NETPFT. The changes seem large compared to those under the Hatfield proposal, but they are still very low and would have only a minimal impact on relative probabilities. Only in cases where the probabilities of two alternatives were very close might there be a change in the most likely choice for an elevator. The probabilities would remain very close after the change.

It was stressed earlier that the elasticities of shipper choice will vary for different values of the independent variables. Tables 6.1-6.7 were presented to show how large the variability can be. The above results from the "average" elasticities should therefore be used with care. The concern in policy analysis is frequently not in how the average individual will be impacted by a policy, but in how the impacts may differ across individuals. The next section will analyze how each user fee proposal will affect the relative probabilities of Tables 6.1-6.7.

6.2.2 Use of "Individual" Elasticities to Assess Impacts

Tables 6.10-6.16 show the relative probabilities before user fees compared to the probabilities after each user fee proposal. There is some variability in the absolute magnitudes of the probabilities, but by far the most important result these tables show is that only in two out of 126 cases does the most probable choice change after the imposition of user fees. Both of these change in favor of Great Lakes destinations. Table 6.14 shows that for the smallest Wisconsin elevator shipping in September, the Great Lakes by truck alternative replaces

Table 6.9

Percentage Changes in Probabilities of Each Choice as a Result of the Moynihan Bill

$Alternative_j$	Percent Change in $NETPFT_j$	Measured by the Elasticity of the "Average" Elevator in Winter (% Change)	Measured by the "Market" Elasticity (% Change)
Gulf by Rail	-.225	-2.395	-2.113
River by Rail	-.225	-3.116	-3.049
River by Truck	-.225	-3.309	-3.233
Atlantic by Rail	-.225	-2.556	-2.399
Great Lakes by Rail	-.105	-1.372	-1.365
Great Lakes by Truck	-.105	-1.656	-1.521
Pacific by Rail	-.225	-3.123	-2.966

Table 6.10

Changes in Relative Probabilities After Enactment of User Fee Alternatives in Grand Ledge, Michigan

MAXCARS	Month of Shipment → / Alternative$_j$	January: P_{ij} Before User Fee	January: P_{ij} After Hatfield	January: P_{ij} After Moynihan	June: P_{ij} Before User Fee	June: P_{ij} After Hatfield	June: P_{ij} After Moynihan	September: P_{ij} Before User Fee	September: P_{ij} After Hatfield	September: P_{ij} After Moynihan
5	1	.023	.023	.023	.004	.004	.004	.003	.002	.003
	2	.260	.256	.258	.241	.234	.238	.224	.218	.221
	3	.034	.034	.034	.058	.056	.057	.059	.057	.058
	4	.198	.194	.197	.036	.035	.036	.051	.050	.051
	5	.176	.181	.178	.170	.172	.171	.148	.150	.149
	6	.209	.214	.211	.488	.496	.491	.513	.521	.516
	7	.101	.099	.100	.003	.003	.003	.001	.001	.001
25	1	.054	.054	.054	.014	.014	.014	.010	.009	.010
	2	.256	.253	.254	.374	.367	.370	.353	.346	.350
	3	.017	.017	.017	.045	.044	.044	.046	.045	.046
	4	.372	.368	.371	.107	.105	.106	.155	.152	.154
	5	.195	.201	.197	.296	.303	.299	.263	.269	.266
	6	.044	.045	.044	.161	.165	.163	.172	.177	.174
	7	.063	.062	.062	.003	.003	.003	.001	.001	.001
75	1	.179	.178	.179	.097	.014	.097	.060	.059	.060
	2	.079	.079	.079	.236	.367	.235	.204	.202	.203
	3	.004	.004	.004	.020	.044	.020	.019	.019	.019
	4	.648	.645	.647	.381	.105	.379	.502	.497	.500
	5	.082	.086	.084	.257	.303	.260	.207	.214	.210
	6	.001	.001	.001	.009	.165	.009	.008	.009	.008
	7	.007	.007	.007	.001	.003	.001	.000	.000	.000

Table 6.11

Changes in Relative Probabilities After Enactment of User Fee Alternatives in Columbus, Ohio

MAXCARS	Month of Shipment → / Alternative$_j$	January P_{ij} Before User Fee	January P_{ij} After Hatfield	January P_{ij} After Moynihan	June P_{ij} Before User Fee	June P_{ij} After Hatfield	June P_{ij} After Moynihan	September P_{ij} Before User Fee	September P_{ij} After Hatfield	September P_{ij} After Moynihan
5	1	.020	.020	.020	.003	.003	.003	.002	.002	.002
	2	.271	.269	.270	.233	.231	.232	.215	.213	.214
	3	.301	.299	.299	.468	.463	.466	.476	.470	.473
	4	.205	.204	.205	.035	.034	.035	.049	.049	.049
	5	.084	.087	.085	.075	.077	.076	.065	.067	.066
	6	.085	.088	.086	.184	.190	.187	.192	.199	.195
	7	.035	.034	.035	.001	.001	.001	.000	.000	.000
25	1	.048	.048	.048	.011	.011	.011	.007	.007	.007
	2	.272	.271	.271	.350	.348	.349	.323	.320	.322
	3	.151	.150	.150	.352	.349	.350	.356	.354	.355
	4	.394	.392	.394	.100	.099	.100	.141	.140	.141
	5	.095	.098	.096	.127	.132	.129	.110	.114	.112
	6	.018	.019	.019	.059	.061	.060	.062	.064	.063
	7	.022	.022	.022	.001	.001	.001	.000	.000	.000
75	1	.158	.157	.158	.082	.082	.082	.049	.049	.049
	2	.083	.083	.083	.239	.237	.238	.200	.199	.200
	3	.033	.033	.033	.171	.170	.171	.158	.157	.158
	4	.682	.681	.682	.383	.381	.382	.494	.492	.493
	5	.041	.042	.041	.121	.126	.123	.096	.099	.097
	6	.000	.001	.000	.003	.004	.004	.003	.003	.003
	7	.003	.003	.003	.000	.000	.000	.000	.000	.000

Table 6.12

Changes in Relative Probabilities After Enactment of User Fee Alternatives in Indianapolis, Indiana

	Month of → Shipment	January			June			September		
MAXCARS	Alter-native$_j$	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan
5	1	.030	.030	.030	.005	.005	.005	.004	.004	.004
	2	.269	.266	.267	.247	.245	.246	.268	.267	.268
	3	.279	.276	.278	.465	.460	.462	.556	.552	.554
	4	.095	.094	.095	.017	.017	.017	.029	.029	.029
	5	.163	.168	.166	.114	.117	.116	.057	.059	.058
	6	.090	.093	.092	.149	.154	.152	.085	.088	.087
	7	.073	.072	.073	.002	.002	.002	.001	.001	.001
25	1	.079	.078	.078	.017	.017	.017	.013	.013	.013
	2	.294	.291	.292	.360	.356	.358	.387	.385	.386
	3	.153	.151	.152	.339	.335	.337	.400	.398	.399
	4	.201	.199	.200	.048	.048	.048	.080	.079	.080
	5	.202	.209	.205	.187	.193	.190	.092	.096	.094
	6	.021	.022	.021	.047	.048	.047	.026	.027	.027
	7	.051	.050	.051	.002	.002	.002	.001	.001	.001
75	1	.309	.309	.309	.139	.138	.101	.101	.101	.101
	2	.109	.108	.108	.270	.267	.275	.275	.274	.274
	3	.040	.040	.040	.181	.180	.203	.203	.202	.203
	4	.428	.427	.427	.208	.207	.326	.326	.325	.326
	5	.105	.107	.107	.198	.204	.093	.093	.096	.094
	6	.001	.001	.001	.003	.003	.002	.002	.002	.002
	7	.007	.007	.007	.001	.001	.000	.000	.000	.000

Table 6.13

Changes in Relative Probabilities After Enactment of User Fee Alternatives in Decatur, Illinois

	Month of → Shipment	January			June			September		
MAXCARS	Alter-native$_j$	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan
5	1	.033	.033	.033	.006	.006	.006	.005	.005	.005
	2	.230	.227	.228	.218	.215	.217	.248	.246	.248
	3	.248	.245	.247	.426	.420	.423	.534	.530	.532
	4	.054	.053	.053	.010	.010	.010	.017	.017	.017
	5	.157	.162	.160	.113	.116	.115	.059	.061	.060
	6	.131	.135	.132	.223	.229	.225	.133	.138	.135
	7	.147	.145	.146	.004	.004	.004	.003	.003	.003
25	1	.096	.095	.096	.022	.021	.022	.017	.017	.017
	2	.275	.272	.273	.339	.336	.338	.378	.376	.377
	3	.149	.147	.148	.332	.328	.330	.406	.404	.405
	4	.123	.122	.123	.030	.030	.030	.051	.051	.051
	5	.213	.219	.216	.199	.205	.202	.102	.105	.103
	6	.033	.035	.034	.074	.077	.074	.043	.045	.044
	7	.111	.110	.111	.004	.004	.004	.003	.003	.003
75	1	.412	.410	.412	.180	.178	.179	.139	.139	.139
	2	.112	.111	.111	.268	.265	.266	.292	.290	.291
	3	.043	.043	.043	.188	.186	.186	.225	.223	.224
	4	.293	.291	.292	.139	.137	.137	.231	.230	.230
	5	.122	.126	.124	.221	.228	.224	.110	.115	.112
	6	.001	.001	.001	.005	.005	.005	.003	.003	.003
	7	.017	.017	.017	.001	.001	.001	.001	.001	.001

Table 6.14

Changes in Relative Probabilities After Enactment
of User Fee Alternatives in Baraboo, Wisconsin

	Month of Shipment →	January			June			September		
MAXCARS	Alternative$_j$	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan
5	1	.014	.014	.014	.002	.002	.002	.002	.002	.002
	2	.074	.073	.074	.106	.103	.105	.123	.121	.122
	3	.113	.111	.112	.298	.290	.294	.377	.369	.373
	4	.035	.034	.035	.006	.005	.006	.014	.014	.014
	5	.240	.245	.242	.146	.149	.148	.108	.111	.110
	6	.302	.309	.305	.437	.445	.441	.370	.379	.374
	7	.220	.215	.218	.005	.005	.005	.005	.005	.005
25	1	.048	.047	.048	.009	.009	.009	.010	.010	.010
	2	.105	.103	.104	.199	.195	.197	.225	.221	.223
	3	.080	.079	.079	.279	.274	.276	.343	.338	.341
	4	.096	.094	.096	.020	.020	.020	.048	.048	.048
	5	.383	.391	.386	.310	.316	.313	.223	.229	.226
	6	.091	.094	.092	.176	.180	.177	.144	.148	.146
	7	.197	.192	.195	.006	.006	.006	.006	.005	.006
75	1	.280	.277	.279	.095	.094	.095	.095	.094	.094
	2	.056	.055	.056	.185	.182	.183	.186	.184	.185
	3	.030	.030	.030	.187	.183	.185	.205	.203	.203
	4	.305	.302	.304	.112	.111	.112	.242	.239	.241
	5	.285	.293	.288	.405	.414	.409	.260	.268	.264
	6	.004	.004	.004	.014	.014	.014	.010	.011	.010
	7	.040	.039	.039	.002	.002	.002	.002	.002	.002

Table 6.15

Changes in Relative Probabilities After Enactment of User Fee Alternatives in Des Moines, Iowa

MAXCARS	Month of Shipment → Alternative$_j$	January P_{ij} Before User Fee	January P_{ij} After Hatfield	January P_{ij} After Moynihan	June P_{ij} Before User Fee	June P_{ij} After Hatfield	June P_{ij} After Moynihan	September P_{ij} Before User Fee	September P_{ij} After Hatfield	September P_{ij} After Moynihan
5	1	.021	.021	.021	.009	.009	.009	.010	.010	.010
	2	.071	.071	.071	.304	.301	.308	.324	.321	.323
	3	.045	.045	.045	.358	.354	.362	.414	.411	.412
	4	.024	.024	.024	.011	.011	.012	.026	.026	.026
	5	.123	.127	.125	.224	.231	.214	.152	.157	.155
	6	.009	.010	.009	.040	.042	.042	.031	.032	.032
	7	.706	.701	.704	.052	.052	.053	.043	.042	.043
25	1	.066	.065	.066	.027	.027	.027	.029	.029	.029
	2	.092	.091	.091	.369	.365	.367	.400	.396	.398
	3	.029	.029	.029	.217	.214	.215	.255	.253	.254
	4	.061	.060	.060	.027	.027	.027	.062	.062	.062
	5	.179	.186	.182	.309	.318	.313	.213	.219	.216
	6	.003	.003	.003	.010	.011	.011	.008	.009	.008
	7	.571	.565	.569	.040	.039	.040	.003	.033	.033
75	1	.429	.427	.428	.238	.235	.237	.224	.222	.224
	2	.043	.042	.042	.229	.227	.228	.219	.218	.218
	3	.009	.009	.009	.091	.089	.090	.094	.093	.094
	4	.224	.223	.224	.134	.133	.134	.273	.271	.272
	5	.126	.131	.128	.292	.300	.296	.178	.184	.180
	6	.000	.000	.000	.001	.001	.001	.000	.000	.000
	7	.169	.167	.168	.016	.016	.016	.012	.011	.012

Table 6.16

Changes in Relative Probabilities After Enactment of User Fee Alternatives in New Ulm, Minnesota

	Month of → Shipment	January			June			September		
MAXCARS	Alter-native$_j$	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan	P_{ij} Before User Fee	P_{ij} After Hatfield	P_{ij} After Moynihan
5	1	.003	.003	.003	.003	.003	.003	.003	.003	.003
	2	.027	.027	.026	.199	.197	.198	.216	.214	.215
	3	.029	.029	.029	.406	.401	.403	.479	.475	.477
	4	.004	.004	.004	.003	.003	.003	.008	.008	.008
	5	.055	.057	.056	.177	.182	.179	.122	.126	.124
	6	.013	.014	.013	.099	.102	.101	.078	.081	.080
	7	.869	.866	.868	.113	.112	.113	.094	.093	.094
25	1	.012	.012	.012	.009	.009	.009	.010	.010	.010
	2	.040	.040	.040	.282	.278	.280	.313	.310	.311
	3	.022	.022	.022	.287	.283	.285	.347	.343	.345
	4	.012	.012	.012	.009	.009	.009	.022	.022	.022
	5	.094	.098	.096	.283	.291	.287	.200	.207	.203
	6	.004	.004	.004	.030	.031	.030	.024	.025	.025
	7	.815	.811	.814	.100	.098	.099	.085	.084	.084
75	1	.190	.189	.189	.090	.089	.090	.095	.094	.095
	2	.056	.056	.056	.260	.256	.258	.279	.276	.278
	3	.022	.022	.022	.190	.187	.188	.222	.219	.220
	4	.103	.103	.103	.053	.052	.053	.121	.120	.121
	5	.188	.195	.191	.372	.382	.377	.254	.262	.258
	6	.001	.001	.001	.002	.002	.002	.002	.002	.002
	7	.440	.435	.438	.033	.032	.032	.027	.026	.027

the river by truck alternative after the imposition of either user fee. Table 6.16 shows the Great Lakes by rail alternative replacing the river by truck alternative for the medium-sized elevator shipping in June. The closeness in probability of the competing alternatives in each of these cases makes it very difficult to say that either alternative is "most" probable. It would be more accurate to say that the alternatives are equally probable, both before and after user fees.

It is clear from Tables 6.10-6.16 that the level of user fee under consideration here is not high enough to have a large short-run impact on the shippers' choice of destination. If higher recovery levels for port costs are proposed, however, user fees would be higher and the impacts could be larger. Many shippers are concerned with what they call the "foot in the door" effect of passing any user fee bill. It would be much easier in the future to pass an increase in the user fee than to pass the initial legislation. The increase in a user fee would have to be substantial before major changes in shipper choice would occur.

Two major points need to be considered when interpreting the above results. The first is that the estimated model only shows short-run impacts of a user fee bill. The provisions in the user fee proposals regarding new development at ports may have a substantially larger and longer-term effect than the provisions regarding operations and maintenance. If ports on the salt water coasts continue to develop more efficient facilities, while the Great Lakes ports are limited by the St. Lawrence Seaway constraints, then the competitiveness of the Great Lakes ports will decline.[5]

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[5]Recall from Chapter 3 that the user fee bills will probably speed up the process of development for most ports.

The second point is that the provisions in the user fee proposals for partial or total elimination of the Seaway debt completely dominated the effect of any user fee on the relative competitiveness of the Great Lakes ports. If a user fee bill is passed without those provisions, the impact on the Great Lakes ports would be much different than those presented here. The choice of Great Lakes alternatives tends to be more elastic than some of the other alternatives and, therefore, these choices would be more negatively impacted by the imposition of a user fee without any reduction in Seaway tolls.

CHAPTER 7

SUMMARY AND CONCLUSIONS

7.1 Assessment of the Impact of User Fees on Great Lakes Export Grain Trade

There have been two types of user fee assessments presented in this thesis. The first used an institutional approach to describe the changes in the structure of rights that would result from the imposition of various user fee proposals. The second used a model to quantitavely assess the short-run impact of user fees on the inland shippers' choice of mode and destination. The results of this second analysis cannot be interpreted independently of the results of the first. Each user fee proposal needs to be considered in its entirety, and the quantitative model only addresses a part of each proposal. The model does provide useful information, however, which can be used in the policy analysis process.

7.1.1 Magnitude of the Impacts

The shipper choice model clearly showed that the current user fee proposals would have a minimal short-run impact on relative port competitiveness. This assumes that the proposals are passed as written in 1983, including the provisions for partial or total elimination of U.S. tolls on the St. Lawrence Seaway system. The estimated model can also give some insights into how user fees other than those considered here might impact the short-run situation. If a proposal for 100 percent cost recovery were enacted, the user fee would be at least double that of the Hatfield and Moynihan proposals, which call for 40 percent and 50 percent cost recovery for operations and maintenance, respectively. Under a uniform tonnage tax, this would approach 1¢ per bushel for grains. At this level of user fee, some of the relative probability estimates by the model would begin to change for some types of elevators. The change would still be small, however, and alternatives which were close in probability before the user fee would still be close after the user fee, even if the relative positions were changed.

The magnitude of the impacts from other provisions of the user fee bills (other than operations and maintenance) is likely to be much greater. A user fee for port development may result in the larger ports upgrading their facilities faster than the smaller ports. The increase in efficiency at the larger ports could lower the level of current port charges that a vessel pays. These charges were around $5.00 per ton for grain in 1981,[1] which would be 31 times the level of the user fees considered here. If a large port could cut these costs by 4 percent through port development efforts, they would offset the effect of the user fee proposed in either the Hatfield or Moynihan proposals. The Great Lakes ports would find it more difficult to increase efficiency through port development because of each port's reliance on the capacity of the entire Seaway system. The estimates of elasticity developed in Chapters 5 and 6 can be used to assess the magnitude of the impacts from port development, if the reduction in port charges were known.

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[1]Committee on Environmental and Public Works, U.S. Senate, "Report on the National Harbors Improvement and Maintenance Act of 1981," U.S. Government Printing Office, Washington, D.C., 1981.

7.1.2 Difference in Impacts Between Proposals

The short-run impacts predicted by the estimated model show that the Hatfield Bill is much more favorable for Great Lakes ports than the Moynihan Bill. This is mostly due to the 100 percent (versus 50 percent) Seaway toll reduction of the Hatfield Bill, but it is also due to the lower charge involved with an ad valorem tax as opposed to a tonnage tax. Since the inland shippers' choices are more responsive to the conditions at the Great Lakes ports than at the Gulf or Atlantic ports, a larger user fee will result in a greater impact at the Great Lakes ports.

The Hatfield Bill would also be favored by the Great Lakes ports because of the provisions which place the Great Lakes - St. Lawrence Seaway system into the overall deep draft system. The facilities of the Seaway would have the same standing as the facilities at other ports, with respect to access to government funding. Neither proposal addresses any remedies for past discrimination towards the Seaway system. However, the nationally uniform nature of the proposed user fees in either bill will give the right of subsidization to high costs ports which includes most of the Great Lakes ports. The subsidy will be paid by low-cost ports under the user fee proposals, while the present subsidization of all port areas is financed by the general taxpayers. The Hatfield Bill also allows the high-valued commodities to subsidize the low-valued commodities, to the extent that all commodities require the same services from ports and harbors.

7.1.3 Ability of the Model to Assess Impacts of Other User Fee Alternatives

The Hatfield and Moynihan proposals were used in this study because they were the major pieces of legislation under consideration at this time. However, other forms of user fee legislation could be easily assessed by the same model used here. The only requirement is that the level of the user fee be converted to a change in the price offered for grain at a port. The approach taken here was to use an extreme type of scenario where the entire amount of the user fee was subtracted from the port price for grain. This is an appropriate place from which to start to conduct sensitivity analysis. In this case, the impacts were so small at even the extreme scenario that there was no reason to consider other assumptions regarding the effect of user fees on port prices. When other user fee proposals are analyzed, however, it might be useful to do more sensitivity analysis of this type. It would also be helpful to conduct future research on the actual relationship between ocean shipping rates and grain prices at ports to test alternative hypotheses regarding marketing margins and elasticities of supply and demand in this market. A more exact measurement of the impact of user fees on grain prices would then be available.

It must be stressed that the quantitative model developed here should not be used alone for assessing the impacts of new user fee proposals. Changes in the structure of rights resulting from any new legislation should also be analyzed, along with a consideration of long-run and secondary impacts.

7.2 Advantages and Disadvantages of Using a Multinomial Logit Model

A number of alternative models are available for analyzing transportation issues. The multinomial logit model was adopted for this study because the structure of this type of model best fit the theoretical description of the problem. For any given shipment of grain, the inland elevator will choose only one option out of a set of alternative mode-destination combinations. Discrete choice analysis has been fairly well developed recently to handle these types of problems. The particular framework used here allowed for alternative specific coefficients and, therefore, the hypothesis that the Great Lakes is a "residual" transportation route could be tested. The results showed that the equation with alternative specific variables was significantly better (in the statistical sense) than an equation with "generic" variables. However, the differences in elasticities between the Great Lakes alternatives and the other alternatives may not be large enough to conclude that the Great Lakes is a "residual" route. A more accurate description is that inland shippers will be slightly more responsive to price and rate changes at the Great Lakes ports than they would be to price and rail rate changes at either the Gulf or Atlantic ports.

The conclusion that alternative mode-destination combinations are viewed differently by shippers implies that costs or net returns are not the only important variable in determining shipper choice. This study did not make any effort to explain what these other variables may be (e.g., habitual business relationships, risk spreading behavior, perception of the Great Lakes as an "inferior" transportation route), but future research on this issue would be helpful. The fact that costs cannot be considered alone gives the multinomial logit framework an advantage over cost minimizing linear programming models. A cost minimization model would not predict any traffic diversion between ports as a result of a nationally uniform user fee, no matter how high the fee was. The results of this study would contradict such a conclusion.

The major drawbacks of the multinomial logit approach are its theoretical complexity and its relatively high cost for running large models. Only a few software options are available for handling multinomial logit problems, and their documentation is not very complete. There is a gap in the literature between the theory of multinomial logit models and the presentation of case study results. There is a need for some comprehensible literature on how to manipulate variables and functional forms which are consistent with theory and which are appropriate for the available software.

7.3 Related Research Problems

Some suggestions for future research have been included in the discussion above. There are many other issues related to the Great Lakes transportation system which also deserve attention. While this research was focused on user fees, the methodology and results may be helpful for analyzing other policies which affect the relative competitiveness between ports.

An immediate extension of the work done here would be to use the data from an upcoming 1984 grain flow survey to see if structural changes have occurred in the system between 1977 and 1984. Any improvements in the available rate and price data could also be used to reestimate this model. However, in the absence of data which matches shipments to actual prices offered and rates charged (information which is virtually impossible to get), there is not likely to be a significant improvement over the methodology used here.

Finally, it is possible that the framework set out in this research can be used to analyze the impact of user fee proposals on other commodity flows. The multinomial logit approach may be quite useful for commodities where quality-of-service variables are important in the transportation choice. It would also be helpful to analyze how the mix of commodity trades that use a port area influence the revenues generated by user fees and the costs incurred by the port authority. There may be economies or diseconomies associated with certain combinations of commodity traffic.

The results presented here will hopefully assist in the policy making process regarding user fees. The proposal of any type of user fee tends to be an emotional issue and polarization of the relevant interests quickly takes place. This polarization is often not based on a careful weighing of all sides of the issue, but rather on habitual responses to terms such as "user fees." With a better information base, more informed debate can take place and, therefore, more rational decisions can be made. The information provided here, along with information for other sources, will assist in the policy analysis process.

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