AN ANALYSIS OF INTERREGIONAL COMPETITION IN THE WHEAT AND FLOUR ECONOMIES

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

Figure | Page

LIST OF FIGURES (Continued)

CHAPTER I

INTRODUCTION

Changing conditions affecting the wheat and flour economies initiate varied adjustment problems throughout the production and marketing systems. Information useful in making adjustment decisions pertaining to production and marketing problems is lacking with respect to the relative profitability of producing and marketing wheat in current wheat producing regions. This information includes optimum markets for each region, the competitive position among regions, and equilibrium intermarket and shipping point price differentials. Knowledge of price differentials at all stages of the marketing system is useful in making decisions at all levels of the wheat and flour economies.

The volume of wheat marketed in each region affects the operation of marketing firms such as local elevators. In addition, the competitive position of each producing region influences production patterns of wheat over time. The choice of markets facing marketing firms in each region depends on their location with respect to major markets, transportation cost structure, and market prices. The competitive advantage of millers and exporters as measured by market price differentials is essential information in evaluating possible changes in supply and market area boundaries. Exporting firms are primarily concerned with production distribution and price differentials at production points since prices they receive are affected exogenously by export subsidy programs. However, milling firms are concerned with price differentials at both production and consumption points since millers compete for both domestic flour markets and grain supply sources. The net farm price, useful in making production decisions, is dependent upon the competitive position of regions as determined by market prices, transportation cost, and location of producing areas relative to the major markets.

Knowledge of production and consumption patterns is necessary for evaluating the competitive position among regions. The production of wheat in the United States is concentrated in the Central Plains, the North Central, and the Pacific Northwest regions. Consumption of wheat is scattered throughout the nation with population concentration and ports for exporting wheat determining the major deficit consumption regions. Eighty percent of the population resides where only 30 percent of the wheat is grown.[1] Thus, large quantities of wheat and flour are transported from production to consumption areas annually.

Decreasing per capita consumption of wheat coupled with offsetting population increases over the past few years have resulted in very little change in total domestic consumption. With a relatively inelastic

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[1]H. Wayne Bitting and Robert O. Rogers, "Utilization of Wheat for Food," Agricultural Economic Research, Vol. XV, No. 2 (April, 1963), p. 61.

demand, competition among regions for the major markets may become more intensified if the industry moves into a less restricted supply control situation. Production is expected to increase under relaxed production controls. Hence, some regions may find they cannot successfully compete with other regions having a more favorable competitive position for the wheat markets unless prices are artificially supported above competitive levels.

Exports have provided a supplementary market for United States wheat but may have reached an upper limit unless trade can be established with Iron Curtain countries. In recent years, exports of wheat have exceeded domestic utilization. In 1962, the United States exported about 615 million bushels of wheat, of which about 100 million bushels were exported as flour. All five classes of wheat were exported with hard red winter wheat accounting for the largest quantity. A large portion of wheat exports moved through the gulf ports, but considerable quantities were exported from Atlantic and Pacific ports.

The flour-milling industry is even more concentrated than the production of wheat. The states of New York, Minnesota, Illinois, Missouri, Kansas, and Texas milled 58 percent of the total wheat processed in the United States in 1962. The location of major milling centers has remained relatively unchanged over time. Due to concentration and rigidity of the milling industry, it is important to consider the milling process in evaluating the competitive position of regions for domestic markets. For example, wheat produced in South Dakota may be consumed in New York City, but may be milled in Kansas City.

Problem

One of the problems confronting the wheat and flour industries is lack of information essential in making important adjustment decisions. These adjustment decisions involve both regional and interregional relationships. Information of the type needed includes optimum grain and flour flows, optimum markets for each producing and milling region, alternative markets, opportunity cost of entering these alternative markets, and equilibrium intermarket and shipping-point price differentials.

Several hypotheses were posed to guide the analysis in attacking the problem of insufficient information:

(1) Significant differences in competitive advantage as measured by equilibrium shipping price differentials and transportation costs do exist among producing regions.

(2) Significant differences in competitive advantage as measured by equilibrium intermarket price differentials and transportation costs do exist for milling and consuming regions.

(3) Optimum flow patterns and price differentials for wheat grain are relatively stable under varying transportation cost conditions.

(4) Optimum flow patterns and price differentials for flour are relatively stable under varying demand conditions.

(5) Oklahoma and other Great Plains states can successfully compete for the major export and domestic markets with other producing regions.

Objectives

The purpose of the study was to determine the optimum trade flows of wheat and flour in the United States and to measure the competitive advantage among producing and consuming regions. The competitive position of Oklahoma and other Great Plains states was emphasized. The specific objectives of the study were to determine the following:

(1) Optimum markets for grain-producing regions relative to location and type of demand, i.e., export, domestic milling, or storage,

(2) Equilibrium market and shipping-point price differentials for wheat,

(3) Optimum markets for flour-producing regions with respect to location,

(4) Equilibrium intermarket and shipping-point price differentials for each class of flour.

Conditions of Analysis

The calendar year of 1962 was selected as the period of analysis. Appropriate criterion for determining optimum flows of wheat grain was defined to be minimization of cost associated with transporting grain from producing regions to milling and export markets. Optimum flows of flour were defined as movements of flour from millers to consumers which minimized transportation costs.

Other assumptions used in the analysis were as follows:

(1) Conditions of pure competition,

(2) No quality variation existed among regions within each class of wheat and flour,

(3) Production and milling costs were the same in each region,

(4) Flour mills had fixed locations,

(5) Intraregional transportation costs were zero,

(6) An adequate network of transportation and handling facilities existed at each point of origin and destination.

CHAPTER II

ANALYTICAL FRAMEWORK

A regional trade model[1] was developed to analyze the problem of competition among spatially separated production and marketing areas. A two-region case is used to illustrate the application of the model. The model can be expanded to include "n" regions, but illustrating the results would be more complex. The equilibrium conditions specified for two regions in the model hold for "n" regions of the economy if the trading structure is stable and transportation costs are minimized. Information necessary in determining equilibrium trade conditions among regions is knowledge of existing supply and demand relationships in each region and transportation cost which separate each pair of surplus and deficit regions.

The derivation of surplus and deficit quantities and equilibrium trading conditions is shown in Figure 1. S_1 and S_2 represent the known and fixed supplies in each region. D_1 and D_2 depict the linear functions representing demand for the commodity in each region. Assuming no trade, the price would be OP_1 and the quantity consumed would be CA in Region I. Price in Region II would be OP_2 with consumption equal to OB. Given S_2

[1] P. A. Samuelson, "Spatial Price Equilibrium and Linear Programming," The American Economic Review, Vol. 42 (1952), pp. 283-303.

and D_2, ES_2 represents the excess supply in Region II. Given S_1 and D_1, ES_1 represents the excess demand of Region I. Assuming that trade takes place between the two regions, the equilibrium price would be OP_o in Region II and CP_o in Region I. At a price of OP_o, Region II would consume OB' and ship OB - OB' to Region I. At the price of CP_o, Region I would consume OA' and import OA' - OA from Region II (OB - OB' = OA' - OA). The total transportation cost in this case would be OC (OB - OB') = OC (OA' - OA). Trade would take place between these two regions as long as $OC \leq OP_o - OP_2$.

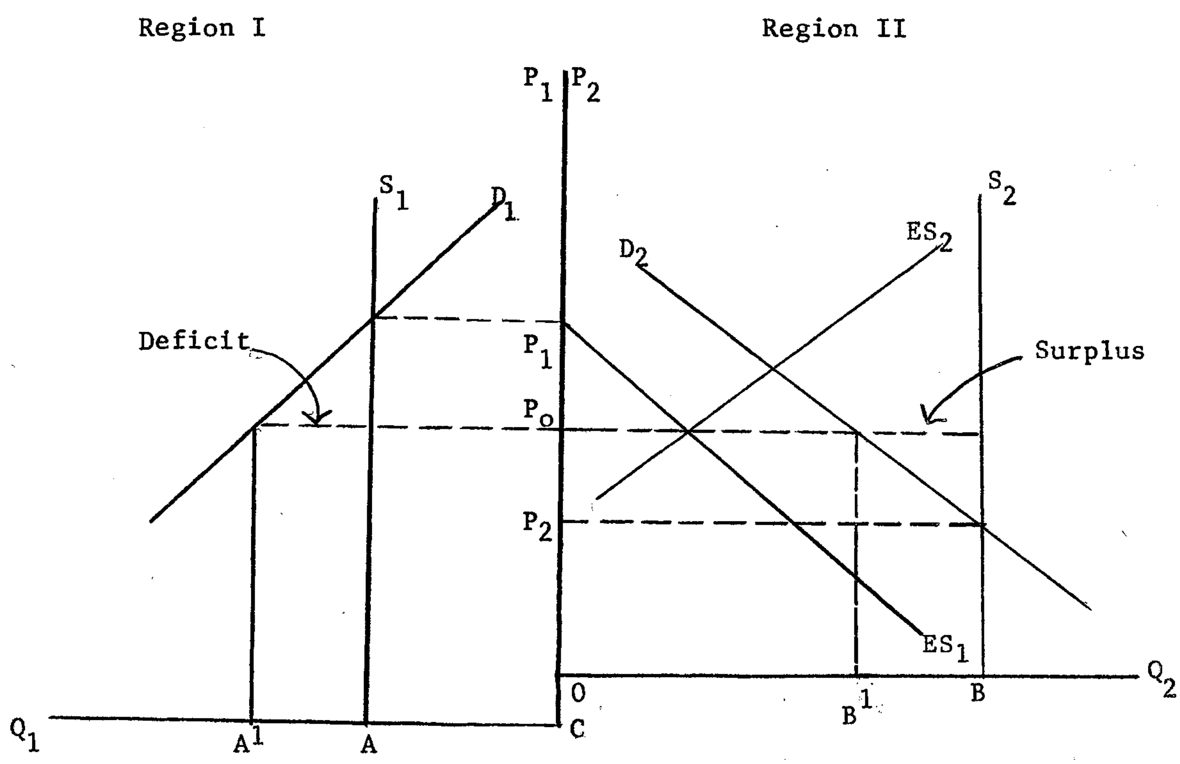

Figure 1. Hypothetical Relationships Used to Illustrate Equilibrium Trade Conditions Between Two Regions.

Application of the Model

The transportation model is an analytical technique often used to derive trade equilibrium and the least cost shipping structure among regions. The transportation model is a linear programming technique designed to solve the problem of allocating surplus supplies among deficit demand areas in such a manner that total transportation charges are minimized. The formal conditions of the model can be expressed algebraically as follows:

(1) Minimize $Z_o = \sum_{i=1}^{m} \sum_{j=1}^{n} C_{ij} X_{ij}$ subject to

(2) $\sum_{i=1}^{m} X_{ij} = Y_j$ and

(3) $\sum_{j=1}^{n} X_{ij} = b_i$ and

(4) $\sum_{j=1}^{n} Y_j = \sum_{i=1}^{m} b_i$ and

(5) $X_{ij} \geq 0$

where: Z_o = total transportation costs;

C_{ij} = the cost of transporting a unit of product from origin i to destination j;

X_{ij} = the quantity of the product transferred from origin i to destination j;

Y_j = the amount required by the j^{th} region;

b_i = the supply available in the i^{th} region.

Whether or not a problem can be solved by a transportation model depends upon how well the problem fulfills the formal assumptions of the model. The important assumptions of the model are as follows:[2]

(1) Resources and products are homogeneous; that is, the supply of products from any surplus area serves equally well to satisfy demands of any deficit area.

(2) Supply and demand in each region are known and total supply equals total demand. In practice, dummy origins or destinations may be introduced to equate supply and demand. A dummy region may represent surplus quantities that move into storage or deficit quantities which are not satisfied.

(3) Per unit cost of moving the commodity from origins to destinations is known and independent of the number of units moved.

(4) Total transportation costs are to be minimized.

(5) Transportation of the product from surplus supply areas to deficit demand areas can be effected only at positive levels.

The applicability of the transportation model to the problem in this study depends on how well the conditions of the problem fulfill the assumptions of the model. Therefore, a comparison of the model with conditions of the problem is necessary to determine whether or not the model is appropriate.

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[2] Earl O. Heady and Wilfred Candler, Linear Programming Methods (Ames, Iowa, 1960), pp. 334, 341.

(1) Homogeneous product: Wheat in the aggregate is not a homogeneous product but is in fact five separate products. Flour was divided into these classes, and the aggregate of these cannot be considered homogeneous. The substitution rates among the various classes of wheat and flour are not generally known but usually are considered to be low. Thus, separate analysis of each class of wheat and flour is appropriate.

(2) The assumption that total supply equals total demand is fulfilled by permitting surplus quantities of wheat and flour to be stored, and is accomplished analytically by the use of "dummy" variables.

(3) Per unit transportation costs are independent of volume shipped; this condition is satisfied by the problem situation because transportation costs are estimated as a function of total miles and are independent of volume and direction of shipment.

(4) $X_{ij} \geq 0$; this is true by definition since it is not possible to move a negative amount of a good. The movement from point A to point B is not considered a negative movement from B to A. The fact that wheat may move out of one region and flour may move into the same region has no significance since wheat and flour are analyzed separately.

The models outlined above have been used in several studies. Judge and Wallace made a study of spatial equilibrium in the livestock economy.[3] Judge has also conducted studies of interregional competition of other products including a study of the Connecticut poultry industry.[4] At North Carolina State University, King and Farris studied interregional competition in marketing green peppers.[5] All of these studies are similar in that the transportation model was used to arrive at a solution of the respective problems.

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[3]G. G. Judge and T. D. Wallace, Spatial Price Equilibrium Analysis of the Livestock Economy, Oklahoma State University, Technical Bulletin TB-78 (Stillwater, 1959).

[4]G. G. Judge, Competitive Position of the Connecticut Poultry Industry, University of Connecticut, Bulletin 318 (Stores, 1956).

[5]R. A. King and D. E. Farris, Interregional Competition in Marketing Green Peppers, North Carolina State University (Raleigh, 1960).

CHAPTER III

ANALYSIS OF THE WHEAT GRAIN ECONOMY

This chapter presents results of the analysis concerning interregional competition in the wheat grain economy. This part of the analysis considered movements of wheat grain from producing regions to domestic milling and export markets. Movements of flour from milling points to the consumer are considered in the following chapter.

Wheat is frequently considered as a homogeneous product in economic analysis. The broad classification, wheat, is made up of five distinct products, or classes, and each class has physical characteristics which distinguish it from any other class. Furthermore, each class of wheat is suited for a specific type food, and substitution among classes is limited. The five classes of wheat are hard red winter, hard red spring, soft red winter, white, and durum. Hard red winter and hard red spring wheats are high in protein and low in starch. Soft red winter and white wheats are low in protein and high in starch. Durum wheat also is high in starch and low in protein. Concentrated production regions for each class of wheat exist within the major production areas. Production of each class in different geographic regions is a result of varying climatic conditions required for producing each class of wheat.

A particular region will not likely produce enough of each class of wheat to satisfy local demand. For example, a region may be surplus in total wheat but deficit for specific classes. Hence, it is important that demand and supply of each class of wheat be considered in determining the competitive position among regions.

Regional Demarcation

The United States was divided into 45 geographical regions for purposes of analysis (Figure 2). Consideration was given to available data and an a priori knowledge of important production areas in specifying the regional boundaries. The regional boundaries follow state boundaries for the most part with some regions containing two or more states which had low production. The central plains states of Texas, Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota were each subdivided into more than one region to give more attention to these important producing regions. Crop reporting districts were used as a basis for subdividing these states.

Total supply and demand for each region were assigned to a point in the region. Except in a few regions where separate points were selected, the same point represents both supply and demand. Available data allowed subdividing the central plains states into producing regions but necessitated specifying demand for the state as a whole.

The selection of a single demand and supply point within each region is subjective and was based on geographic location of the point within the region and the relative importance of the point in wheat marketing. Fifty-five supply and demand points were selected to represent the 45 production and consumption regions (Table I).

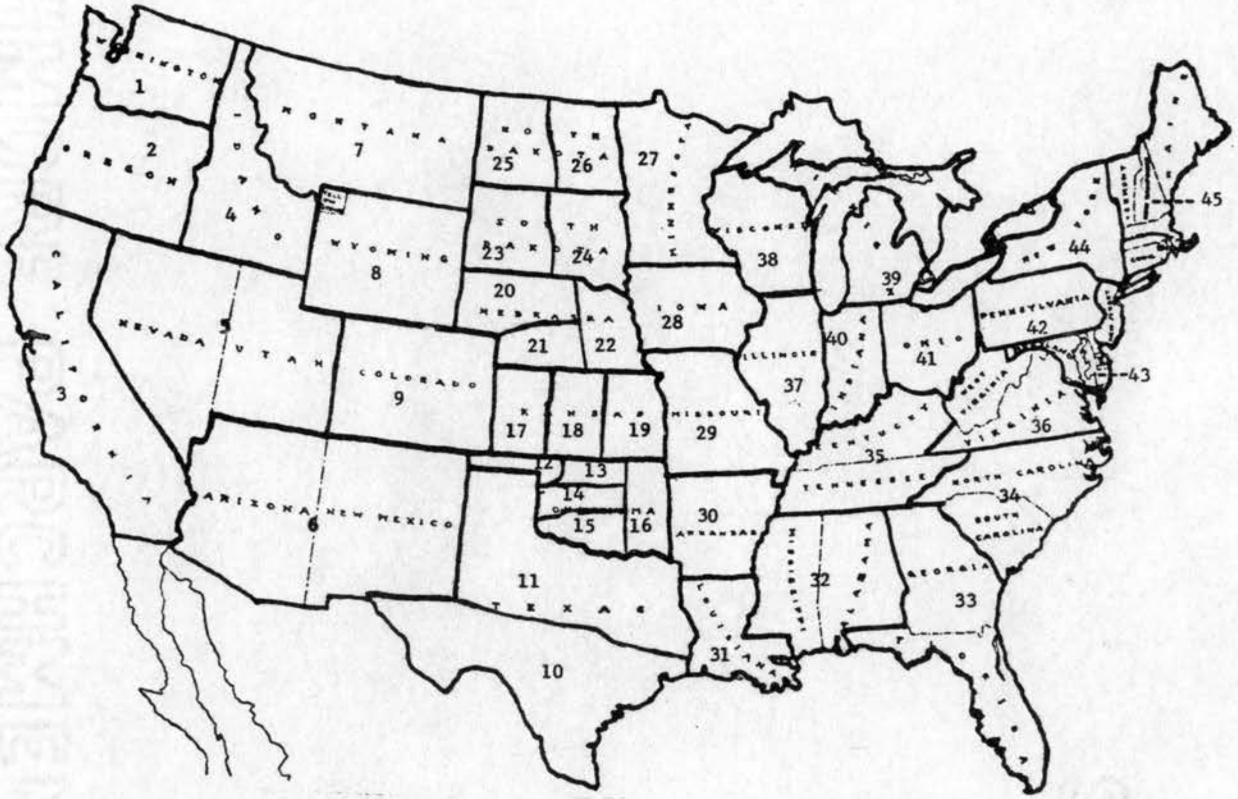

Figure 2. Regions Selected for Studying Interregional Competition in the Wheat Grain Economy.

TABLE I

ORIGINS AND DESTINATIONS SELECTED FOR STUDYING INTERREGIONAL COMPETITION IN THE WHEAT GRAIN ECONOMY

No.	Purpose[a]	Location	No.	Purpose[a]	Location
1	S	Spokane, Wash.	29	S	Sioux Falls, S.D.
2	D	Seattle, Wash.	30	S	Bismarck, N.D.
3	S	Pendleton, Ore.	31	SD	Fargo, N.D.
4	D	Portland, Ore.	32	SD	Minneapolis, Minn.
5	SD	Los Angeles, Calif.	33	SD	Des Moines, Iowa
6	SD	Boise, Idaho	34	D	Kansas City, Mo.
7	SD	Salt Lake City, Utah	35	S	Jefferson City, Mo.
8	SD	Albuquerque, N. M.	36	S	Little Rock, Ark.
9	SD	Billings, Montana	37	SD	New Orleans, La.
10	SD	Casper, Wyo.	38	SD	Mobile, Ala.
11	SD	Denver, Colo.	39	S	Jacksonville, Fla.
12	SD	Houston, Tex.	40	SD	Charlotte, N.C.
13	S	Amarillo, Tex.	41	SD	Nashville, Tenn.
14	D	Fort Worth, Tex.	42	D	Chicago, Ill.
15	S	Guymon, Okla.	43	S	Peoria, Ill.
16	SD	Enid, Okla.	44	SD	Milwaukee, Wis.
17	S	Oklahoma City, Okla.	45	D	Toledo, Ohio
18	S	Lawton, Okla.	46	S	Columbus, Ohio
19	S	Muskogee, Okla.	47	SD	Philadelphia, Pa.
20	S	Garden City, Kans.	48	D	Buffalo, N.Y.
21	S	Wichita, Kans.	49	D	New York, N.Y.
22	S	Topeka, Kans.	50	S	Utica, N.Y.
23	D	Salina, Kans.	51	SD	Baltimore, Md.
24	S	Scottsbluff, Nebr.	52	SD	Boston, Mass.
25	S	North Platte, Nebr.	53	SD	Indianapolis, Ind.
26	S	Lincoln, Nebr.	54	SD	Detroit, Mich.
27	D	Omaha, Nebr.	55	SD	Norfolk, Va.
28	S	Rapid City, S.D.			

[a]S represents a supply point, D represents a demand point, and SD represents both a supply and demand point. Demand for wheat fed on farms where grown and seed in each region was subtracted from their respective supplies.

Estimation of Regional Supply

Total supply for each class of wheat in any region was defined as:

$$S_{ij} = P_{ij} + B_{ij}$$

where:

S_{ij} = total supply of the i^{th} class of wheat in the j^{th} region;

P_{ij} = production of the i^{th} class of wheat in region j for 1962;

B_{ij} = available stocks of class i in region j as of January 1, 1962.

Estimation of Current Production

Data showing production by regions were available on a total wheat basis only. Therefore it was necessary to estimate the quantity of each class of wheat produced in each region. This was accomplished by adjusting acres of wheat harvested for each region. The distribution among classes of wheat at harvest was considered to be the same as at planting.[1] A 1959 survey[2] by the Department of Agriculture estimated the distribution among classes of wheat at planting by states. This distribution was used to derive regional estimates of production by classes for 1962. Appendix Table I shows the distribution of wheat among classes by regions.

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[1]Implicit in this assumption is the second assumption that the ratio of harvested acres to planted acres is the same for each class of wheat.

[2]United States Department of Agriculture, Agricultural Research Service, Distribution of the Varieties and Classes of Wheat in the United States in 1959, Statistical Bulletin 272 (Washington, November, 1960).

Data were available showing total harvested acres of all wheat by states for 1962.[3] These data along with the percentage estimates of Appendix Table I were used to estimate harvested acres of each class by producing regions. These estimates are shown in Appendix Table II. Regional estimates of production of each class of wheat were obtained by multiplying average production per acre[4] of each class of wheat by the estimated harvested acreage. The estimated production for Minnesota, North Dakota, South Dakota, Montana, and California was adjusted to correspond with published estimates of durum production.[5] The class estimates of production for each region were summed and checked against published estimates of total production for each region. This comparison showed no appreciable differences.

Estimation of Available Stocks

Twenty percent of the total stocks of each class of wheat was considered to be available.[6] In 1962, about 80 percent of all wheat stocks were government owned.[7] It was assumed that government stocks

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[3] United States Department of Agriculture, Statistical Reporting Service, Crop Reporting Board, Annual Crop Summary 1962 (Washington, December, 1962).

[4] Ibid.

[5] Ibid.

[6] The reason for limiting stock reduction to a given level was to prevent the depletion of stocks at favorable port locations before current production could move into the marketing channels.

[7] United States Department of Agriculture, Statistical Reporting Service, Crop Reporting Board, Stocks of Grain in All Positions (Washington, January and July, 1962).

moved into domestic trade subject to restrictions and thus were not considered free. Government stocks were, however, free to move into export trade. If government stocks did move into export trade, these stocks would be replaced by current production and the net effect would be zero.

The percentage distribution of stocks among classes was assumed to be the same as the percentage distribution of production in those regions not having a port of exit. The class estimates of available stocks for these regions were obtained by applying the percentage distributions of Appendix Table I to 20 percent of total wheat stocks in each region.

An adjustment was made for those regions having one or more port of exit. Estimation of available stocks by classes for those regions with ports of exit was made by using weighted percentages of production and exports. The weighted percentages for those regions with ports of exit are shown in Appendix Table III. These percentages were computed by weighting exports and production of each class of wheat according to the ratio of total exports to total production in the region.

The final step in estimating regional supply of wheat by classes was to aggregate current production and available stocks of each class within the region.

Estimation of Regional Demand for Wheat

The total demand for each class of wheat in any region was defined as:

$$D_{ij} = E_{ij} + M_{ij} + F_{ij}$$

where:

D_{ij} = total demand for the i^{th} class of wheat in the j^{th} region;

E_{ij} = demand for exports of the i^{th} class of wheat from region j;

M_{ij} = demand for milling of class i in the j^{th} region;

F_{ij} = use of wheat for feed on farms where grown and total used for seed of the i^{th} class of wheat in region j.

Demand for Exports

The demand for exports of each class of wheat was defined as the quantity actually exported from ports of exit in the region during the calendar year 1962. Hence, only those regions with ports of exit had an explicit demand for exports. For regions having more than one port of exit that shipped wheat in 1962, the sum of the exports was obtained and allocated to the port selected for the region. Published data were available showing exports of each class of wheat by port of exit for the calendar year 1962.[8] These data were used as published and no adjustments were made.

Demand for Milling

Data were not available showing the amount of each class of wheat by regions used for milling. However, data were available showing the total quantity of wheat milled in 24 regions.[9] These 24 regions accounted for 95 percent of the total millings in 1962. The remaining

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[8]United States Department of Agriculture, Agricultural Marketing Service, Grain Division, Grain Market News (Washington).

[9]U. S. Department of Commerce, Bureau of the Census, Current Industrial Reports, Series M20A (Washington).

five percent was allocated among the 24 regions in the same proportion as the 95 percent. This was done on the supposition that the additional five percent would be milled in regions bordering the 24 milling regions and the end result would not be significantly affected.

Historical data indicate that millers have not stored large quantities of flour relative to total millings. Thus millings approximated consumption and exports. The distribution of total wheat milled among classes was therefore approximately equal to the distribution of each class of flour consumed.

A recent study[10] by the Department of Agriculture indicated that hard flour made up about 66.2 percent of total consumption of flour, soft flour accounted for 29.4 percent, and durum made up 4.4 percent of total consumption. Considering these restrictions, the percentage distribution among classes milled in each region was derived using the production distribution for those regions having no port of exit. For those regions having a port of exit, the class distribution of millings was determined by the weighted percentages presented in Appendix Table III. These distributions were applied to the total quantity of wheat milled in each region.

Demand for Feed and Seed

Data on quantity of wheat fed to livestock in each region were available only for wheat fed on farms where grown. The amount of wheat

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[10] H. Wayne Bitting and Robert O. Rogers, "Utilization of Wheat for Food," Agricultural Economics Research, Vol. XV, No. 2 (Washington, April, 1963).

bought and sold for livestock feed off the farm was small relative to total marketings of wheat and was not considered in estimating the demand for wheat. The total amount of wheat fed to livestock on farms where grown was obtained from published data.[11] To estimate this useage on a class basis, it was assumed that the classes were used for feed in the same distribution as produced in each region. The quantities of each class of wheat used for feed on farms where grown were computed by applying the percentage estimates of Appendix Table I to total feed used in each region.

The same procedure outlined above also was used to estimate total class useage of wheat for seed. That is, the distributions presented in Appendix Table I were applied to total wheat used for seed in each region[12] to obtain class estimates.

Surplus and Deficit Regions for Each Class of Wheat

The estimated components of supply and demand for each class of wheat are presented in Tables II through VI. Comparison of quantity demanded with available supplies of each class of wheat was necessary in order to determine which regions were surplus and deficit regions. A region was considered surplus if $S_i > D_i$ and deficit if $S_i < D_i$.

The states of Oklahoma, Kansas, and Texas accounted for 64 percent of total hard red winter wheat surpluses. The major deficit regions in

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[11]United States Department of Agriculture, Statistical Reporting Service, Crop Reporting Board, Field and Seed Crops, Production Farm Use and Sales Value by States, 1961-62 (Washington).

[12]Ibid.

TABLE II

SUPPLY AND DEMAND COMPONENTS OF HARD RED WINTER WHEAT, BY REGIONS, 1962

	Region[a]	Production	20 Per-cent of Stocks	Feed and Seed	Export	Milling	Surplus*	Deficit*
				- Thousand Bushels -				
1	Spokane, Wash.	9,300	1,793	339	--	--	10,753	--
2	Vancouver, Wash.	--	--	--	16,695	6,587	--	23,282
3	Pendleton, Ore.	242	1,247	12	--	--	1,477	--
4	Portland, Ore.	--	--	--	12,756	4,257	--	17,013
5	Los Angeles, Calif.	--	138	--	2,371	1,981	--	4,214
6	Boise, Idaho	15,791	1,566	2,260	--	--	15,096	--
7	Salt Lake City, Utah	3,167	715	807	--	10,478	--	7,403
8	Albuquerque, N. M.	4,244	1,076	344	--	--	4,976	--
9	Billings, Mont.	31,117	5,662	2,061	--	2,443	32,275	--
10	Casper, Wyo.	4,063	953	409	--	--	4,608	--
11	Denver, Colo.	36,660	15,667	1,944	--	9,135	41,248	--
12	Houston, Tex.	652	449	45	194,468	--	--	193,412
13	Amarillo, Tex.	41,278	30,615	2,808	--	--	69,086	--
14	Fort Worth, Tex.	--	--	--	--	38,177	--	38,177
15	Guymon, Okla.	15,960	6,281	1,167	--	--	21,074	--
16	Enid, Okla.	23,066	9,136	1,697	--	21,552	8,953	--
17	El Reno, Okla.	18,278	7,137	1,326	--	--	24,089	--
18	Lawton, Okla.	12,213	4,829	897	--	--	16,144	--
19	Muskogee, Okla.	2,363	1,136	211	--	--	3,288	--
20	Garden City, Kans.	82,744	48,465	4,002	--	--	127,207	--
21	Wichita, Kans.	104,364	64,770	5,371	--	--	163,763	--
22	Topeka, Kans.	23,879	13,864	1,149	--	--	36,593	--
23	Salina, Kans.	--	--	--	--	102,989	--	102,989
24	Alliance, Nebr.	12,136	9,418	942	--	--	20,612	--

TABLE II (Continued)

Region[a]	Production	20 Percent of Stocks	Feed and Seed	Export	Milling	Surplus*	Deficit*
	- Thousand Bushels -						
25 North Platte, Nebr.	20,630	15,980	1,598	--	--	35,012	--
26 Lincoln, Nebr.	20,893	16,156	1,617	--	--	35,433	--
27 Omaha, Nebr.	--	--	--	--	17,804	--	17,804
28 Rapid City, S. D.	3,280	1,890	425	--	--	4,745	--
29 Sioux Falls, S. D.	1,658	1,197	269	--	--	2,586	--
32 Minneapolis, Minn.	483	433	46	--	1,383	--	513
33 Des Moines, Iowa	2,081	1,520	321	--	13,314	--	10,034
34 Kansas City, Mo.	--	--	--	--	36,253	--	36,253
35 Jefferson City, Mo.	17,648	6,934	1,913	--	--	22,669	--
36 Little Rock, Ark.	293	107	39	--	--	361	--
37 New Orleans, La.	6	3,665	2	89,893	--	--	86,223
38 Mobile, Ala.	--	423	--	44,596	--	--	44,173
39 Jacksonville, Fla.	7	1	2	--	--	7	--
40 Charlotte, N. C.	25	6	6	--	41	--	16
41 Nashville, Tenn.	364	76	69	--	1,344	--	973
42 Chicago, Ill.	--	--	--	--	27,847	--	27,847
43 Peoria, Ill.	28,304	3,177	1,951	--	--	29,530	--
44 Milwaukee, Wis.	106	277	28	--	--	355	--
45 Toledo, Ohio	--	--	--	--	83	--	83
46 Columbus, Ohio	81	13	9	--	--	84	--
47 Philadelphia, Pa.	80	29	19	363	81	--	354
48 Buffalo, N. Y.	--	--	--	--	1,429	--	1,429
49 New York City, N. Y.	--	--	--	221	--	--	221
50 Utica, N. Y.	--	174	--	--	--	174	--
51 Baltimore, Md.	11	12	2	118	--	--	97
53 Indianapolis, Ind.	864	65	66	--	404	458	--
54 Detroit, Mich.	120	18	12	10	71	45	--
55 Norfolk, Va.	88	545	23	1,891	494	--	1,775

[a]Regions not listed do not enter the hard red winter wheat market.

*Individual sums may not equal totals due to rounding.

TABLE III

SUPPLY AND DEMAND COMPONENTS FOR HARD RED SPRING WHEAT, BY REGIONS, 1962

	Region[a]	Production	20 Per- cent of Stocks	Feed and Seed	Export	Milling	Surplus*	Deficit*
				- Thousand Bushels -				
1	Spokane, Wash.	238	17	10	--	--	245	--
2	Vancouver, Wash.	--	--	--	--	66	--	66
3	Pendleton, Ore.	243	30	15	--	--	258	--
4	Portland, Ore.	--	--	--	227	111	--	338
6	Boise, Idaho	2,264	162	234	--	--	2,192	--
7	Salt Lake City, Utah	176	19	22	--	281	--	107
8	Albuquerque, N. M.	13	3	1	--	--	15	--
9	Billings, Mont.	40,095	6,978	2,540	--	2,994	41,539	--
10	Casper, Wyo.	417	86	37	--	--	465	--
11	Denver, Colo.	49	158	20	--	93	95	--
12	Houston, Tex.	--	--	--	117	--	--	117
24	Alliance, Nebr.	51	38	4	--	--	85	--
25	North Platte, Nebr.	21	16	2	--	--	35	--
26	Lincoln, Nebr.	39	32	3	--	--	68	--
27	Omaha, Nebr.	--	--	--	--	57	--	57
28	Rapid City, S. D.	4,310	1,304	293	--	--	5,321	--
29	Sioux Falls, S. D.	17,706	7,051	1,585	--	--	23,172	--
30	Bismarck, N. D.	51,975	5,447	2,637	--	--	54,785	--
31	Fargo, N. D.	46,943	6,736	2,385	--	3,703	47,590	--
32	Minneapolis, Minn.	15,816	14,500	1,440	2,212	46,562	--	19,897
33	Des Moines, Iowa	144	130	20	--	1,141	--	887
37	New Orleans, La.	--	141	--	3,462	--	--	3,321
38	Mobile, Ala.	--	46	--	1,979	--	--	1,933

TABLE III (Continued)

	Region[a]	Production	20 Per- cent of Stocks	Feed and Seed	Export	Milling	Surplus*	Deficit*
				- Thousand Bushels -				
41	Nashville, Tenn.	5	1	1	--	40	--	34
42	Chicago, Ill.	--	--	--	--	102	--	102
43	Peoria, Ill.	99	11	7	--	--	103	--
44	Milwaukee, Wis.	697	1,833	211	40	--	2,279	--
47	Philadelphia, Pa.	--	27	--	449	81	--	503
48	Buffalo, N. Y.	--	--	--	--	11,083	--	11,083
49	New York City, N. Y.	--	--	--	1,713	--	--	1,713
50	Utica, N. Y.	--	1,349	--	--	--	1,349	--
51	Baltimore, Md.	--	443	--	5,499	--	--	5,056
52	Boston, Mass.	--	286	--	1,162	--	--	876
54	Detroit, Mich.	--	482	--	7,341	1,742	--	8,601
55	Norfolk, Va.	--	111	--	391	105	--	385

[a]Regions not listed do not enter Hard Red Spring Wheat market.

*Individual sums may not equal total due to rounding.

TABLE IV

SUPPLY AND DEMAND COMPONENTS FOR SOFT RED WINTER WHEAT, BY REGIONS, 1962

	Region[a]	Production	20 Percent of Stocks	Feed and Seed	Exports	Milling	Surplus*	Deficit*
				- Thousand Bushels -				
1	Spokane, Wash.	204	15	7	--	--	211	--
2	Vancouver, Wash.	--	--	--	--	34	--	34
9	Billings, Mont.	76	14	5	--	7	78	--
12	Houston, Tex.	38	29	3	122	--	--	58
13	Amarillo, Tex.	1,720	1,276	117	--	--	2,879	--
14	Fort Worth, Tex.	--	--	--	--	1,116	--	1,116
18	Lawton, Okla.	61	24	5	--	--	81	--
19	Muskogee, Okla.	12	6	1	--	--	17	--
22	Topeka, Kans.	184	108	9	--	--	283	--
26	Lincoln, Nebr.	20	16	2	--	--	34	--
33	Des Moines, Iowa	29	21	3	--	131	--	84
34	Kansas City, Mo.	--	--	--	--	12,478	--	12,478
35	Jefferson City, Mo.	8,643	3,396	937	--	--	11,103	--
36	Little Rock, Ark.	2,786	1,011	366	--	--	3,431	--
37	New Orleans, La.	714	198	28	4,858	--	--	3,974
38	Mobile, Ala.	1,620	68	363	3,101	--	--	1,776
39	Jacksonville, Fla.	1,168	247	278	--	--	1,137	--
40	Charlotte, N. C.	6,215	1,392	1,465	--	3,233	2,909	--
41	Nashville, Tenn.	5,459	749	1,033	--	13,954	--	8,779
42	Chicago, Ill.	--	--	--	130	14,559	--	145
43	Peoria, Ill.	21,062	2,364	1,452	--	--	21,974	--
44	Milwaukee, Wis.	864	2,313	226	175	--	2,776	--
45	Toledo, Ohio	--	--	--	8,040	29,760	--	37,800
46	Columbus, Ohio	38,568	6,430	4,506	--	--	40,492	--

TABLE IV (Continued)

	Region[a]	Production	20 Percent of Stocks	Feed and Seed	Exports	Milling	Surplus*	Deficit*
				- Thousand Bushels -				
47	Philadelphia, Pa.	12,426	1,509	2,980	4,120	3,292	3,544	--
48	Buffalo, N. Y.	--	--	--	--	19,104	--	19,104
49	New York City, N. Y.	--	--	--	3,959	--	--	3,959
50	Utica, N. Y.	239	3,313	41	--	--	3,511	--
51	Baltimore, Md.	5,134	630	870	3,749	--	1,145	--
53	Indianapolis, Ind.	38,044	2,850	2,917	--	13,110	24,867	--
55	Norfolk, Va.	4,461	2,396	1,145	6,733	1,549	--	2,571
52	Boston, Mass.	--	175	--	1,907	--	173	--
23	Salina, Kans.	--	--	--	--	186	--	186
54	Detroit, Mich.	4,144	650	415	363	1,649	2,367	--

[a]Regions not listed do not enter Soft Red Winter Wheat market.

*Individual sums may not equal total due to rounding.

TABLE V

SUPPLY AND DEMAND COMPONENTS FOR WHITE WHEAT, BY REGIONS, 1962

	Region[a]	Production	20 Per- cent of Stocks	Feed and Seed	Exports	Milling	Surplus*	Deficit*
				- Thousand Bushels -				
1	Spokane, Wash.	56,653	6,835	2,118	--	--	61,370	--
2	Seattle, Wash.	--	--	--	40,311	17,663	--	57,974
3	Pendleton, Ore.	26,296	3,632	1,351	--	--	28,577	--
4	Portland, Ore.	--	--	--	28,004	8,721	--	36,725
5	Los Angeles, Calif.	8,880	1,284	544	1,658	13,008	--	5,046
6	Boise, Idaho	18,464	1,831	2,643	--	--	17,652	--
7	Salt Lake City, Utah	3,030	298	461	--	2,756	111	--
8	Albuquerque, N. M.	938	46	37	--	--	948	--
9	Billings, Mont.	549	55	20	--	20	564	--
10	Casper, Wyo.	45	11	5	--	--	51	--
34	Kansas City, Mo.	--	--	--	--	88	--	88
35	Jefferson City, Mo.	61	24	7	--	--	78	--
41	Nashville, Tenn.	39	10	8	--	200	--	158
54	Detroit, Mich.	25,701	4,000	2,575	1,737	10,158	15,231	--
45	Toledo, Ohio	--	--	--	3,623	818	--	4,441
46	Columbus, Ohio	39	178	5	--	--	212	--
47	Philadelphia, Pa.	123	164	29	2,538	356	--	2,637
51	Baltimore, Md.	17	265	3	3,218	--	--	2,938
48	Buffalo, N. Y.	--	--	--	--	39,112	--	39,112
49	New York City, N. Y.	--	--	--	1,999	--	--	1,999
50	Utica, N. Y.	6,592	6,789	1,138	--	--	12,244	--
55	Norfolk, Va.	--	619	--	2,187	412	--	1,980

[a]Regions not listed do not enter White Wheat market.

*Individual sums may not equal total due to rounding.

TABLE VI

SUPPLY AND DEMAND COMPONENTS FOR DURUM WHEAT, BY REGIONS, 1962

	Region[a]	Production	20 Percent of Stocks	Feed and Seed	Exports	Milling	Surplus*	Deficit*
		- Thousand Bushels -						
3	Pendleton, Ore.	22	1	1	--	--	22	--
4	Portland, Ore.	--	--	--	--	9	--	9
5	Los Angeles, Calif.	703	97	20	48	3,050	--	2,318
8	Albuquerque, N. M.	13	1	--	--	--	13	--
9	Billings, Mont.	6,380	1,161	423	--	1,085	6,034	--
12	Houston, Tex.	7	5	--	--	--	12	--
28	Rapid City, S. D.	206	65	15	--	--	257	--
29	Sioux Falls, S. D.	2,674	1,030	232	--	--	3,472	--
30	Bismarck, N. D.	11,284	1,429	506	--	--	12,207	--
31	Fargo, N. D.	48,298	6,143	2,175	--	4,334	47,932	--
32	Minneapolis, Minn.	1,683	1,597	111	601	11,174	--	8,607
54	Detroit, Mich.	--	243	--	3,674	1,919	--	5,350
37	New Orleans, La.	--	15	--	375	--	--	360

[a]Regions not listed do not enter Durum Wheat market.

*Individual sums may not equal total due to rounding.

hard red winter wheat for milling purposes were Salina with deficits of 103.0 million bushels and Fort Worth with 38.2 million bushels. Houston, New Orleans, and Mobile were the major deficit regions in hard red winter wheat for export purposes with deficits of 193.4 million bushels, 86.2 million bushels, and 44.2 million bushels, respectively.

Montana, North Dakota, and South Dakota accounted for 96 percent of total hard red spring wheat surpluses. Minneapolis, Buffalo, and Detroit represented the major deficit regions for hard red spring wheat with deficits of 19.9 million bushels, 11.1 million bushels, and 8.6 million bushels, respectively.

Illinois, Indiana, Ohio, and Missouri accounted for 80 percent of the surplus soft red winter wheat. Toledo with 37.8 million bushels, Buffalo with 19.1 million bushels, and Kansas City with 12.5 million bushels, represented the largest deficit areas for soft red winter wheat.

The major surplus states for white wheat, accounting for 98 percent of total white wheat surpluses, were Washington, Oregon, Idaho, Michigan, and New York. Seattle, Portland, and Buffalo represented the major deficit areas for white wheat with 58.0 million bushels, 36.7 million bushels, and 39.1 million bushels, respectively.

North Dakota accounted for 85 percent of total durum surpluses with 60.1 million bushels. Montana had the second largest durum surplus with 6.0 million bushels. The two states of Montana and North Dakota accounted for 94 percent of total durum surpluses. Only five regions were deficit for durum wheat. Minneapolis with 8.6 million bushels and Detroit with 5.4 million bushels, represented the major deficit regions.

Transportation Rates

The transportation model used in finding the least cost shipping structure for wheat requires that the lowest cost mode of transport be used between each pair of origins and destinations. Wheat is transported by either rail, truck, barge, or a combination of these three methods of transportation. The lowest cost mode of transport between each pair of origins and destinations was determined by comparing the cost of each method and combination of methods.[13]

Truck Rates

Wheat is an exempt commodity and trucks hauling wheat are not subject to Interstate Commerce Commission rulings. As a result, truck rates are extremely competitive, and it is difficult to determine a stable pattern in the rate structure. Examination of sample rates[14] indicated that the relationship between charges per bushel and distance traveled was of the general form $Y_t = a + bX$,

where:

Y_t = transportation charges in cents per bushel;

X = highway miles traveled.

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[13]It would have been desirable to have the exact rate applicable between each origin and destination, but this presents an almost impossible task. As a substitution for actual rates, equations were derived to estimate truck and rail transportation cost as a function of mileage.

[14]Rates were obtained from the transportation divisions of Union Equity Cooperative Exchange at Enid, Oklahoma, and the Tennessee Valley Authority.

The least squares estimating procedure was used to estimate the values of the parameters in the equation. The resulting equation,

$$\hat{Y}_t = 4.67 + \underset{(12.36)^{**}}{.02808X},$$

explained 97.2 percent of the variation in the sample. The coefficient of X (miles traveled) indicates that for each additional mile, transportation charges increase .02808 cents per bushel. Although all sample rates pertained to the southern and southwestern regions, the equation was considered to be valid for the entire United States. The above equation was used to compute all trucking charges used in the study.

Rail Rates

Preliminary examination of rail rates for wheat indicated that one estimating equation would not be satisfactory for determining rail charges. It was noted that the major producing areas had advantages in rail rates due to volume of shipments. Also, export rates were quoted for wheat moving to export markets and direction of movement had an influence on rail charges.

Five basic rail rate equations were estimated to account for the differences in rate structure among regions. These equations were estimated by least squares regression from carload waybill statistics published by the Interstate Commerce Commission.[15] The general form accepted to represent the data was $Y_r = ax^b$

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[15]Interstate Commerce Commission, <u>Mileage Block Distribution, Products of Agriculture</u> (Washington, 1960).

**The number in parenthesis is the statistic t-value which is significant at the 95 percent probability level.

where:

Y_r = transportation charges in cents per bushel;

X = short line miles traveled.

These equations were used to estimate the rail charges for any shipment originating in the respective region regardless of destination. Export rates were considered to be 70 percent of domestic rail charges[16] moving to the same point. The following equations were used to estimate the rail charges for shipments originating in the respective regions as shown in Figure 3.

Region I: $\log \hat{Y}_{r1} = .54255 + \underset{(8.4)^{**}}{.28811} \log X$ $(R^2 = .84)$

Region II: $\log \hat{Y}_{r2} = -.03208 + \underset{(7.62)^{**}}{.45790} \log X$ $(R^2 = .89)$

Region III: $\log \hat{Y}_{r3} = .39507 + \underset{(10.7)^{**}}{.43019} \log X$ $(R^2 = .87)$

Region IV: $\log \hat{Y}_{r4} = .72958 + \underset{(11.5)^{**}}{.29638} \log X$ $(R^2 = .91)$

Region V: $\log \hat{Y}_{r5} = -.05251 + \underset{(13.6)^{**}}{.59149} \log X$ $(R^2 = .91)$

The figures in parenthesis are the statistical t-values for the respective coefficients. The negative value of the constant term in two of the equations does not indicate negative charges for zero miles but indicates that the a-value is less than one when the logarithmic equations are stated in natural numbers. The positive coefficient of

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[16]The estimate of 70 percent was determined in a personal interview with Mr. Dick Warman, Chief Rate Clerk of Santa Fe Railroad Co., Oklahoma City. This is a rough estimate at best and is not valid in each specific case. It is felt, however, that it is a good approximation to the relationship between export and domestic rates in general.

**Statistically significant at the 95 probability level.

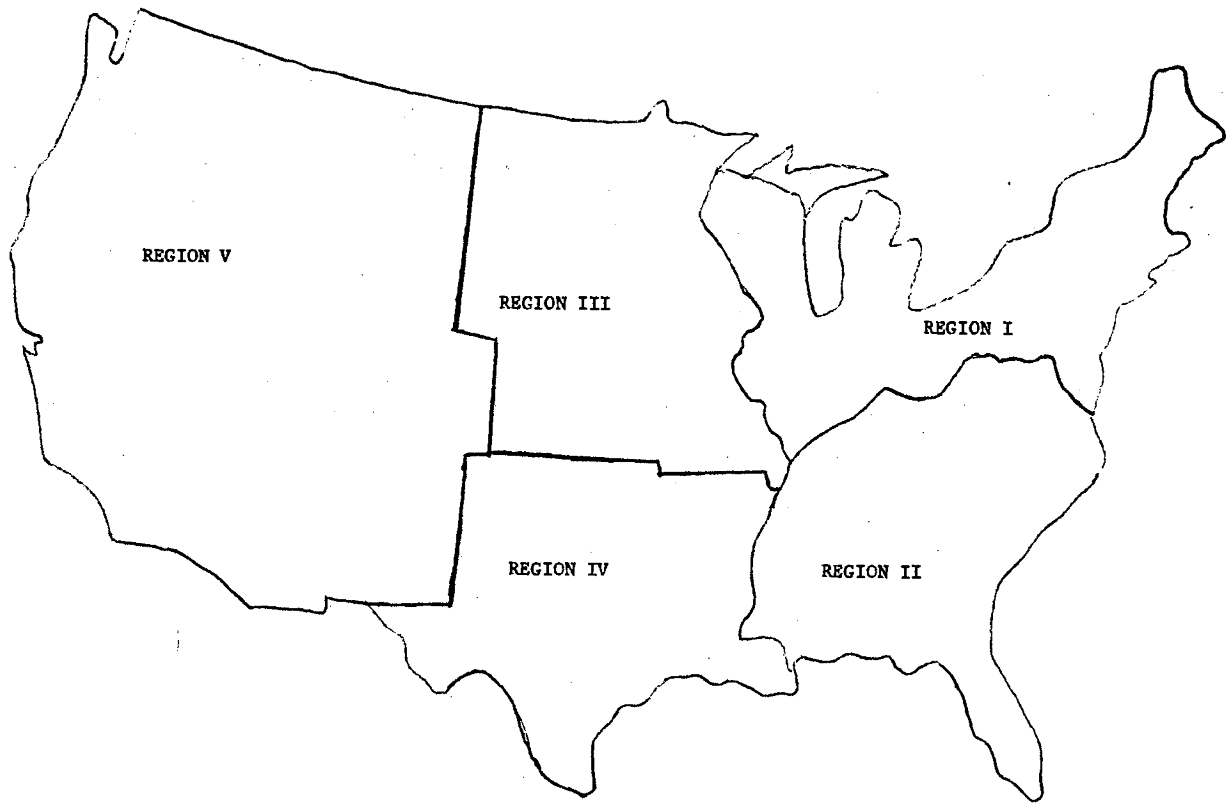

Figure 3. Rail Rate Territories Used in Study.

log X in each equation indicates that rail charges increase with mileage traveled. The estimated charges increase at a decreasing rate since distance traveled (X) is expressed in logarithmic form. Variation in the estimated transportation cost for a given distance denotes the relative advantage or disadvantage each territory has in rail rates.

Barge Rates

Only a few of the origins and destinations used in the study had facilities necessary to accomodate barge traffic. Most of these locations were situated along the Mississippi River. Actual barge rates between these points[17] were obtained and used in determining the least-cost mode of transportation. The method of transportation, selected on the basis of least cost, and the actual charges used between each region are shown in Appendix Table VI.

Results of Analysis

Optimum flows for each class of wheat were determined under two transportation conditions. First, the least cost method of transportation was used between each region. Second, trucks were restricted to distances of not more than 700 miles. This restriction was placed on trucks because at the present time trucks are not moving large quantities of wheat in excess of 700 miles.

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[17] Barge rates were obtained in correspondence with A. L. Meckling Barge Lines, Inc., Joliet, Illinois, and Federal Barge Lines, St. Louis, Missouri.

Hard Red Winter Wheat

Hard red winter wheat has been the predominant class of wheat grown in Oklahoma and other southern plains states. The total production, consumption, and exports of hard red winter wheat were larger than for any other class of wheat. Vast quantities of hard red winter wheat were exported from gulf ports in 1962. The demand for milling purposes was concentrated in the Mid-West and North Central regions.

Table VII shows the equilibrium solution for hard red winter wheat for 1962. The underlined figures in the cells of Table VII are the optimum flows of hard red winter wheat from surplus to deficit regions in 1,000 bushels. For example, the optimum flow solution indicates that Enid (16)[18] would ship 9.0 million bushels to Houston (12A), Boise (6) would ship 2.3 million bushels to Portland (4B), and so on.

The demand in each deficit region was separated into demand for exports and for domestic uses. The separation of demand into domestic and export uses in the deficit areas was done in order to investigate the competitive position each surplus region had in both the export and domestic market. An A is used to denote export demand and B indicates domestic demand. Thus 5A represents the export demand in Region V and 5B represents the demand for domestic uses in Region 5. Examination of Table VII shows which surplus regions would ship to domestic markets and which would ship to export markets under the optimum flow solution.

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[18]Numbers in parentheses following the city refer to the number of the origin or destination as specified in Table I.

TABLE VII

OPTIMUM FLOWS, EQUILIBRIUM PRICE DIFFERENTIALS, AND OPPORTUNITY COST OF ALTERNATIVE SHIPMENTS FOR HARD RED WINTER WHEAT, 1962[a]

Destination	Origin									
	1	3	6	8	9	10	11	13	15	16
2A	4166	4.7	4.7	18.2	12,529	8.2	13.4	13.2	10.9	15.8
2B	6587	4.7	4.7	18.2	0	8.2	14.5	28.6	26.0	31.4
4A	0	0	12,756	13.5	0	6.3	9.8	9.9	10.7	12.8
4B	0	1477	2340	13.5	440	6.3	9.8	24.8	24.3	28.1
5A	28.2	27.5	16.2	2371	13.9	9.1	10.4	9.5	8.5	13.6
5B	28.2	27.5	16.2	1843	13.9	9.1	10.4	14.1	15.1	23.5
7B	35.2	38.9	24.8	25.6	17.0	18.2	16.5	15.5	12.7	22.4
12A	49.2	52.5	41.8	0.5	21.7	13.5	5.7	52,550	0.8	8953
14B	53.5	55.9	42.7	1.7	21.7	13.5	5.7	0	0.8	0.1
23B	50.5	54.9	41.7	11.3	18.8	10.5	4.8	10.1	4.8	5.9
27B	49.2	55.0	41.8	18.1	17.4	10.0	7.7	17.0	11.7	12.5
32B	42.8	53.1	42.5	22.0	11.1	10.8	11.5	21.4	16.2	17.1
33B	48.4	54.9	41.7	17.9	16.7	9.5	7.6	16.4	11.3	11.5
34B	51.0	55.6	42.7	12.3	19.2	11.0	5.7	10.8	5.8	6.0
37A	47.4	50.3	40.0	3.6	18.6	11.2	5.7	1.7	1.0	0.6
38A	44.7	50.3	39.9	4.2	19.5	15.5	8.0	16,536	21,074	1.1
41B	56.1	60.7	47.5	12.9	24.4	16.1	10.9	11.0	8.7	7.2
42B	46.0	54.9	41.7	16.7	14.3	8.8	7.6	14.8	9.8	10.0
45B	47.2	55.8	42.6	16.5	15.3	9.9	8.4	14.6	10.1	9.5
47A	44.5	51.9	41.7	20.5	20.0	18.4	15.3	3.9	1.7	4.0
48B	47.9	56.5	43.3	16.3	16.1	10.6	8.7	14.2	10.3	9.3
49A	46.2	52.8	43.5	22.4	21.9	17.8	17.8	4.8	2.1	5.0
51A	45.3	52.4	42.5	21.3	21.0	16.6	14.5	4.3	2.0	4.9
55A	50.3	58.8	47.3	23.7	25.9	21.0	21.0	7.5	9.5	8.2
40B	54.7	60.9	47.7	13.2	22.9	16.4	11.0	11.3	9.3	7.7
Storage	15.9	20.5	13.9	762	19,306	4608	41,248	6.1	4.3	8.1
U_i	8.4	8.4	10.8	10.8	7.1	7.1	-0.3	7.5	7.5	0.0

TABLE VII (Continued)

Destination	Origin 17	18	19	20	21	22	24	25	26	28
2A	18.8	19.1	20.4	14.1	23.8	27.3	11.3	13.5	22.0	10.1
2B	34.8	34.8	36.4	24.9	34.3	38.4	13.3	18.4	30.5	10.8
4A	15.6	16.6	17.6	13.4	19.7	23.1	8.5	10.2	18.6	8.8
4B	31.2	32.3	33.4	20.2	29.6	33.7	10.0	13.9	26.4	10.8
5A	15.7	16.8	18.0	13.5	19.2	24.9	11.7	13.6	21.8	13.4
5B	25.7	25.2	31.2	15.6	23.3	31.8	12.8	16.7	29.2	16.5
7B	26.1	26.6	31.0	8.9	18.4	23.8	7403	3.9	16.4	3.7
12A	24,089	16,144	2.0	89,030	2646	7.0	9.3	4.6	7.4	12.2
14B	0.7	0	3.4	38,177	0.5	8.5	9.3	4.6	8.1	13.9
23B	9.8	13.0	13.0	0.1	102,989	4.8	5.4	0.3	3.3	9.6
27B	16.3	19.6	16.0	6.7	6.6	6.6	5.2	0.2	17,804	7.1
32B	20.7	24.3	19.6	10.7	11.2	11.6	7.8	3.9	4.6	3.8
33B	14.4	18.1	13.4	6.6	5.7	13.8	5.1	0.1	10,034	6.3
34B	8.8	12.5	7.8	1.4	0.1	36,253	5.8	0.8	0.7	9.1
37A	0.5	1.7	1.0	0.9	58,128	340	6.4	1.4	1.2	8.3
38A	1.0	2.3	3288	1.3	0.3	4.5	6.3	3.9	5.3	7.7
41B	7.8	10.5	5.9	5.2	3.0	5.2	11.0	5.9	5.8	14.0
42B	12.2	15.9	10.7	5.4	4.1	4.0	5.1	474	7595	4.4
45B	11.4	15.1	9.9	5.7	4.4	4.3	6.0	1.0	0.9	5.5
47A	6.0	7.5	15.9	6.6	8.0	10.4	6.9	4.8	7.4	6.9
48B	11.2	14.9	9.7	5.9	4.6	4.5	6.7	1.7	1.4	6.2
49A	7.0	8.3	8.0	7.9	9.5	11.9	8.2	6.1	9.1	8.1
51A	6.8	8.4	7.6	7.2	8.7	9.9	7.3	5.1	8.0	7.1
55A	10.1	10.8	10.6	11.6	12.6	16.4	11.5	9.5	13.5	11.8
40B	8.1	10.8	6.2	5.9	3.7	5.3	11.2	6.2	5.8	12.9
Storage	10.3	11.1	11.7	1.8	5.4	9.5	13,209	34,538	6.0	4745
U_i	-7.8	-7.8	-8.0	-3.6	4.4	15.1	6.8	5.6	11.0	16.8

TABLE VII (Continued)

Destination	Origin 29	35	36	39	43	44	46	50	53	54	V_j
2A	20.4	30.2	28.0	21.3	14.6	12.6	20.1	24.4	14.8	19.3	37.1
2B	26.7	45.1	44.5	32.7	24.4	22.3	30.3	34.8	24.5	29.2	37.1
4A	18.9	27.0	25.2	19.0	12.1	9.9	17.8	22.2	12.7	17.1	37.1
4B	26.7	40.5	41.5	30.1	21.8	19.4	28.0	32.6	22.6	27.1	37.1
5A	23.2	28.3	25.7	20.4	15.5	14.2	21.0	25.9	15.9	20.8	31.0
5B	31.8	37.7	40.6	30.6	25.1	23.9	31.0	36.4	25.6	30.8	32.8
7B	19.0	30.6	43.8	36.5	29.0	28.0	35.7	41.1	30.3	35.2	29.0
12A	13.2	9.5	7.5	11.5	10.9	10.3	17.2	22.1	11.3	16.7	26.4
14B	14.0	11.3	13.1	27.0	25.1	25.1	30.0	38.1	25.8	31.8	25.4
23B	9.1	11.7	25.8	37.7	27.8	30.2	37.6	44.0	31.6	38.2	35.3
27B	3.4	12.7	27.8	36.8	23.4	25.2	37.1	43.5	29.7	36.2	31.7
32B	513	12.2	29.0	33.4	20.1	16.2	32.0	38.2	25.4	30.7	31.7
33B	2.0	6.4	22.7	32.6	16.0	17.3	31.3	38.7	22.2	30.3	27.6
34B	5.3	3.1	18.1	31.6	19.0	22.8	32.3	39.5	23.0	32.1	37.1
37A	4.6	2.8	1.8	3.1	27,755	3.4	10.3	15.6	4.5	10.0	37.1
38A	9.2	2907	361	7	2.2	1.3	7.2	13.2	1.9	7.5	31.1
41B	9.8	973	5.9	14.9	9.8	11.3	13.9	26.9	6.5	18.0	37.1
42B	2073	17,668	15.3	21.0	2.2	37	12.6	26.4	4.6	11.3	31.3
45B	1.2	38	13.9	15.2	8.7	1.2	2.2	16.4	0.2	45	26.8
47A	8.2	6.2	11.8	1.6	0.5	6.5	3.0	4.8	354	3.7	18.9
48B	1.8	1067	13.6	8.8	4.2	1.9	84	174	104	0.7	13.0
49A	9.6	8.8	12.9	2.7	2.0	221	4.1	3.5	0.8	4.1	16.6
51A	8.4	5.4	12.1	2.0	1.6	97	3.9	6.8	0.7	4.6	18.3
55A	13.4	11.7	14.6	3.9	1775	3.4	7.6	11.4	3.9	8.4	12.0
40B	8.5	16	6.2	1.5	7.7	8.7	4.8	14.8	2.9	10.1	8.2
Storage	5.8	10.3	18.2	24.1	20.5	18.8	25.1	28.9	20.7	25.0	16.4
U_i	18.8	16.4	15.7	13.2	18.1	-20.3	-20.3	-21.2	16.6	23.2	

[a]Total shipments (1,000 bu.) = 672,285; total cost = $111,808,933. Numbers underlined are optimum flows in 1,000 bushels. Other numbers are cents per bushel.

The numbers in the cells of Table VII which are not underlined can be interpreted as the opportunity cost of initiating nonoptimum shipments. For example, total transportation cost would be increased 5.9 cents per bushel if Enid were to ship to Salina rather than to Houston.

The U_i's and V_j's have important implications in analysis of interregional competition.[19] First, the U_i values measure the comparative location advantage of the supply points relative to the base region (Enid, Oklahoma). For instance, hard red winter wheat is worth 21.2 cents per bushel more in Utica, New York than in Enid because of its proximity to the heavy consumption areas of the East. Second, the V_j values indicate the delivered price differentials relative to Region 16 for the deficit regions. Thus, the equilibrium price differentials estimated by the analysis implied that the price of hard red winter wheat would be 31.3 cents per bushel higher in Chicago (42B) than in Enid. The resulting price differentials obtained were the competitive equilibrium price differentials that would result from the 30 surplus regions attempting to sell their excess supplies to the 25 deficit regions at the maximum possible gain to the industry. Therefore, the optimum flows are simultaneous and interdependent.

Examination of Table VII shows the optimum market for each surplus region and the equilibrium flow pattern for hard red winter wheat. The

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[19] For an elaborate discussion of the interpretation of the U_i and V_j values, see G. G. Judge and T. D. Wallace, Spatial Price Equilibrium of the Livestock Economy, Oklahoma State University Technical Bulletin TB-78, Vol. 1 (Stillwater, 1959).

solution indicated that optimum markets for Oklahoma were the export markets of Houston (12A) and Mobile (38A). The regions represented by Enid (16), Oklahoma City (17), and Lawton (18) would ship to Houston. Regions represented by Guymon (15) and Muskogee (19) would ship to Mobile. Although no region in Oklahoma would ship wheat to New Orleans (37A), the opportunity cost of shipping to this market was less than two cents per bushel for each region.

The region represented by Enid supplied the milling demand for Oklahoma, but no other hard red winter wheat produced in Oklahoma moved to mills in the equilibrium solution. The opportunity cost was zero for Lawton (18) to ship to the milling market of Fort Worth (14). The opportunity cost was less than one cent per bushel for Enid (16), Guymon (15), and Oklahoma City (17) to enter the Fort Worth market. These opportunity costs suggested that Lawton could successfully compete for the Fort Worth market, and with very small decreases in transportation costs, the other three regions could compete for the market. No hard red winter wheat from Oklahoma was shipped to Fort Worth in the optimum solution due to the excessive demands at the gulf ports. Oklahoma had a poor competitive position for the milling markets at Salina (23B) and Kansas City (34B). Opportunity costs were from 8 to 13 cents per bushel for the regions in Oklahoma entering these markets.

The surplus wheat in the region represented by Amarillo (13) would be shipped to Mobile and Houston. The milling demand at Fort Worth was supplied by Garden City (20). This indicates that the closest markets are not necessarily optimum when total transportation cost is to be minimized.

The optimum markets for hard red winter wheat produced in Kansas were the export markets of Houston and New Orleans. The milling markets at Salina, Fort Worth, and Kansas City were also optimum for Kansas which supplied the total demand of these three milling points in the equilibrium solution. Mobile represented the best alternative market for Kansas hard red winter wheat. The equilibrium solution suggested that Denver (11), Casper (10), and Rapid City (28) had very unfavorable competitive positions and stored all their surplus hard red winter wheat. These regions faced opportunity costs ranging from 4 to 21 cents per bushel above the storage alternatives for entering any market. The opportunity costs faced by regions of western United States was high relative to other shipping points. Spokane (1), Pendleton (3), and Boise (6), had opportunity costs of from 20 to 58 cents per bushel for markets in central and eastern United States.

Optimum flows of hard red winter wheat with no restrictions on trucks are shown in Figure 4. The flow patterns show that wheat produced in the southern plains would supply milling demands in the midwest and the export demands of the gulf ports. North central regions shipped to markets of the north and east. Hard red winter wheat produced in the northern great plains and eastern slope of the rocky mountains for the most part would move into storage. Surplus hard red winter wheat produced in the Pacific Northwest would supply the export and milling demands of that region.

Optimum flows of hard red winter wheat with trucks restricted to 700 miles are shown in Figure 5. No significant changes in the general flow pattern were evident in the alternative solution. However, a few

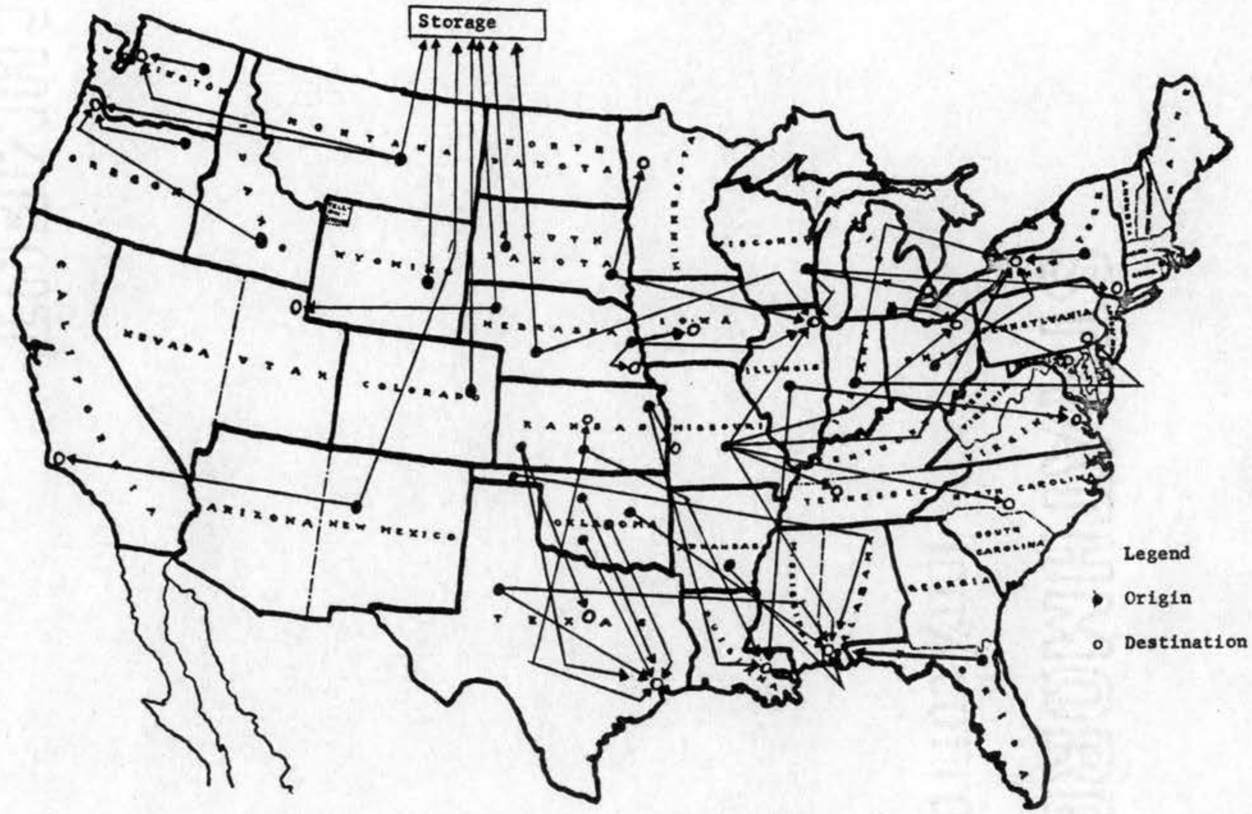

Figure 4. Optimum Flows of Hard Red Winter Wheat, 1962.

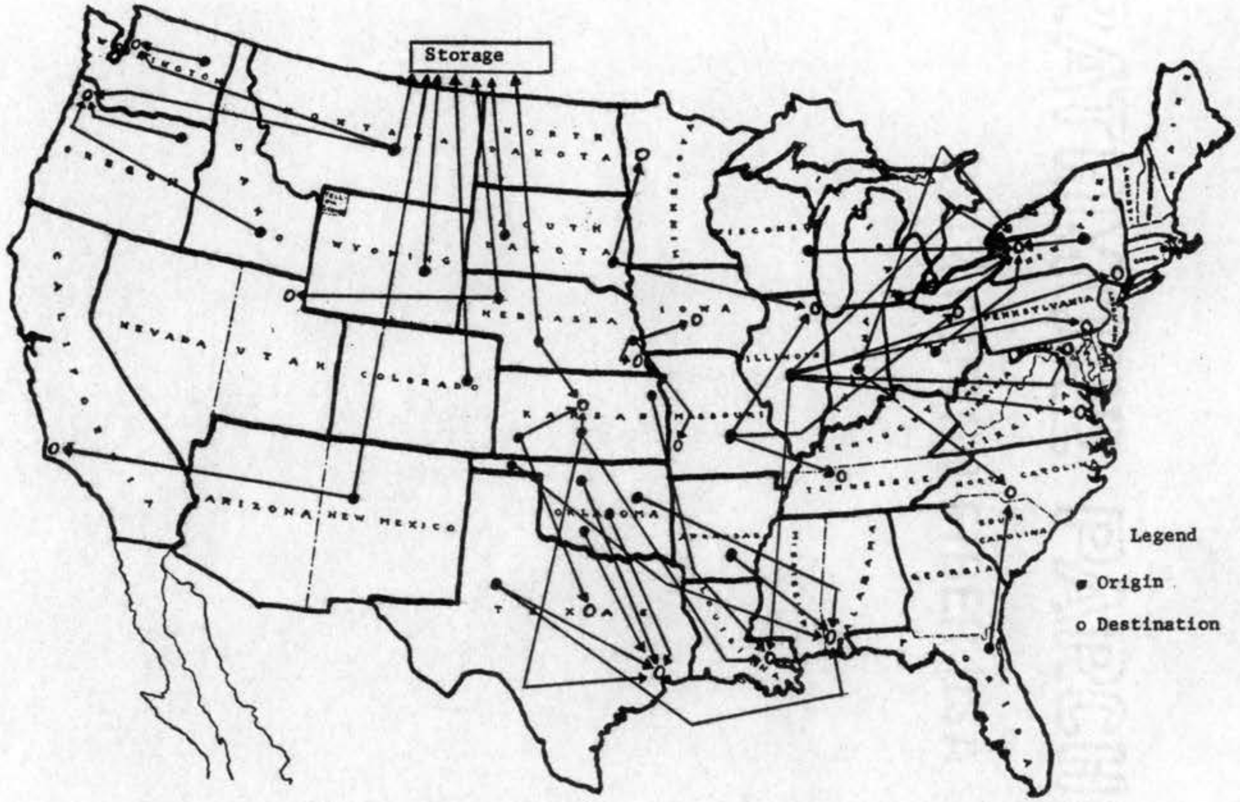

Figure 5. Optimum Flows of Hard Red Winter Wheat with Trucks Restricted to 700 Miles, 1962.

changes in specific movements did occur. The major changes included the milling demand at Kansas City being supplied by Nebraska rather than Kansas. Also, Garden City ceased shipping to Houston and shipped only to Salina and Fort Worth. No changes were observed in optimum markets for Oklahoma when trucks were restricted to 700 miles.

Hard Red Spring Wheat

Production of hard red spring wheat was concentrated in the north central United States. States of North Dakota, Montana, and South Dakota were the major surplus areas. The major demand for milling was located in the north central and northeastern United States. Most of the hard red spring wheat exported moved through the Great Lakes and Atlantic ports.

Optimum flows and equilibrium price differentials for hard red spring wheat are presented in Table VIII. The interpretation of U_i, V_j, and opportunity costs is the same as for Table VII.

Oklahoma, Kansas, and Texas produced no hard red spring wheat. Houston was the only demand point in the southern plains states. The export demand at Houston was supplied by producing regions in North Platte (25), Denver (11), and Albuquerque (8).

The results indicated that Billings (9), Casper (10), and the regions represented by Scottsbluff (24), Rapid City (28), and Bismarck (30), had unfavorable competitive positions and would have to store all surplus hard red spring wheat produced in these regions. The opportunity costs of marketing wheat in these regions was about 15 cents per bushel for most markets.

TABLE VIII

OPTIMUM FLOWS, EQUILIBRIUM PRICE DIFFERENTIALS, AND OPPORTUNITY COST OF ALTERNATIVE SHIPMENTS FOR HARD RED SPRING WHEAT, 1962[a]

Destination[b]	Origin 1	3	6	8	9	10	11	24	25
2B	66	4.7	6.7	39.3	15.9	24.1	30.4	29.2	35.4
4A	0	227	2.0	34.6	15.9	22.2	25.7	24.4	27.2
4B	80	31	2.0	34.6	15.9	22.2	25.7	25.9	30.9
7B	10.6	11.2	107	12.2	5.8	1.5	4.3	5.1	10.1
12A	27.5	30.9	22.2	15	16.0	7.8	67	3.6	35
27B	34.7	40.5	29.3	24.7	18.8	11.4	9.1	6.6	2.7
32A	32.7	42.7	34.4	33.0	16.9	16.6	17.3	13.6	10.8
32B	32.7	43.0	34.4	33.0	16.9	16.6	17.3	13.6	10.8
33B	35.3	41.8	30.6	25.9	19.5	12.3	10.4	7.9	4.0
37A	37.3	40.2	31.9	14.6	23.5	2.0	13.3	12.2	8.3
38A	24.4	30.0	21.6	5.0	15.1	11.1	3.6	1.9	0.6
41B	35.3	39.9	28.7	13.2	19.5	11.2	6.0	6.1	2.1
42B	34.9	43.8	32.6	26.3	19.1	13.6	12.4	9.9	5.9
47A	25.9	33.3	25.1	23.0	17.3	15.7	12.6	4.2	3.2
47B	35.9	44.3	33.1	23.7	20.0	14.4	11.3	10.4	6.4
48B	34.9	43.6	32.4	24.5	16.2	13.6	11.7	9.7	5.8
49A	26.7	33.3	23.3	24.0	18.3	17.4	14.3	4.6	3.6
51A	25.8	32.9	25.0	22.9	17.4	14.0	10.9	3.7	2.6
52A	27.8	34.3	27.1	25.8	19.6	20.2	15.7	6.1	5.3
54A	28.6	36.0	27.8	25.4	19.0	13.5	12.1	9.5	5.7
54B	34.9	43.5	32.4	25.9	19.0	13.5	12.1	9.6	5.7
55A	27.4	35.9	26.4	21.9	18.9	17.7	14.0	4.5	3.6
Storage	99	4.6	2085	5.2	41,539	465	28	85	1.1
U_i	0	2.4	2.4	2.1	20.7	-1.9	-1.5	-1.5	0.7

TABLE VIII (Continued)

Destination[b]	Origin 26	28	29	30	31	43	44	50	V_j
2B	45.5	18.5	29.7	19.4	24.9	47.3	41.8	50.8	26.8
4A	33.7	24.7	30.0	24.1	26.4	35.0	29.4	38.2	27.9
4B	41.4	26.7	37.8	27.5	33.1	44.7	38.9	48.6	15.9
7B	20.6	8.8	19.3	16.7	22.3	41.1	36.7	46.3	15.9
12A	0.8	6.5	2.7	9.1	7.0	12.2	8.2	16.5	27.7
27B	0.5	8.5	57	10.2	5.8	31.8	30.2	45.0	-12.8
32A	9.5	9.6	1.0	5.6	2212	30.6	24.1	36.2	-12.8
32B	9.5	9.6	1.0	5.6	17,685	32.9	25.6	44.1	12.8
33B	1.9	9.1	887	10.1	4.5	25.8	23.7	41.6	8.2
37A	6.1	14.1	5.6	5.6	3321	12.8	12.8	21.5	12.8
38A	34	3.3	1899	3.8	0.2	4.8	0.5	8.9	7.6
41B	34	9.1	0.1	8.6	3.0	11.9	10.0	22.1	12.8
42B	3.9	9.2	102	7.8	2.2	14.0	8.4	31.3	12.8
47A	3.1	4.2	0.7	2.3	0.2	5.4	449	1.3	12.8
47B	3.9	10.1	1.0	8.7	1.1	11.7	9.4	54	12.8
48B	3.5	9.2	11,083	7.8	2.2	14.2	8.5	3.1	11.7
49A	4.6	4.5	1.2	2.8	0.7	5.4	418	1295	7.7
51A	3.5	3.5	543	2.3	4259	5.0	254	3.3	12.8
52A	5.5	5.9	2.9	3.5	1.4	5.5	876	0.5	11.8
54A	3.6	6.3	7341	6.7	2.1	11.8	7.0	14.5	12.8
54B	3.6	9.1	1260	7.7	2.1	14.7	8.4	20.6	12.8
55A	5.6	4.8	1.6	3.2	1.1	103	282	4.5	-14.7
Storage	5.1	5321	1.0	54,785	20,113	27.5	22.4	29.0	-12.0
U_i	14.7	27.0	19.2	8.3	20.7	28.3	23.3	27.5	

[a]Total shipments (1,000 bu.) = 55,076; total cost = $12,901,358. Underlined numbers are optimum flows in 1,000 bushels; other numbers are in cents per bushel.

[b]An A represents export demand, B represents milling demand.

Optimum flows for hard red spring wheat with no restrictions on trucks are shown in Figure 6. The major flows were from the northern plains states of Nebraska and South Dakota to the export markets of the gulf ports and to milling and export points in the East and Northeast.

Optimum flows for hard red spring wheat when trucks were restricted to 700 miles are shown in Figure 7. No changes in the general flow patterns resulted; however, a few changes in actual shipments did occur. These changes included the region represented by Lincoln (26) shipping to Houston, rather than Mobile. Peoria would ship to Buffalo instead of Norfolk, and Sioux Falls would begin shipping to Norfolk.

Soft Red Winter Wheat

The production of soft red winter wheat was scattered throughout the eastern half of the United States with concentrated production areas in Illinois, Indiana, and Ohio. The greatest demand for milling and export occurred in the Great Lakes area, but considerable quantities were also demanded in regions of the south and southeast.

Optimum flows and equilibrium price differentials for soft red winter wheat are shown in Table IX. Soft red winter wheat was produced in only two of the five regions of Oklahoma. The milling market of Kansas City (34) was the optimum market for the region represented by Muskogee (19). The optimum market for Lawton (18) was the milling market of Fort Worth. Muskogee had opportunity costs of .2 and .4 cents per bushel for shipping to Fort Worth (14) and Salina (23), respectively. However, Lawton had an opportunity cost of 3.6 cents per bushel for its second best market at Salina.

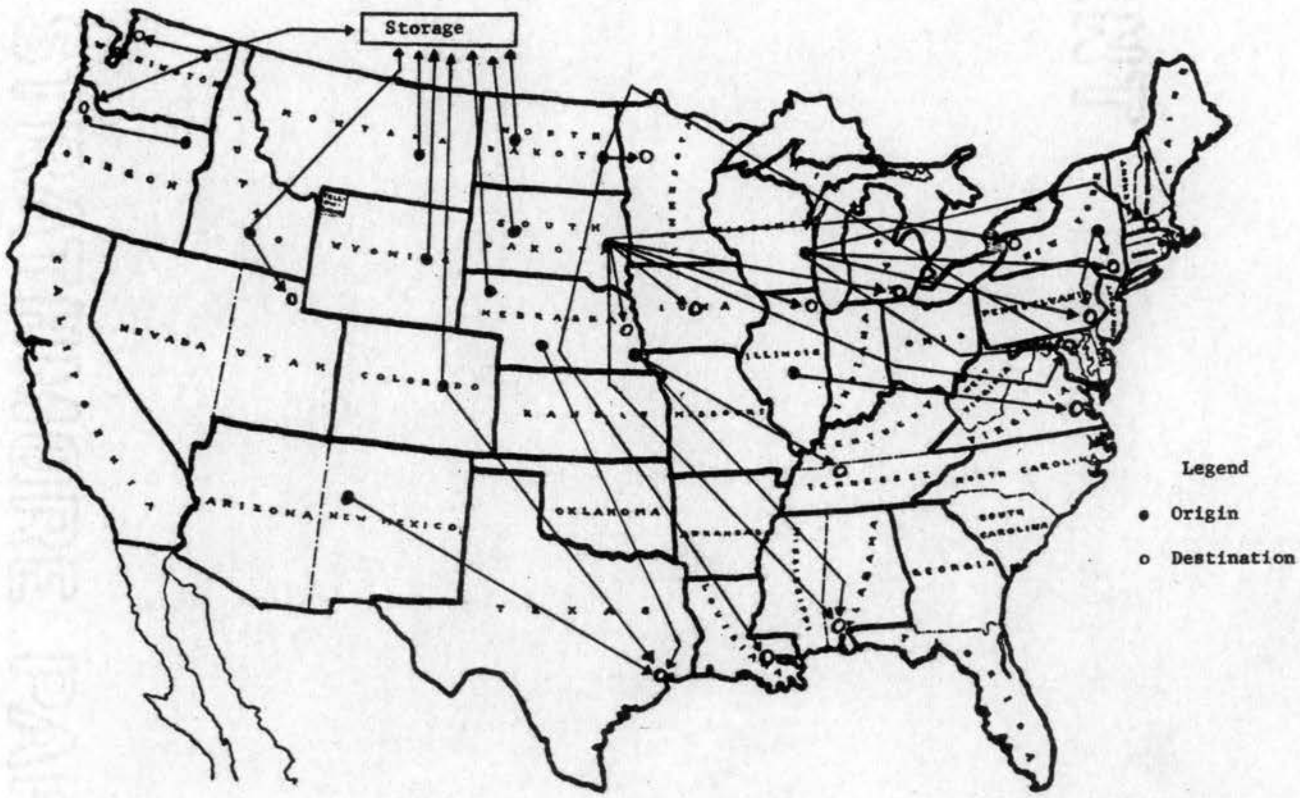

Figure 6. Optimum Flows of Hard Red Spring Wheat, 1962.

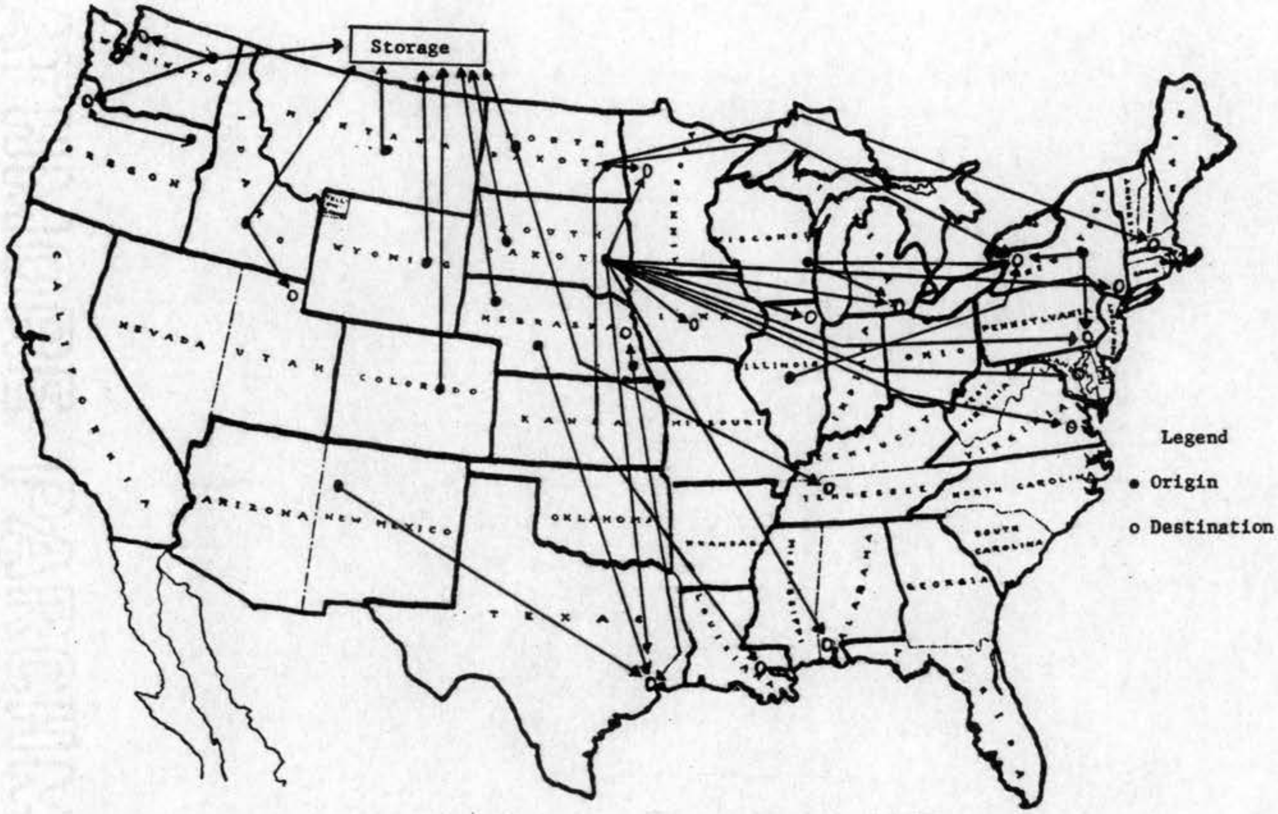

Figure 7. Optimum Flows of Hard Red Spring Wheat with Trucks Restricted to 700 Miles, 1962.

TABLE IX

OPTIMUM FLOWS, EQUILIBRIUM PRICE DIFFERENTIALS, AND OPPORTUNITY COSTS OF ALTERNATIVE SHIPMENTS FOR SOFT RED WINTER WHEAT, 1962[a]

	Origin										
Destination[b]	1	9	13	18	19	22	26	35	36	39	40
2B	34	7.7	35.6	44.6	43.0	52.8	46.4	56.4	42.4	29.0	27.1
12A	43.8	32.2	4.4	4.4	3.2	16.0	17.9	15.4	58	2.7	2.2
14B	43.7	27.8	1305	81	0.2	13.1	14.2	12.8	1.2	13.8	12.7
33B	37.0	21.2	14.8	16.5	8.6	16.8	4.5	6.3	9.2	17.8	14.2
34B	36.6	20.7	6.2	7.9	17	131	2.2	11,103	1.6	13.8	10.9
37A	47.7	35.0	10.9	11.8	7.9	14.7	17.4	14.4	3373	429	0.0
38A	48.5	39.2	13.6	15.9	10.4	22.7	25.0	15.1	1.7	708	1068
41B	54.4	38.6	19.1	18.6	10.8	17.9	20.0	9.6	2.1	9.8	6.3
42A	45.7	33.1	22.1	26.1	20.2	21.3	18.8	14.2	15.8	13.7	9.9
42B	48.9	33.1	27.9	28.6	20.2	21.3	18.8	14.2	15.8	20.6	16.0
45A	45.8	35.9	21.2	24.9	20.4	23.3	21.4	15.9	16.4	9.7	5.6
45B	51.8	35.9	29.0	29.5	21.1	23.3	21.4	15.9	16.4	16.4	11.4
48B	54.7	38.8	30.8	31.5	23.1	25.7	24.1	18.1	18.3	12.2	6.3
49A	55.5	47.1	23.9	27.6	23.9	35.6	34.3	29.4	20.1	8.6	3.4
55A	55.1	46.6	22.1	25.4	22.0	35.6	34.2	27.8	17.3	5.3	1841
23B	31.3	15.5	0.7	3.6	0.4	152	34	3.8	53.0	15.1	11.5
Storage	177	78	1844	5.0	2.4	8.0	6.0	5.7	0.2	4.8	2.7
U_i	0.0	4.5	1.4	-1.0	1.8	4.3	2.9	0.1	-5.7	-5.7	-2.0

TABLE IX (Continued)

Destination[b]	Origin 43	44	46	47	50	51	53	54	52	V_j
2B	19.8	19.4	23.5	26.2	28.0	27.7	19.7	24.6	24.2	7.8
12A	0.9	2.0	4.3	7.3	9.9	5.8	1.1	6.7	5.8	10.4
14B	10.7	12.4	13.4	10.8	21.5	16.6	11.3	17.4	18.0	4.8
33B	84	3.0	13.1	19.0	20.5	18.0	6.0	14.3	17.7	6.8
34B	1227	5.5	11.1	16.6	10.3	13.8	3.8	13.1	15.4	7.1
37A	0.4	0.8	3.8	6.1	9.1	3.9	172	5.7	7.8	12.6
38A	1.4	2.2	4.2	6.9	10.2	4.4	0.9	6.7	5.7	8.0
41B	3.5	6.7	5.4	15.6	18.4	11.0	8779	12.5	14.0	10.1
42A	0.5	130	8.2	13.9	15.5	17.2	2.7	9.6	12.4	12.8
42B	0.5	15	8.7	21.2	22.5	21.1	2.7	9.6	18.1	12.8
45A	2.9	2.1	0.0	8.6	10.1	5.5	5673	2367	7.4	10.4
45B	8.7	2.9	25,072	12.5	13.6	10.6	4688	0.0	8.0	8.7
48B	6.4	5.8	15,420	2.7	3511	2.4	2.0	2.9	173	6.6
49A	6.7	6.4	6.6	3544	6.0	415	5.3	8.8	0.2	8.3
55A	0.2	5.3	5.6	33.0	9.4	730	3.9	8.6	4.7	12.8
23B	4.0	8.1	11.6	16.7	18.0	14.1	7.6	14.4	15.7	8.3
Storage	20,663	2631	2.4	4.1	6.2	45.0	5555	6.5	17.7	11.3
U_i	-2.0	3.6	-1.3	0.0	3.0	-12.8	12.8	12.8	12.8	

[a]Total shipments (1,000 bu.) = 92,064; total cost = $9,837,528. Underlined numbers are optimum flows in 1,000 bushels; all other numbers are cents per bushel.

[b]An A represents export demand, B represents milling demand.

Surplus soft red winter wheat in Kansas would move to Salina and Kansas City for milling. The surplus soft red winter wheat in Texas would go to storage and to Fort Worth for milling. The export demand at Houston was supplied by Little Rock (36) with Amarillo (13) facing a 4.4 cents per bushel opportunity cost for entering the market.

There was no change in the optimum flow pattern or equilibrium price differentials for soft red winter wheat when trucks were restricted to 700 miles. A possible explanation for this is that demand points were located relatively close to supply points, and trucks did not transport soft red winter wheat great distances in the unrestricted solution. The optimum flows of soft red winter wheat are presented in Figure 8.

White Wheat

The production of white wheat occurred throughout the western United States but was concentrated in the Pacific Northwest. Considerable production of white wheat occurred in Michigan and New York. The major points of export demand were Washington and Oregon. Some white wheat was exported through the Great Lakes and Atlantic ports. New York, Michigan, Washington, and California were the principal milling states for white wheat.

White wheat was the only class of wheat for which demand exceeded supplies as defined by the study. Therefore, a dummy origin was used to equate total supply and demand for white wheat. The deficit regions supplied by the dummy origin in the optimum flow solution can be regarded as the least profitable demands for the surplus regions to supply. The movement from the dummy origin to a deficit region indicates that stocks would be reduced in the deficit region if available.

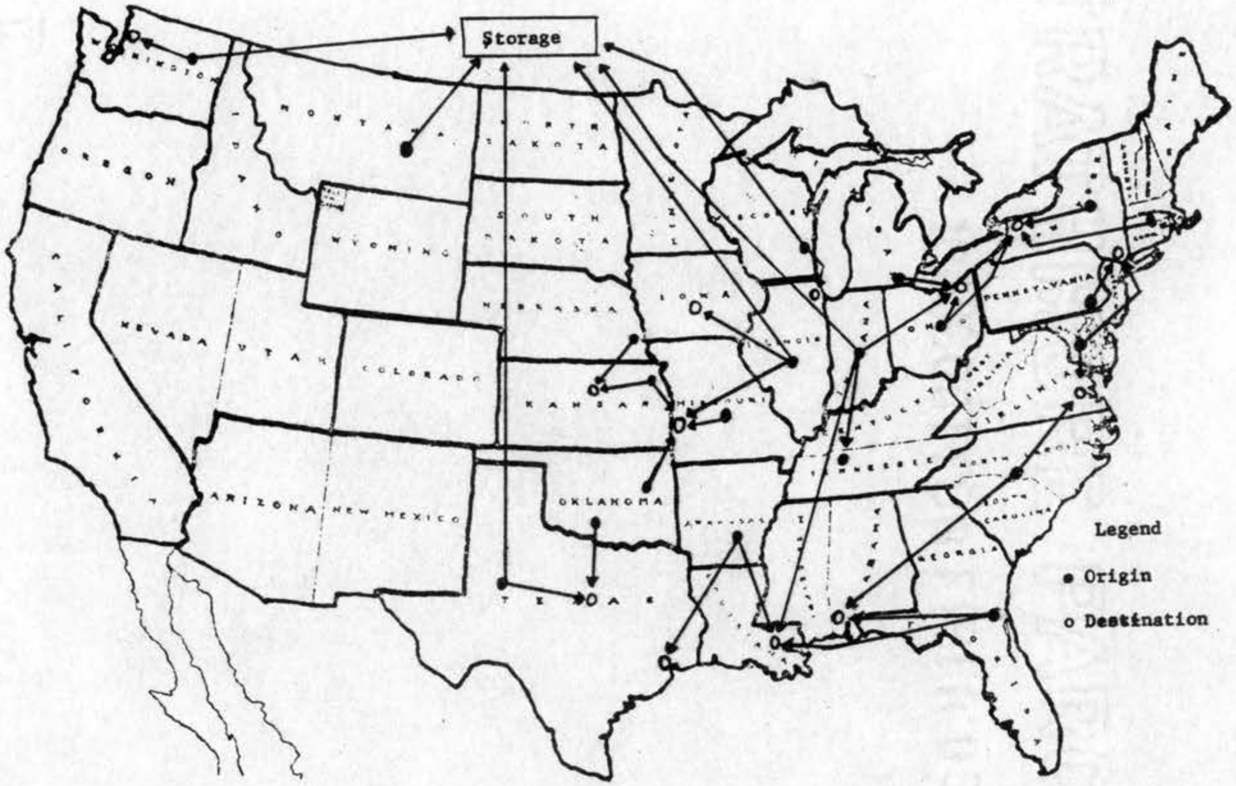

Figure 8. Optimum Flows of Soft Red Winter Wheat, 1962.

The optimum flows and equilibrium price differentials for white wheat with no restrictions on trucks are shown in Table X. White wheat was neither produced nor demanded in the southern plains regions. The largest quantity was shipped from Spokane (1) to Seattle (2). These quantities were 40.3 million bushels for exports and 17.7 million bushels for milling (Table X).

Optimum flows of white wheat with no restrictions on trucks are shown in Figure 9. The demand being greater than supplies and surplus areas being so distant from demand points resulted in white wheat moving almost transcontinental from west to east.

Optimum flows of white wheat with trucks restricted to 700 miles are presented in Figure 10. Some specific changes did result even though the general flow pattern did not change. These include Salt Lake City (7) shipping to Los Angeles (5) rather than Buffalo (48). Boise (6) limited eastward shipments only to Toledo (45) rather than Norfolk (55), Baltimore (51), Philadelphia (47), and New York City (49). The latter markets were taken over by Casper (10), Albuquerque (8), and the dummy origin.

Durum Wheat

Durum wheat accounted for a small portion of total production and consumption of wheat in the United States. Practically all durum wheat was produced in North Dakota, Montana, and South Dakota. The main demand for milling was located at Minneapolis and Fargo. Considerable milling was also done in California. Most all durum wheat exports moved through the Great Lakes ports.

TABLE X

OPTIMUM FLOWS, EQUILIBRIUM PRICE DIFFERENTIALS, AND OPPORTUNITY COSTS OF ALTERNATIVE SHIPMENTS FOR WHITE WHEAT, 1962[a]

Destination[b]	Origin 1	3	6	7	8	9	10	35	54	46	50	Dummy	V_j
2A	40,311	4.7	4.7	21.8	43.0	27.4	50.3	71.9	60.3	61.8	66.1	52.1	49.8
2B	17,663	4.7	4.7	21.8	43.0	27.4	50.3	86.8	70.2	72.0	76.5	52.1	52.1
4A	245	27,759	0.0	17.1	38.3	27.4	48.4	68.7	58.2	60.1	63.9	49.7	51.5
4B	3,151	0.0	5,570	17.1	38.3	27.4	48.4	82.2	68.2	70.5	74.3	49.7	52.1
5A	12.0	11.3	1,658	2.6	8.6	25.1	35.0	53.8	45.6	46.5	51.4	37.2	12.8
5B	12.0	11.3	3,388	2.6	8.6	25.1	35.0	63.2	55.6	56.5	61.9	37.2	8.2
34B	13.9	18.5	5.3	3.7	88	9.5	16.0	7.7	36.0	36.9	44.2	27.6	14.8
41B	18.4	23.0	9.8	8.3	158	14.1	20.5	4.0	21.3	17.9	30.9	16.0	7.9
45A	25.8	23.6	13.3	19.1	17.6	564	51	12.0	32.3	117.4	84.8	3,008	3.9
45B	3.9	818	68.4	79.5	0.6	2.1	11.3	1.0	0.3	3.0	17.4	8.8	1.3
47A	2.8	10.2	2,538	2.8	3.6	5.7	18.8	6.2	3.0	3.0	3.9	2.0	-13.4
47B	12.1	20.5	7.3	5.7	3.6	7.7	16.8	4.2	6.0	3.8	1.9	99	-23.3
51A	2.8	10.0	2,938	2.9	3.6	5.9	17.2	5.2	3.1	4.1	6.5	2.3	-37.3
48B	6.2	14.8	1.6	111	3.6	7.7	16.8	78	15,231	212	12,244	11,236	-38.1
49A	2.7	9.4	1,297	2.9	702	2.4	11.6	7.0	1.6	2.5	1.7	0.6	-41.9
55A	3.0	11.5	263	2.8	1.2	6.0	20.1	6.1	2.1	2.0	5.8	1,717	46.9
U_i	0.0	0.0	2.4	2.4	14.9	14.9	24.5	36.1	19.7	43.3	50.1	52.1	

[a]Total shipments (1,000 bu.) = 152,999; total cost = $37,483,639. Underlined numbers are optimum flows in 1,000 bushels; other numbers are cents per bushel.

[b]An A represents export demand, B represents milling demand.

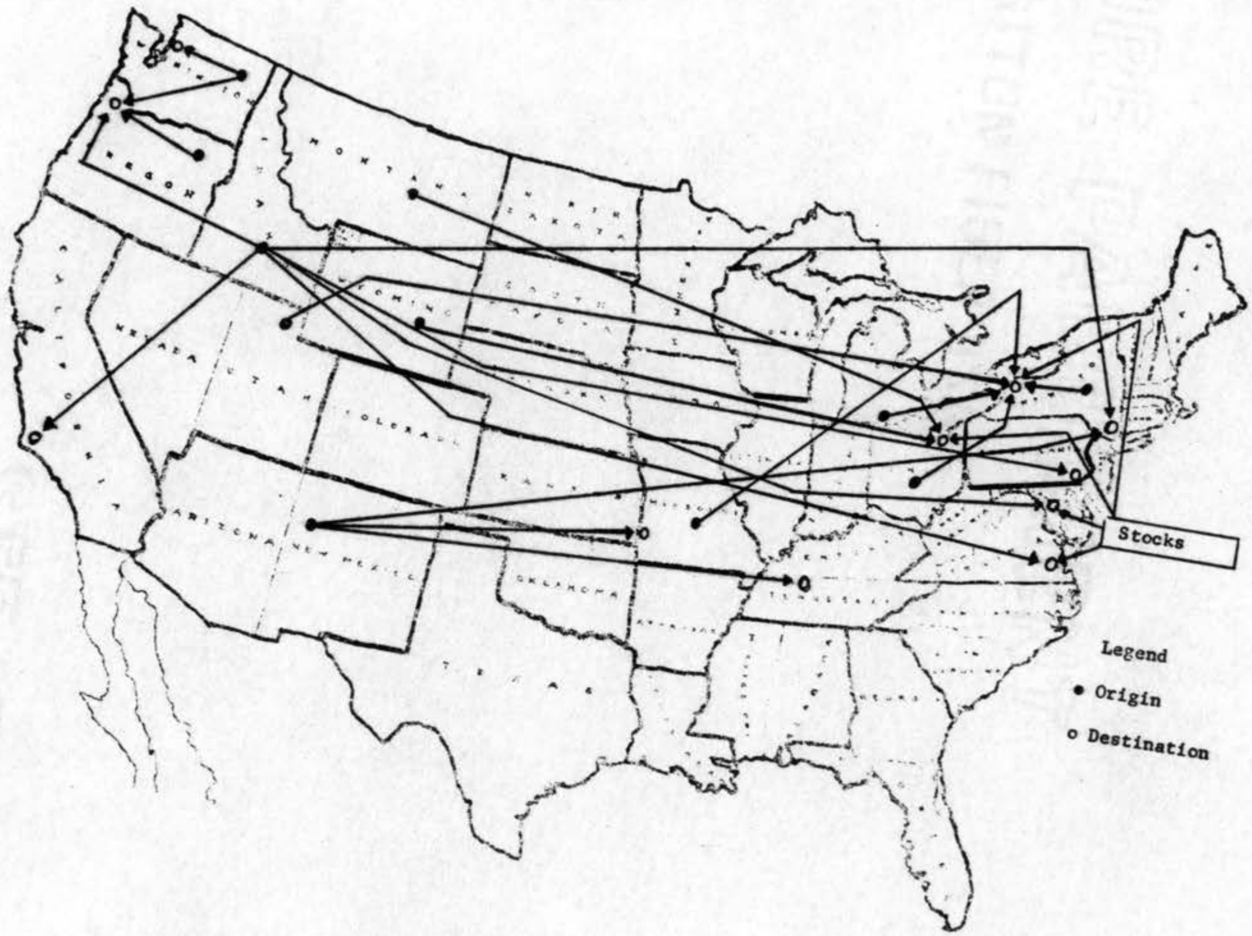

Figure 9. Optimum Flows of White Wheat, 1962.

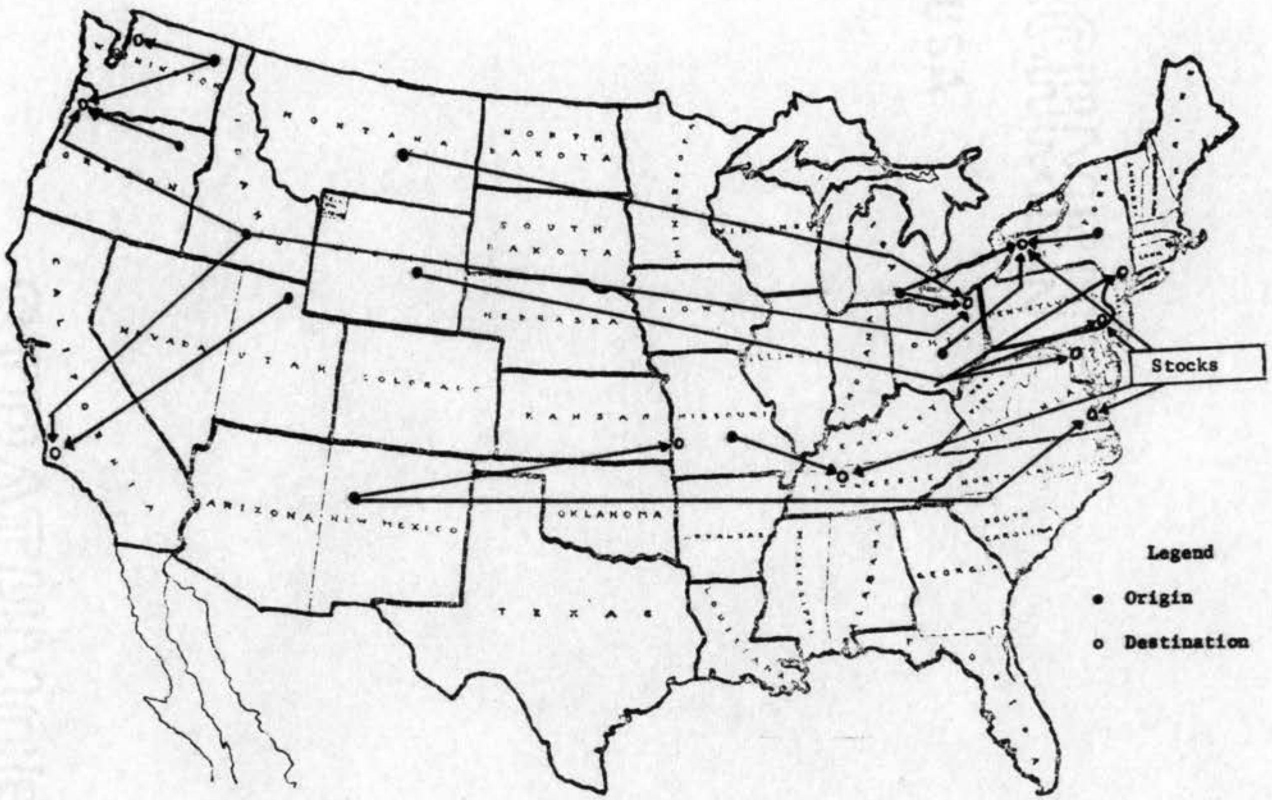

Figure 10. Optimum Flows of White Wheat with Trucks Restricted to 700 Miles, 1962.

The equilibrium solution for durum wheat is shown in Table XI. The solution suggested that Rapid City (28) had an unfavorable competitive position and would have to store all its surplus durum wheat. Opportunity costs were from .4 to 24 cents per bushel above the storage alternative for the region. Fargo (31) shipped durum wheat to New Orleans (37A), Minneapolis (32B), and Detroit (54B). The demand at Los Angeles (5) was supplied by Albuquerque (8), Billings (9), and Pendleton (3). Optimum flows of durum wheat with no restriction on trucks are shown in Figure 11.

Restricting trucks to 700 miles reversed the competitive position of Rapid City and Billings. In the alternative solution, Billings would store all its surplus durum wheat. Rapid City would replace Billings in the Los Angeles market. This reversal stemmed from the advantage that Rapid City had in rail rates. The optimum flow results of the alternative solution are shown in Figure 12.

Summary

Results presented in this chapter were derived on the basis of minimizing only transportation costs for the entire industry. Thus, the optimum markets as specified by the equilibrium solution for any particular producing region may not be the best market if the region were considered separately. The results of the analysis implied that Oklahoma had a very favorable competitive position in wheat marketing. All surplus wheat produced in Oklahoma would be marketed in the optimum flow solution. On the other hand, the states of Colorado, Wyoming,

TABLE XI

OPTIMUM FLOWS, EQUILIBRIUM PRICE DIFFERENTIALS, AND OPPORTUNITY COSTS OF ALTERNATIVE SHIPMENTS FOR DURUM WHEAT, 1962[a]

Destination[b]	Origin 3	8	9	12	28	29	30	31	V_i
4B	9	41.0	13.6	61.3	24.4	37.6	25.2	40.8	-17.5
5A	13	13	22	15.5	9.5	16.6	13.4	15.3	10.6
5B	0.0	0.0	2270	29.9	2.6	15.2	10.5	16.0	3.6
32A	45.0	41.7	16.9	33.0	9.6	3.1	5.6	601	17.5
32B	45.3	41.7	16.9	40.3	9.6	3.1	5.6	8006	4.4
54A	36.2	32.0	16.9	14.2	4.2	3472	5.5	202	17.5
54B	48.1	36.9	21.3	27.6	11.4	4.4	1676	4.4	14.4
37A	42.2	22.9	16.5	12	7.0	7.3	5.6	348	17.5
Storage	6.9	13.9	3742	13.1	257	3.1	10,531	38,775	17.5
U_i	0.0	23.8	23.8	-6.2	-6.2	13.3	8.9	10.4	

[a]Total shipments (1,000 bu.) = 16,644; total cost = $3,493,467. Underlined numbers are optimum flows in 1,000 bushels; other numbers are cents per bushel.

[b]An A represents export demand, B represents milling demand.

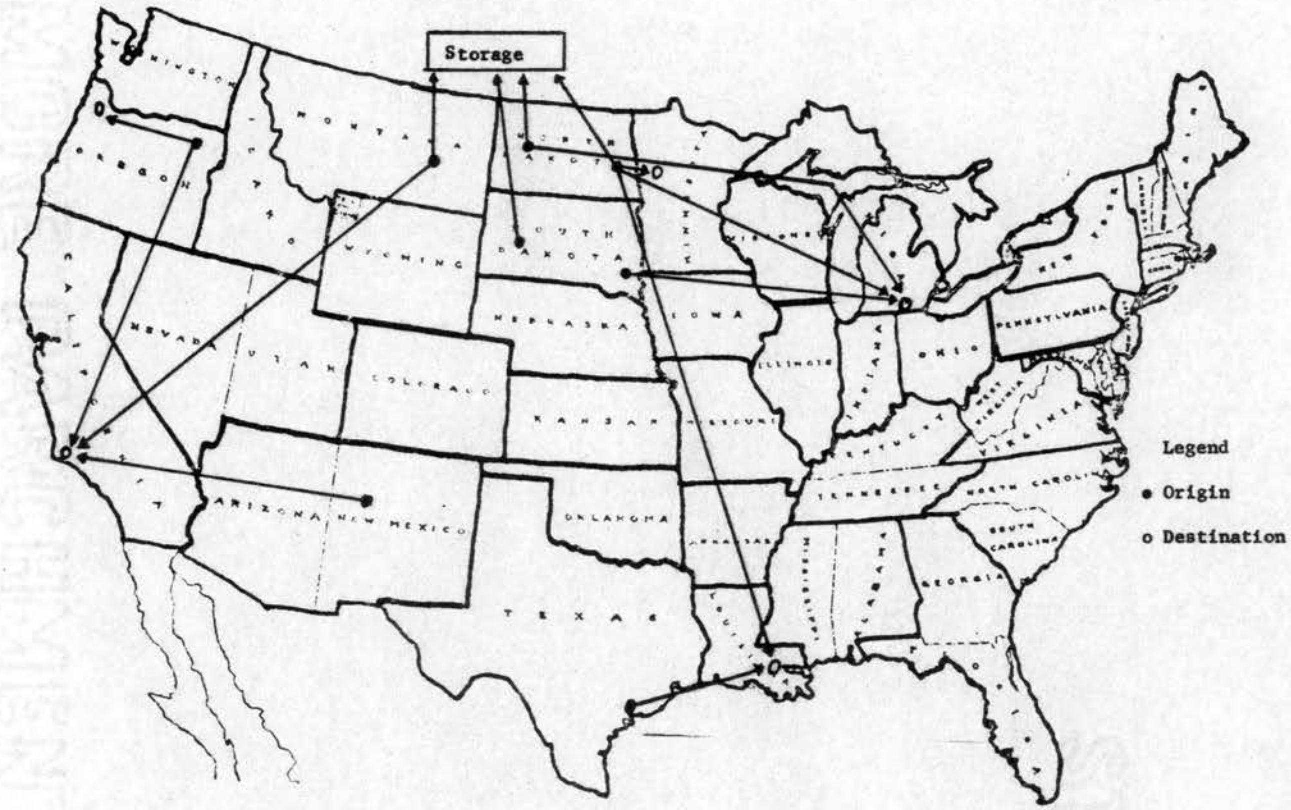

Figure 11. Optimum Flows of Durum Wheat, 1962.

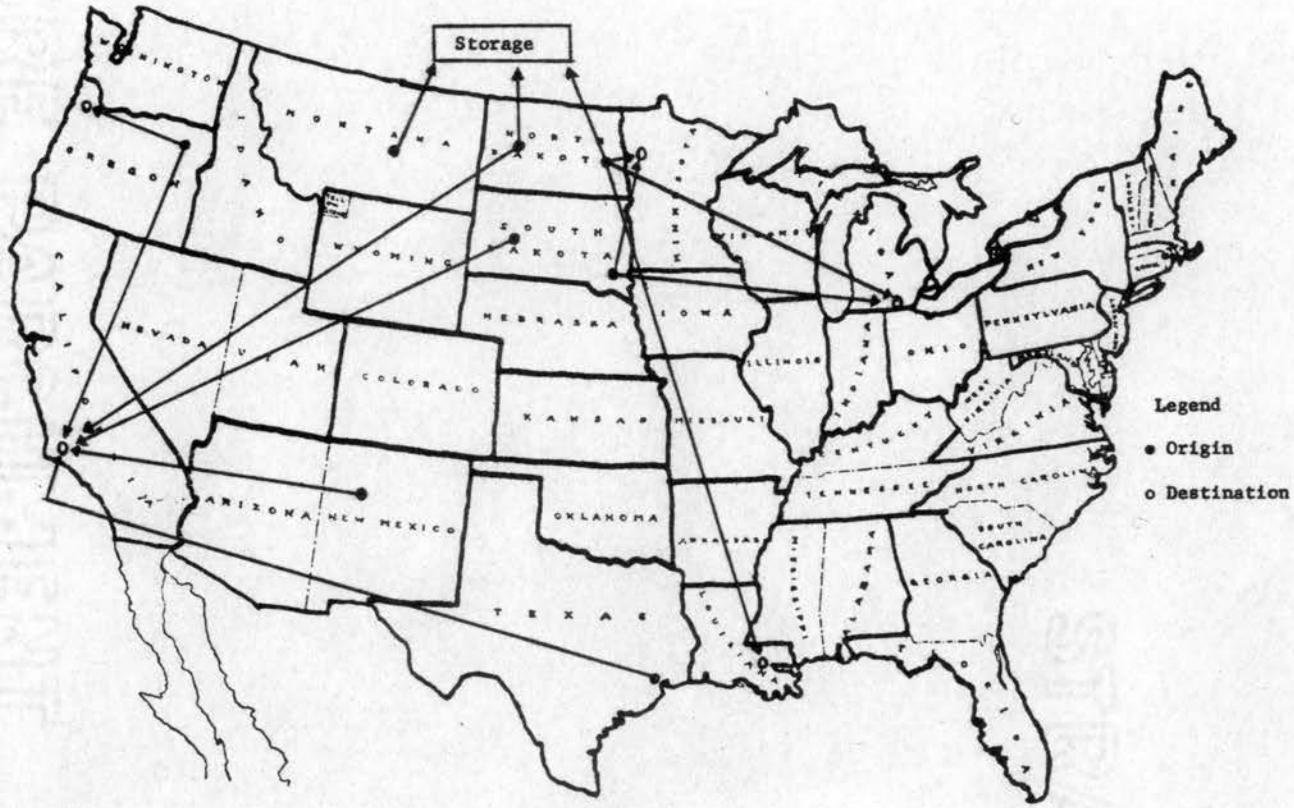

Figure 12. Optimum Flows of Durum Wheat with Trucks Restricted to 700 Miles, 1962.

Montana, and parts of North Dakota, South Dakota, and Nebraska had unfavorable positions for all classes of wheat except white wheat.

Surplus hard red winter wheat produced in Oklahoma would move to the Gulf ports of Houston and Mobile for exports under the optimum flow solution. Surplus soft red winter wheat produced in Oklahoma would move to Kansas City and Fort Worth for milling purposes.

The large demand for hard red winter wheat at the gulf ports would be satisfied for the most part by Oklahoma and Kansas. In general, the estimated optimum flow patterns for wheat conformed to economic expectations. Surplus wheat produced in the Southern Plains would move to the Gulf ports for export and to mid-western milling points. Surplus wheat in the north central regions would move to the milling centers of the North Central and Northeast, and to the Great Lakes and Atlantic ports for exports. Mountain states for the most part had unfavorable competitive positions and would store most surplus wheat produced.

CHAPTER IV

ANALYSIS OF THE FLOUR ECONOMY

The results of the analysis concerned with moving flour from milling points to consumers are presented in this chapter. Approximately 98 percent of the wheat consumed as food in the United States is processed into flour.[1] Hence, wheat moving into domestic consumption moves through the milling process before reaching consumers. Movements of wheat and flour were studied separately to account for the milling process. Although an interdependency between the grain and flour economies exists, they were considered separately in this study.

Flour has been classified into three classes by Bitting and Rogers.[2] The physical characteristics of wheat render each class of flour suitable for a particular food. Hard flour, milled from hard red winter and hard red spring wheats, is used in making yeast breads and rolls. Soft flour, milled from soft red winter and white wheats, is used to make crackers and pastries. Durum flour is a specialty product used in making macaroni and spaghetti. Substitution among the classes of flour is limited. Thus, each class of flour was considered as a separate homogenous product in this study.

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[1]Bitting and Rogers, p. 61.

[2]Ibid.

Export demand for flour was not considered in the study. Most flour exports are affected by government programs. Contracts are awarded to millers by the government for specific shipments. Thus, flour going for exports may not move in a least-cost pattern.

Regional Demarcation

Different regions were specified for flour from those used in the wheat grain analysis so that important consuming areas could be emphasized. Figure 13 shows the 37 regions specified for this part of the analysis. The supply and demand for each class of flour were assigned to a specific point within the region. The supply points were specified by the choice of the milling points (see Tables II through VI, Chapter II). The demand points were chosen mainly on the basis of geographic location and concentration of population. The 43 supply and demand points selected to represent the 37 regions are listed in Table XII.

Regional Supply of Flour

The supply of total flour in each region was taken as given from published data showing quantity of flour milled by states. The regional breakdown of millings on a class basis is presented in Tables II through VI (Chapter II). It was assumed that the yield of flour was 42.95[3] pounds of flour per bushel of wheat. The total supply of each

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[3] Ibid.

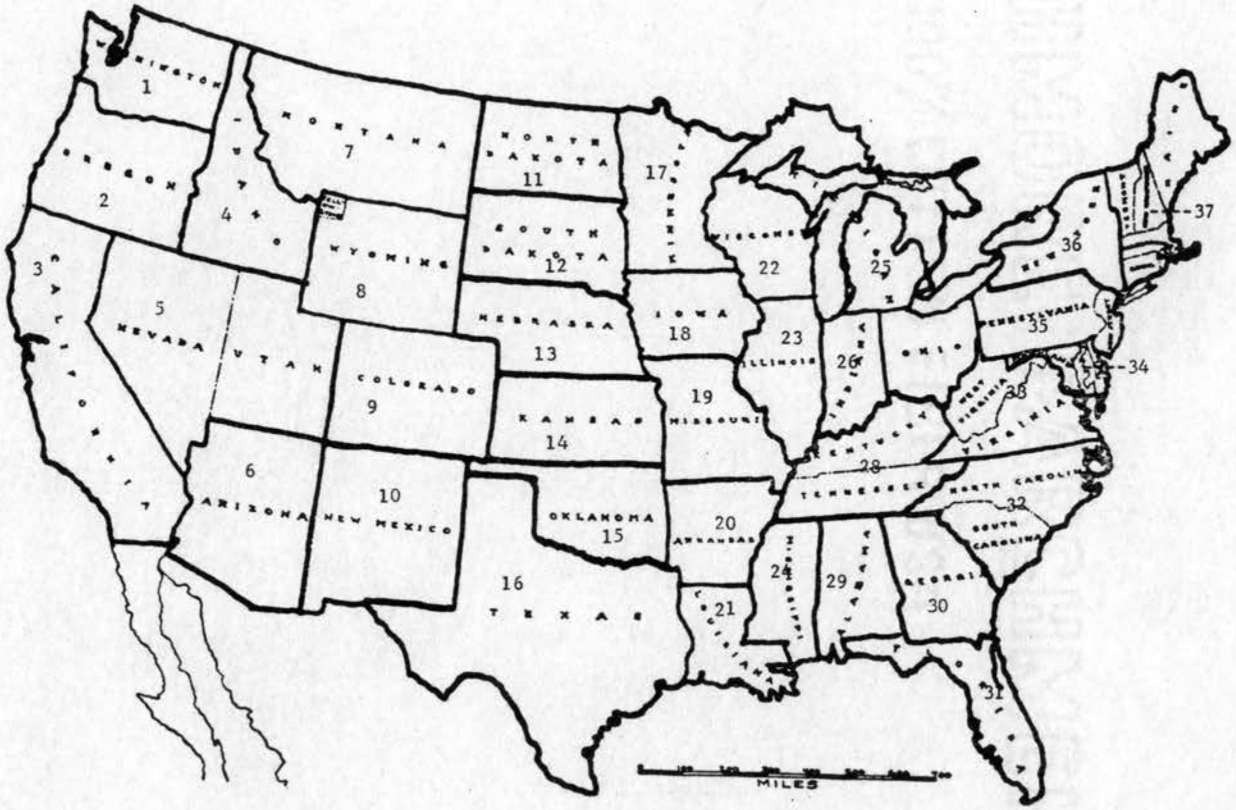

Figure 13. Regions Selected for Studying Interregional Competition in the Wheat Flour Economy.

TABLE XII

ORIGINS AND DESTINATIONS SELECTED FOR STUDYING INTERREGIONAL COMPETITION IN THE FLOUR ECONOMY

No.	Purpose[a]	Location	No.	Purpose[a]	Location
1	DS	Seattle, Wash.	23	DS	Kansas City, Mo.
2	DS	Portland, Ore.	24	D	Little Rock, Ark.
3	DS	Los Angeles, Calif.	25	D	New Orleans, La.
4	DS	Boise, Idaho	26	DS	Milwaukee, Wis.
5	DS	Salt Lake City, Utah	27	DS	Chicago, Ill.
6	D	Tucson, Ariz.	28	D	Jackson, Miss.
7	DS	Billings, Mont.	29	DS	Detroit, Mich.
8	D	Casper, Wyo.	30	DS	Indianapolis, Ind.
9	DS	Denver, Colo.	31	D	Columbus, Ohio
10	D	Albuquerque, N. M.	32	S	Toledo, Ohio
11	D	Bismarck, N. D.	33	DS	Nashville, Tenn.
12	S	Fargo, N. D.	34	D	Mobile, Ala.
13	D	Pierre, S. D.	35	D	Atlanta, Ga.
14	S	Omaha, Nebr.	36	D	Jacksonville, Fla.
16	D	Lincoln, Nebr.	37	D	Charlotte, N. C.
16	D	Salina, Kans.	38	D	Norfolk, Va.
17	S	Wichita, Kans.	39	D	Baltimore, Md.
18	D	Enid, Okla.	40	D	Philadelphia, Pa.
19	S	Oklahoma City, Okla.	41	D	New York City, N. Y.
20	DS	Fort Worth, Tex.	42	S	Buffalo, N. Y.
21	DS	Minneapolis, Minn.	43	D	Boston, Mass.
22	DS	Des Moines, Iowa			

[a]D represents the location of a demand point, S represents a location of a supply point, and DS represents a location of both a demand and supply point.

class of flour by regions was then computed using this yield coefficient and the estimates of each class of wheat milled by regions.

Regional Demand for Flour

Adequate data on regional consumption of flour were not available. To estimate regional per capita consumption of flour, two estimating equations for national per capita consumption were derived. It was assumed that the parameters of the national demand equation were valid for each individual region and only the values of the relevant variables differed between regions. Results of the optimum flow were compared in order to examine possible shifts in optimum flows as a result of different demand relationships. First, regional per capita consumption of flour was estimated as a function of regional per capita disposable income, deflated by the consumer price index (1947-49 = 100), and a time trend. Second, regional consumption was estimated as a function of deflated per capita disposable income only.[4] Time trend alone explained about 95 percent of the variation in the sample data but provided no basis for differences in regional per capita consumption that were expected to exist.

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[4]Other variables including retail price of flour (X_3) and the ratio of farm population to total population (X_4) were also tried but were not statistically significant. These resulting equations were:

$$\hat{Y}_c = 191.58 - \underset{(2.48)}{.044X_1} - \underset{(1.06)}{.5815X_2} + \underset{(.089)}{.0338X_3}, \text{ and}$$

$$\hat{Y}_c = 206.98 - \underset{(5.70)}{.0603X_1} + \underset{(.777)}{.3183X_4}$$

The two equations were estimated by the least squares technique from time series data for 1947 through 1961. Both of the following equations explained 97 percent of the variation in the sample data. The numbers in parenthesis are statistic t-values.

Demand Equation I: $\hat{Y}_c = 192.235 - \underset{(2.66)^{**}}{.043454X_1} - \underset{(1.53)^{*}}{.61362X_2}$

Demand Equation II: $\hat{Y}_c = 222.334 - \underset{(19.15)^{**}}{.067978X_1}$

where:

$\hat{Y}_c$ = per capita consumption of flour in pounds;

X_1 = deflated per capita disposable income;

X_2 = time variable.

The time variable (X_2) was included in Equation I to account for factors affecting per capita consumption other than per capita disposable income. For example, these factors may include availability of substitute of goods, a shift to lower calorie-higher protein diets, and changes in taste and preferences of consumers over time. On the other hand, it may be argued that changes in income have allowed consumers to express existing taste and preferences which have not changed over time. Thus, Equation II may be appropriate.

The negative coefficient of income in both of the equations indicates that flour may be an inferior good.[5] This indicates that the lower income regions will have higher per capita consumption of flour

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*Statistically significant at the 80 percent probability level.

**Statistically significant at the 95 percent probability level.

[5]An inferior good is defined as one for which the consumption decreases as income increases when all other variables are held constant.

than the higher income regions. The variation of per capita income between regions resulted in different estimates of per capita consumption by regions. To estimate per capita consumption of flour by regions, the national estimating equations were used with regional per capita disposable income data.

The time variable used in Demand Equation I had a damping effect on the variation in per capita consumption resulting from changes in per capita income. Therefore, the range of estimated regional per capita consumption using Equation I was less than for Equation II. The examination of optimum flows using demands estimated by both equations provided a look at optimum flows of flour under two demand conditions. If optimum flows of each class of flour change very little between the two demand situations, indications would be that the optimum flow pattern is somewhat stable given existing milling patterns.

Total demand for each class was subtracted from total supply of each class at the milling point for each region to determine surplus and deficit regions for each class of flour. If supply exceeded demand, the region was considered surplus; if demand exceeded supply, the region was considered deficit. Tables XIII through XV show the surplus and deficit regions for each class of flour.

The states of Kansas, Oklahoma, Texas, Missouri, and Minnesota accounted for 74 percent of total hard flour surpluses. Kansas represented the largest surplus with 44.2 million hundredweight. Oklahoma had a surplus of 9.3 million hundredweight of hard flour. The major deficit regions for hard flour were Los Angeles with 10.3 million hundredweight, Columbus with 7.1 million hundredweight,

TABLE XIII

SUPPLY AND DEMAND FOR HARD FLOUR BY REGIONS, 1962

No.	Location	Supply	Demand[a]	Surplus	Deficit
		- Thousand Hundredweight -			
1	Seattle, Wash.	2,857	2,188	669	
2	Portland, Ore.	1,876	1,432	444	
3	Los Angeles, Calif.	851	11,115		10,264
4	Boise, Idaho		587		587
5	Salt Lake City, Utah	4,621	983	3,638	
6	Tucson, Ariz.		856		856
7	Billings, Mont.	2,335	549	1,786	
8	Casper, Wyo.		288		288
9	Denver, Colo.	3,963	1,440	2,523	
10	Albuquerque, N. M.		871		871
11	Bismarck, N. D.		501		501
12	Fargo, N. D.	1,590		1,590	
13	Pierre, S. D.		578		578
14	Omaha, Nebr.	7,671		7,671	
15	Lincoln, Nebr.		1,140		1,140
16	Salina, Kans.	44,234		44,234	
17	Wichita, Kans.		1,749		1,749
18	Enid, Okla.	9,257		9,257	
19	Oklahoma City, Okla.		2,042		2,042
20	Fort Worth, Tex.	16,397	8,174	8,223	
21	Minneapolis, Minn.	20,592	2,714	17,878	
22	Des Moines, Iowa	6,208	2,169	4,039	
23	Kansas City, Mo.	15,571	3,251	12,320	
24	Little Rock, Ark.		1,641		1,641
25	New Orleans, La.		2,910		2,910
26	Milwaukee, Wis.		3,171		3,171
27	Chicago, Ill.	12,004	6,788	5,216	
28	Jackson, Miss.		1,682		1,682
29	Detroit, Mich.	779	5,977		5,198
30	Indianapolis, Ind.	174	3,560		3,386
31	Columbus, Ohio		7,553		7,553
32	Toledo, Ohio	36		36	
33	Nashville, Tenn.	595	5,892		5,297
34	Mobile, Ala.		3,046		3,046
35	Atlanta, Ga.		3,583		3,583
36	Jacksonville, Fla.		4,444		4,444
37	Charlotte, N. C.	18	6,344		6,326
38	Norfolk, Va.	257	4,931		4,674
39	Baltimore, Md.		3,060		3,060
40	Philadelphia, Pa.	70	12,599		12,529
41	New York, N. Y.		11,520		11,520
42	Buffalo, N. Y.	5,374		5,374	
43	Boston, Mass.		7,411		7,411

[a]Demand was computed with Equation I.

TABLE XIV

SUPPLY AND DEMAND FOR SOFT FLOUR BY REGIONS,[a] 1962

No.	Location	Supply	Demand[b]	Surplus	Deficit
		- Thousand Hundredweight -			
1	Seattle, Wash.	7,601	971	6,630	
2	Portland, Ore.	3,746	636	3,110	
3	Los Angeles, Calif.	5,587	4,938	649	
4	Boise, Idaho		260		260
5	Salt Lake City, Utah	1,184	437	747	
6	Tucson, Ariz.		380		380
7	Billings, Mont.	12	244		232
8	Casper, Wyo.		128		128
9	Denver, Colo.		639		639
10	Albuquerque, N. M.		387		387
11	Bismarck, N. D.		223		223
13	Pierre, S. D.		257		257
15	Lincoln, Nebr.		506		506
16	Salina, Kans.	80		80	
17	Wichita, Kans.		777		777
19	Oklahoma City, Okla.		906		906
20	Fort Worth, Tex.	479	3,632		3,153
21	Minneapolis, Minn.		1,206		1,206
22	Des Moines, Iowa	56	964		908
23	Kansas City, Mo.	5,397	1,443	3,954	
24	Little Rock, Ark.		729		729
25	New Orleans, La.		1,292		1,292
26	Milwaukee, Wis.		1,408		1,408
27	Chicago, Ill.	6,253	3,013	3,240	
28	Jackson, Miss.		746		746
29	Detroit, Mich.	5,071	2,653	2,418	
30	Indianapolis, Ind.	5,631	1,580	4,051	
31	Columbus, Ohio		3,352		3,352
32	Toledo, Ohio	13,133		13,133	
33	Nashville, Tenn.	6,079	2,617	3,462	
34	Mobile, Ala.		1,353		1,353
35	Atlanta, Ga.		1,591		1,591
36	Jacksonville, Fla.		1,976		1,976
37	Charlotte, N. C.	1,389	2,818		1,429
38	Norfolk, Va.	842	2,192		1,350
39	Baltimore, Md.		1,359		1,359
40	Philadelphia, Pa.	1,567	5,594		4,027
41	New York, N. Y.		5,116		5,116
42	Buffalo, N. Y.	25,004		25,004	
43	Boston, Mass.		3,290		3,290

[a]Regions not listed do not enter the market for soft flour.

[b]Demand was computed with Equation I.

TABLE XV

SUPPLY AND DEMAND FOR DURUM FLOUR BY REGIONS,[a] 1962

No.	Location	Supply	Demand[b]	Surplus	Deficit
			- Thousand Hundredweight -		
1	Seattle, Wash.		144		144
2	Portland, Ore.	4	95		91
3	Los Angeles, Calif.	1,310	474	563	
4	Boise, Idaho		39		39
5	Salt Lake City, Utah		65		65
6	Tucson, Ariz.		57		57
7	Billings, Mont.	466	36	430	
8	Casper, Wyo.		19		19
9	Denver, Colo.		95		95
10	Albuquerque, N. M.		58		58
11	Bismarck, N. D.		33		33
12	Fargo, N. D.	1,861		1,861	
13	Pierre, S. D.		38		38
15	Lincoln, Nebr.		76		76
17	Wichita, Kans.		115		115
19	Oklahoma City, Okla.		137		137
20	Fort Worth, Tex.		536		536
21	Minneapolis, Minn.	4,799	181	4,618	
22	Des Moines, Iowa		144		144
23	Kansas City, Mo.		217		217
24	Little Rock, Ark.		109		109
25	New Orleans, La.		193		193
26	Milwaukee, Wis.		209		209
27	Chicago, Ill.		446		446
28	Jackson, Miss.		112		112
29	Detroit, Mich.	824	400	424	
30	Indianapolis, Ind.		236		236
31	Columbus, Ohio		505		505
33	Nashville, Tenn.		393		393
34	Mobile, Ala.		201		201
35	Atlanta, Ga.		238		238
36	Jacksonville, Fla.		295		295
37	Charlotte, N. C.		420		420
38	Norfolk, Va.		331		331
39	Baltimore, Md.		205		205
40	Philadelphia, Pa.		844		844
41	New York, N. Y.		766		766
43	Boston, Mass.		490		490

[a]Regions not listed do not enter the durum flour market.

[b]Demand was computed with Equation I.

Philadelphia with 12.5 million hundredweight, and New York City with 11.5 million hundredweight.

Ohio, New York, and Washington represented 67 percent of total soft flour surpluses with 13.1 million hundredweight, 25.0 million hundredweight and 6.6 million hundredweight, respectively. No soft flour was milled in Oklahoma. Although some soft flour was milled in Kansas and Texas, both states were deficit in soft flour. The population centers of the East were the most deficit with New York and Pennsylvania being deficit 4.0 million hundredweight and 5.1 million hundredweight, respectively.

California, Montana, North Dakota, Minnesota, and Michigan were the only regions with a surplus in durum flour. The regions of Minnesota with 4.6 million and North Dakota with 1.9 million hundredweight accounted for 82 percent of total durum flour surpluses. Philadelphia and New York were the heaviest deficit regions in durum flour with .8 million hundredweight each.

Transportation Rates

The same transportation rate structure applies for flour as for wheat grain. An estimate of transportation costs for all three modes of travel was made by converting the rates used for wheat from cents per bushel to cents per hundredweight of flour.

Results of Analysis

Hard Flour

Hard flour was the most important class of flour in terms of quantity, accounting for more than half of total millings and consumption of flour.

Oklahoma, Kansas, Missouri, and Minnesota were the major surplus regions. Heavy population centers of the eastern United States were the major deficit regions. These regions ship in considerable quantities of hard flour. California was also heavily deficit in hard flour.

The equilibrium solution for hard flour using Demand Equation I is presented in Table XVI. The underlined numbers in Table XVI indicate the optimum flows of hard flour. For example, the optimum flow pattern indicated that Enid (16)[6] would ship 2.0 million hundredweight of hard flour to Oklahoma City (19), 2.1 million hundredweight to Los Angeles, and so forth. The numbers in Table XVI which are not underlined may be considered as the opportunity cost of initiating nonoptimum shipments. These figures suggest how much transportation cost between each pair of nontrading regions would have to decrease before shipments could take place without increasing total cost. Note that the opportunity cost for some of the shipments was zero, indicating that more than one optimum solution existed. However, other optimum flow patterns which exist would have the same total

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[6]The number in parenthesis following the city represents the number of the origin or destination as specified by Table XII.

TABLE XVI

OPTIMUM FLOWS, EQUILIBRIUM PRICE DIFFERENTIALS, AND OPPORTUNITY COST OF ALTERNATIVE SHIPMENTS FOR HARD FLOUR, 1962[a]

Destination	Origin 23	1	2	5	7	9	12	14	16
19	17.7	98.4	103.0	77.2	54.1	33.8	33.9	19.9	4.6
3	18.8	669	444	3638	911	2523	20.5	16.2	2.5
4	39.9	1.7	6.3	14.4	587	16.2	23.7	28.5	24.0
6	19.6	43.1	42.8	24.2	22.8	4.5	32.8	19.5	3.6
8	26.3	46.3	55.7	32.5	288	5.9	14.9	14.2	10.7
10	18.8	53.4	58.1	32.1	25.8	4.2	30.3	18.2	2.4
11	36.4	62.5	75.0	68.4	17.6	35.0	501	22.7	23.5
13	21.1	62.4	74.9	57.3	16.1	21.0	578	7.5	7.6
15	11.5	86.0	91.7	68.4	39.9	27.8	14.0	1140	1.2
17	14.8	96.7	101.4	76.0	50.6	32.1	29.3	15.3	1749
24	4.6	99.2	103.8	78.2	53.4	34.6	25.5	105	2.8
25	3.8	110.2	114.9	88.7	46.8	43.9	12.4	8.2	11.5
26	11.6	85.2	97.7	78.4	39.0	38.0	4.5	5.2	10.9
28	6.4	98.3	103.0	76.8	55.0	3.0	26.8	12.1	4.5
29	4.7	85.2	96.9	73.6	39.0	33.3	4.5	0.4	4.5
30	0.2	82.8	97.1	73.9	42.7	30.3	8.4	1.1	3386
31	7023	86.4	96.5	73.2	40.3	30.1	5.8	2.7	530
33	5297	94.9	99.9	76.7	48.8	32.2	15.1	5.6	0.0
34	6.2	98.2	102.9	76.7	54.8	34.5	24.7	12.0	4.3
35	0.1	95.0	99.9	76.3	48.7	32.1	15.1	5.5	2764
36	0.9	95.7	100.6	76.2	49.5	32.1	15.9	6.2	0.0
37	0.1	92.4	99.8	76.7	46.1	32.1	11.6	4.5	6326
38	0.2	87.6	97.1	73.9	41.3	30.7	7.1	1.1	4674
39	0.2	85.2	96.4	73.2	39.0	30.3	4.5	0.1	0.0
40	0.2	85.2	96.4	73.2	38.9	30.3	4.5	6531	2459
41	0.2	85.2	96.4	73.2	38.9	30.3	4.5	0.0	4266
43	8.3	91.4	104.0	79.9	45.3	38.5	10.8	6.7	24.9
Storage	8.7	12.4	20.9	32.8	6.2	12.1	511	4.7	18,080
U_i	0.0	59.8	27.9	40.3	12.3	21.9	1.8	8.2	-0.2

TABLE XVI (Continued)

Destination	Origin 18	20	21	22	27	32	42	V_j
19	2042	15.2	37.0	46.4	56.1	65.5	77.1	32.2
3	2079	11.0	31.2	4.3	10.0	18.0	29.0	28.0
4	12.5	50.9	39.5	38.7	38.6	47.3	56.1	34.7
6	856	7.8	36.7	19.8	25.7	32.2	45.2	39.9
8	22.3	41.4	25.4	40.9	49.0	56.9	69.3	54.4
10	871	12.1	34.5	34.3	40.7	49.6	60.7	47.1
11	35.8	57.5	17.5	43.9	54.8	65.0	76.5	57.2
13	19.7	41.3	9.2	35.4	48.2	57.0	69.9	50.7
15	13.6	34.9	17.5	29.7	52.1	62.7	75.3	53.9
17	4.8	26.5	32.8	43.5	52.9	68.0	80.0	57.6
24	1641	7.3	22.3	31.6	38.2	47.4	59.6	59.1
25	13.2	12.0	2910	37.2	39.6	48.0	59.1	-15.4
26	22.1	39.3	3171	21.7	12.8	29.5	53.5	6.7
28	1.1	1682	22.5	26.8	29.1	37.1	49.9	3.0
29	14.1	30.1	5198	16.9	5.1	9.0	24.9	-5.5
30	8.8	24.8	3.7	18.2	8.8	16.1	38.6	-17.4
31	8.7	24.6	1.3	17.7	6.4	3.7	22.9	9.2
33	4.1	11.6	3.3	22.2	16.9	24.8	42.9	3.3
34	1.0	3046	20.2	20.0	23.1	30.3	41.3	15.4
35	819	5.9	10.5	14.5	15.2	20.4	33.6	10.7
36	949	3495	11.2	3.8	5.4	10.6	22.1	15.4
37	4.7	11.0	7.1	9.5	8.2	11.4	24.7	11.7
38	8.3	15.8	2.4	1.4	1.6	2.8	9.2	2.7
39	8.7	23.6	3060	6.0	5.1	0.1	5.9	8.9
40	8.7	24.7	3539	3.0	2.5	0.1	2.9	-12.3
41	8.7	22.5	0.0	0.3	1844	36	5374	-16.3
43	11.5	22.0	6.3	4039	3372	2.5	2.0	-21.9
Storage	3.7	12.7	6.5	27.7	31.6	37.3	47.1	-31.9
U_i	-3.5	15.4	18.2	15.3	26.2	31.5	23.8	

[a]Surplus and deficit quantities were determined using Demand Equation I.

cost as the one presented so long as supply and demand remain the same in each region.

The U_i's and V_j's of Table XVI are measures of the competitive advantage of production and consumption regions in hard flour markets relative to the base region, Kansas City (23). The U_i is the shipping point price differentials relative to the base region and measures the location advantage of each surplus region relative to the base region. The V_j gives the delivered market price differential relative to the base region. For example, hard flour was worth 28.0 cents per hundredweight more in Los Angeles (3) than in Kansas City.

All hard flour milled in Oklahoma was marketed in the equilibrium solution. The optimum markets for hard flour produced in Oklahoma were Los Angeles (3), Oklahoma City (19), Tucson (6), Albuquerque (10), Little Rock (24), Atlanta (35), and Jacksonville (36). Oklahoma had opportunity costs of 1.0 and 1.1 cents per hundredweight of entering its best alternative markets of Mobile and Jackson, respectively.

Hard flour produced in Kansas and Texas moved to markets of the East and Southeast. The milling points of Salina (16) and Fort Worth (20) had opportunity costs of 3 to 15 cents for entering southwestern markets supplied by Oklahoma. Even though Salina had opportunity costs of zero for markets at Nashville (33), Jacksonville (36), and Baltimore (39), no shipments were made to these points because of available supplies closer to these markets.

Optimum flows of hard flour with demand estimated by Equation I are shown in Figure 14. The flow patterns suggested that part of surplus hard flour produced in Salina and Fargo moved into storage

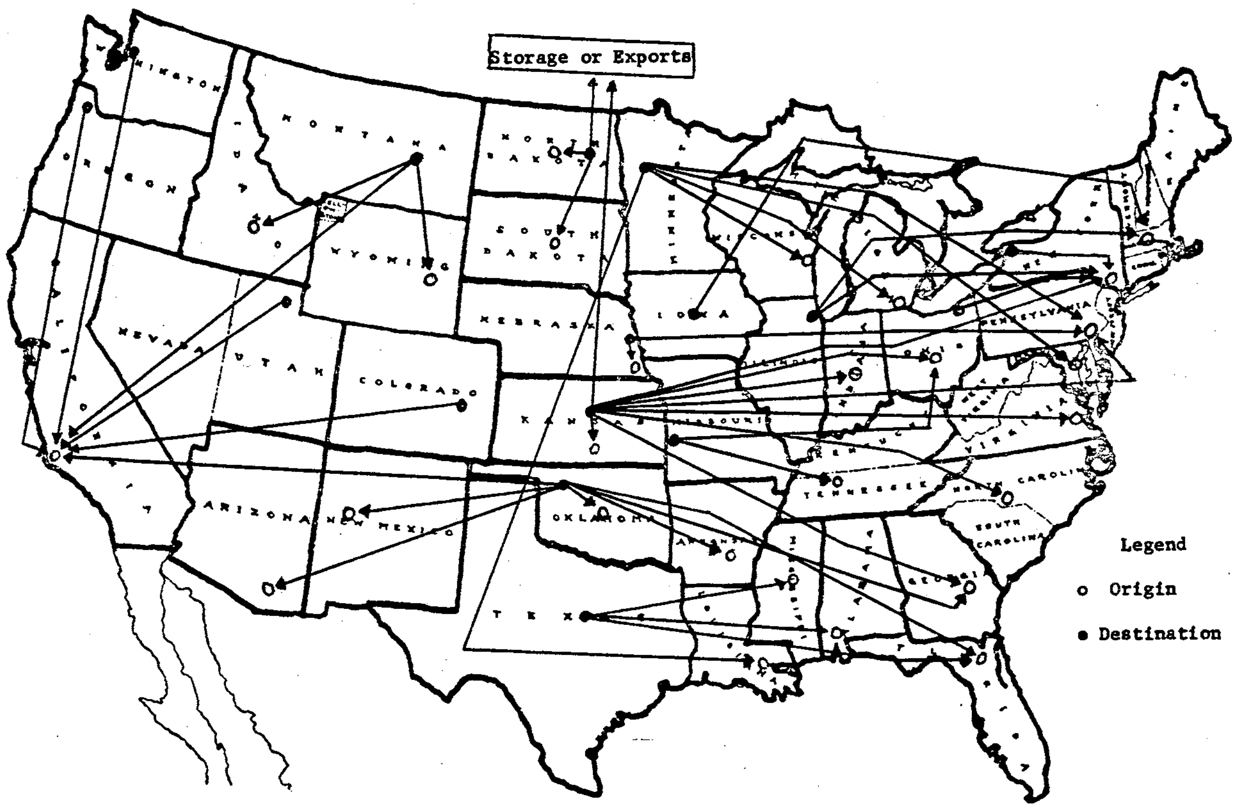

Figure 14. Optimum Flows of Hard Flour Using Demand Equation I, 1962.

or exports. However, the optimum flows were derived using only domestic demand. Had the export demand been considered, different regions than those specified may have optimally supplied these alternatives.

Figure 15 shows the optimum flows of hard flour using Demand Equation II. No changes resulted in the general flow patterns of hard flour moving from the central plains to eastern markets. The alternative demand conditions gave rise only to one shift in optimum markets. Under the alternative condition, Oklahoma could no longer supply the Jacksonville market. Salina replaced Oklahoma in this market.

Soft Flour

The milling of soft flour was more centralized than the production of hard flour, mainly because of the more concentrated production areas for soft wheats. The primary surplus regions were Buffalo, Toledo, Kansas City, and other milling points in the Great Lakes region.

The equilibrium solution for soft flour is shown in Table XVII. The states of Oklahoma, Texas, Kansas, and other central plains states which were surplus in total wheat and flour must import soft flour. This points out the importance of considering both the wheat and flour economies and especially for determining the supply and demand for each class of wheat and flour by regions.

No soft flour was milled in Oklahoma. Small quantities of soft flour were milled in Kansas and Texas but not enough to satisfy local demands. Kansas City (23) supplied the deficit demand in these regions

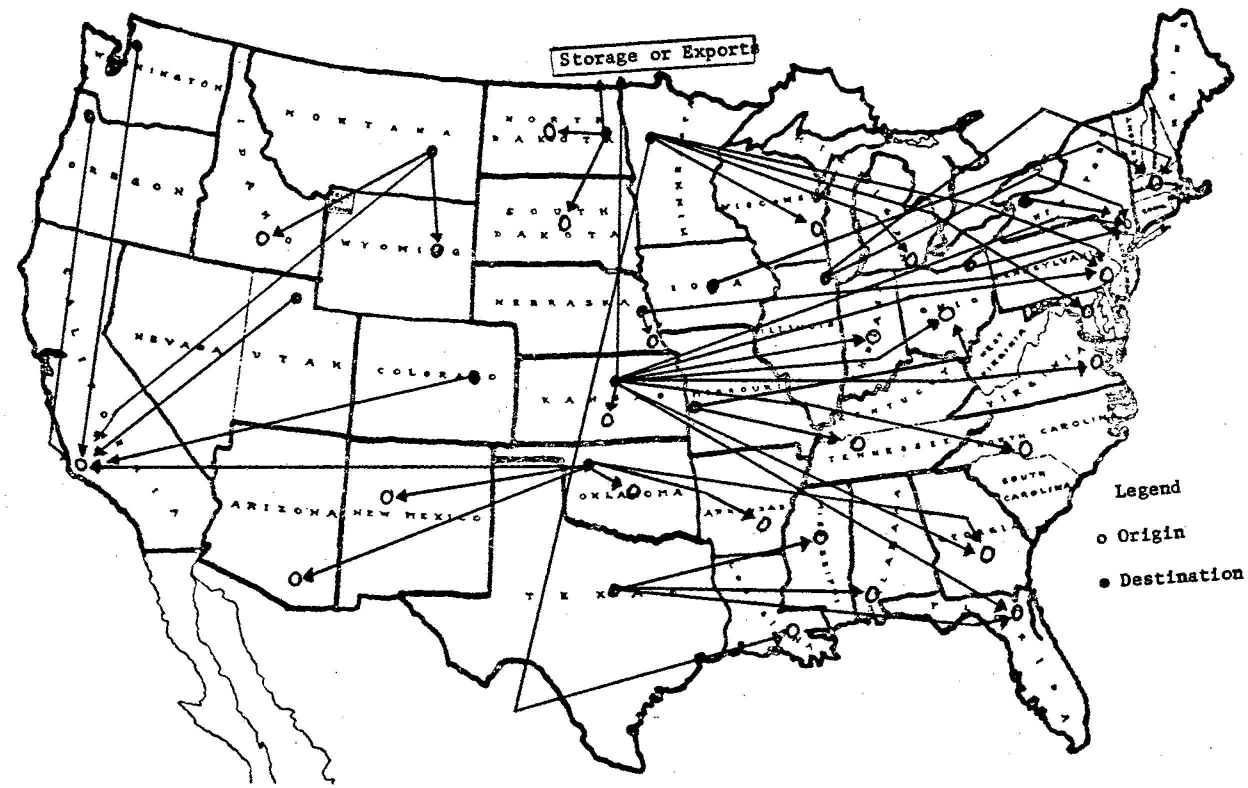

Figure 15. Optimum Flows of Hard Flour Using Demand Equation II, 1962.

TABLE XVII

OPTIMUM FLOWS, EQUILIBRIUM PRICE DIFFERENTIALS, AND OPPORTUNITY COSTS OF ALTERNATIVE SHIPMENTS FOR SOFT FLOUR, 1962[a]

	Origin												
Destination	23	1	2	3	5	16	27	29	30	32	33	42	V_j
19	906	65.8	61.9	35.9	33.4	1.7	8.8	7.5	5.6	8.0	16.7	9.8	3.2
4	5.7	3.9	260	20.9	5.4	55.9	26.1	23.7	24.4	24.6	72.8	23.6	-0.8
6	45.9	54.5	45.7	380	24.6	44.7	22.4	20.0	19.9	18.7	60.8	21.9	6.7
7	26.4	4.1	8.1	25.2	232	25.8	6.4	4.6	5.3	5.5	47.7	6.6	3.5
8	19.9	25.0	25.9	24.4	128	19.1	13.0	12.2	12.7	10.7	46.7	13.3	-12.8
9	1.7	26.2	22.4	17.2	2504	0.3	1.5	564	75	0.9	28.8	2.5	8.8
10	12.8	32.5	28.7	0.0	387	11.2	5.1	3.1	3.0	3.8	32.2	5.1	-15.2
11	12.2	23.4	27.4	42.6	18.1	14.1	1.0	223	0.4	1.0	35.1	2.7	11.9
13	3.9	30.3	34.3	38.5	14.0	5.2	1.4	0.5	1.0	257	30.2	3.1	1.7
15	506	59.6	56.8	55.3	30.8	4.5	11.0	11.0	9.5	11.4	25.4	14.2	13.9
17	697	67.0	63.2	46.5	35.1	80	8.5	12.6	11.0	13.4	26.9	15.6	6.7
20	1563	63.0	59.8	29.6	30.3	3.1	3.2	1.4	1590	1.7	9.6	3.5	5.5
21	8.0	54.8	58.8	67.5	42.9	19.8	1206	8.0	5.5	6.3	26.2	9.4	-4.3
22	282	66.8	66.1	64.8	40.3	14.3	626	7.7	2.8	6.0	21.5	12.7	-4.1
24	2.0	81.7	77.8	51.8	49.5	15.0	6.0	5.2	0.3	5.0	729	7.4	-3.3
25	7.2	98.7	94.9	65.3	66.0	29.7	13.4	11.1	9.5	11.6	11.7	1292	0.2
26	28.4	87.1	91.1	93.7	69.1	42.5	1408	8.8	5.6	6.5	40.4	20.7	-29.2
28	12.5	89.5	85.7	19.2	56.8	25.4	5.6	4.3	2.1	3.4	746	6.4	18.0
31	36.1	107.6	109.2	101.6	83.2	50.9	12.9	2.7	3.5	3352	23.8	9.4	29.2
34	17.7	94.8	91.0	61.9	62.1	30.6	5.0	1.7	957	2.0	396	3.7	29.2
35	27.0	107.0	103.4	81.4	77.1	41.7	12.5	8.2	25.5	7.5	1591	10.9	29.2
36	30.1	110.0	106.4	79.6	79.3	44.0	5.0	0.7	0.2	1976	3.0	1.7	20.0
37	29.2	106.6	105.5	88.2	79.7	43.9	7.7	3.3	1429	0.7	3.2	4.2	11.9
38	40.6	113.1	114.1	103.6	88.2	55.2	12.4	5.5	6.7	3.4	17.7	1350	24.7
39	43.9	114.0	116.7	109.4	90.8	58.5	19.2	6.7	11.2	4.0	28.7	1359	29.2
40	46.9	117.0	119.7	112.3	93.8	61.5	19.6	9.6	14.3	7.0	33.2	4027	27.7
41	49.8	119.9	122.6	115.2	96.7	64.4	20.0	11.7	15.7	9.8	36.9	5116	29.2
43	55.9	123.6	128.2	121.4	101.4	87.3	18.0	9.8	14.2	10.3	43.1	3290	18.0
Storage	11.2	6630	2850	269	9.2	17.3	4.5	1631	1.5	7548	11.2	8570	29.2
U_i	6.4	-0.5	2.7	14.6	7.4	16.7	16.6	14.7	14.1	0.0	0.0	14.7	

[a]Surplus and deficit quantities were determined by using Demand Equation I.

and also in Nebraska. Indianapolis (30) also shipped soft flour to Fort Worth (20). Due to lack of supplies of soft flour in the South, New Orleans (25) was supplied by Buffalo (42).

Optimum flows of soft flour using Demand Equation I are shown in Figure 16. Seattle (1) had an unfavorable competitive position and would have to store all its surplus soft flour. The opportunity cost for this region was less than five cents per hundredweight for entering markets at Boise (4) and Billings (7) but ranged from 23.4 to 123.6 cents per hundredweight for other markets.

Optimum flows using Demand Equation II are presented in Figure 17. No changes in general flow patterns resulted, and only two specific changes occurred. Salt Lake City (5) began shipments to Boise (4), and Indianapolis (30) ceased shipping to Denver (9).

Durum Flour

There were only five regions surplus in durum flour. Fargo and Minneapolis accounted for 82 percent of the total durum flour surpluses. Thus, a large number of shipments originated in these two regions.

The equilibrium solution for durum flour is presented in Table XVIII. No durum flour was produced in Oklahoma and other Southern Plains states. Demands in Oklahoma, Kansas, and Texas were supplied by Fargo (12). Los Angeles (3) also supplied durum flour to Texas. Due to the heavy concentration of durum flour production, the optimum flows for durum flour were identical for both demand conditions. The optimum-flow pattern for durum flour is shown in Figure 18.

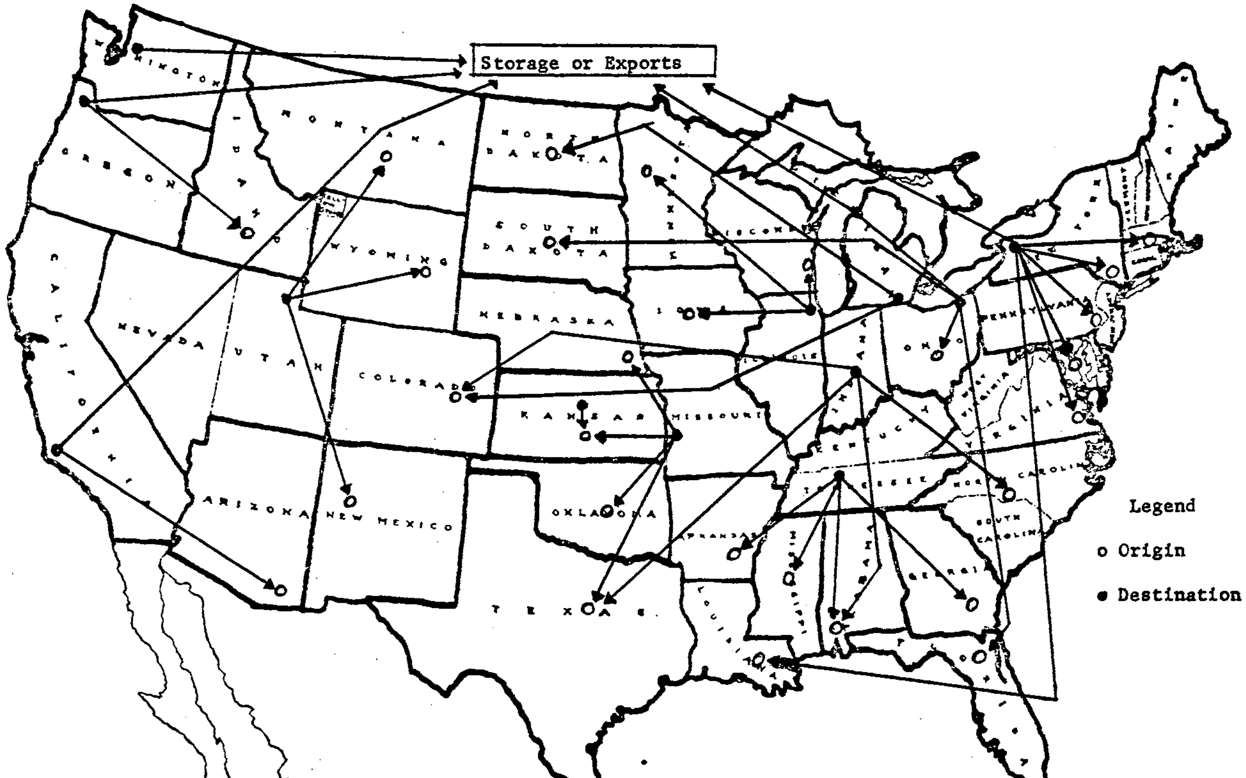

Figure 16. Optimum Flows of Soft Flour Using Demand Equation I, 1962.

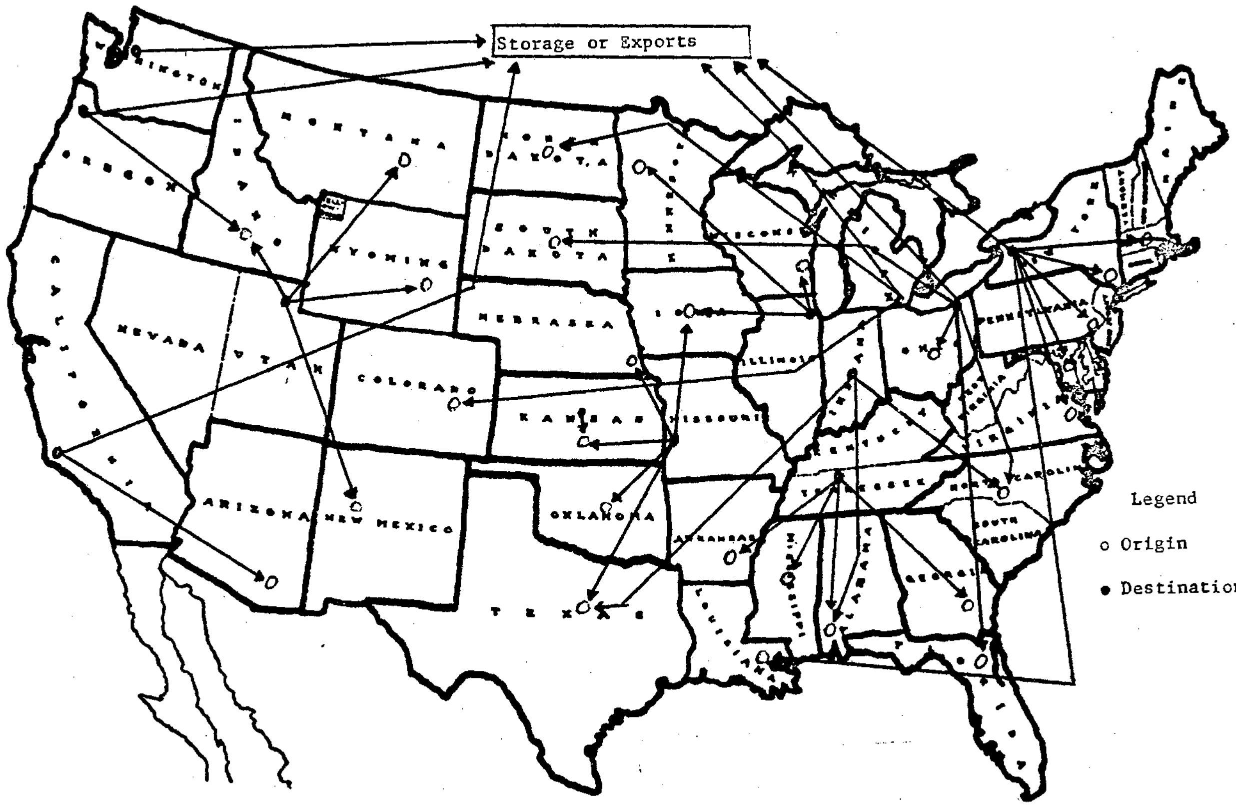

Figure 17. Optimum Flows of Soft Flour Using Demand Equation I, 1962.

TABLE XVIII

OPTIMUM FLOWS, EQUILIBRIUM PRICE DIFFERENTIALS, AND OPPORTUNITY COSTS OF ALTERNATIVE SHIPMENTS FOR DURUM FLOUR, 1962[a]

Destination	Origin					
	3	7	12	21	29	V_j
23	33.6	10.7	217	3.0	47.6	-19.8
1	11.5	144	39.9	61.4	64.2	-26.8
2	91	1.0	40.9	62.4	61.9	-13.1
4	9.1	39	41.0	61.3	72.5	-5.9
5	4.4	65	38.6	53.6	73.0	-20.0
6	57	43.8	71.1	79.5	80.6	-14.8
8	36.1	19	32.2	47.2	84.5	-8.0
9	24.5	95	24.2	34.7	67.9	4.0
10	58	14.5	36.3	45.0	63.7	12.1
11	54.8	0.3	33	22.0	72.8	21.8
13	44.9	38	1.2	14.9	67.5	-7.1
15	40.8	8.6	76	8.0	57.1	19.1
17	20.0	4.0	115	8.0	46.7	0.9
19	7.7	2.9	137	7.6	39.9	-2.0
20	206	30	300	6.1	32.4	-0.6
22	48.6	13.9	144	0.4	52.1	5.5
24	16.9	10.6	109	1.3	30.9	10.2
25	35.4	25.0	7.9	193	51.8	16.2
26	60.4	17.2	0.0	209	35.4	14.0
27	58.0	19.4	2.3	446	29.9	37.6
28	112	36.3	25.7	25.9	45.7	33.1
30	45.5	17.2	0.2	236	19.4	48.3
31	47.7	17.2	0.0	505	9.4	36.9
33	39.0	23.7	7.3	393	28.5	42.3
34	13.7	12.8	0.0	201	14.1	33.4
35	27.5	16.4	0.1	238	14.9	36.6
36	22.7	16.5	0.2	295	4.4	40.3
37	35.5	17.2	0.0	420	11.2	48.1
38	44.3	17.1	0.2	331	6.8	-51.7
39	49.2	17.2	0.0	205	7.1	51.7
40	49.1	17.1	0.0	844	7.0	48.3
41	49.1	17.1	664	102	6.2	37.2
43	53.7	17.2	66	0.0	424	26.2
Storage	39	3.4	14.5	25.5	60.6	-8.9
U_i	0.0	-0.4	2.6	-11.2	-13.7	

[a]Surplus and deficit quantities were determined, using Demand Equation I.

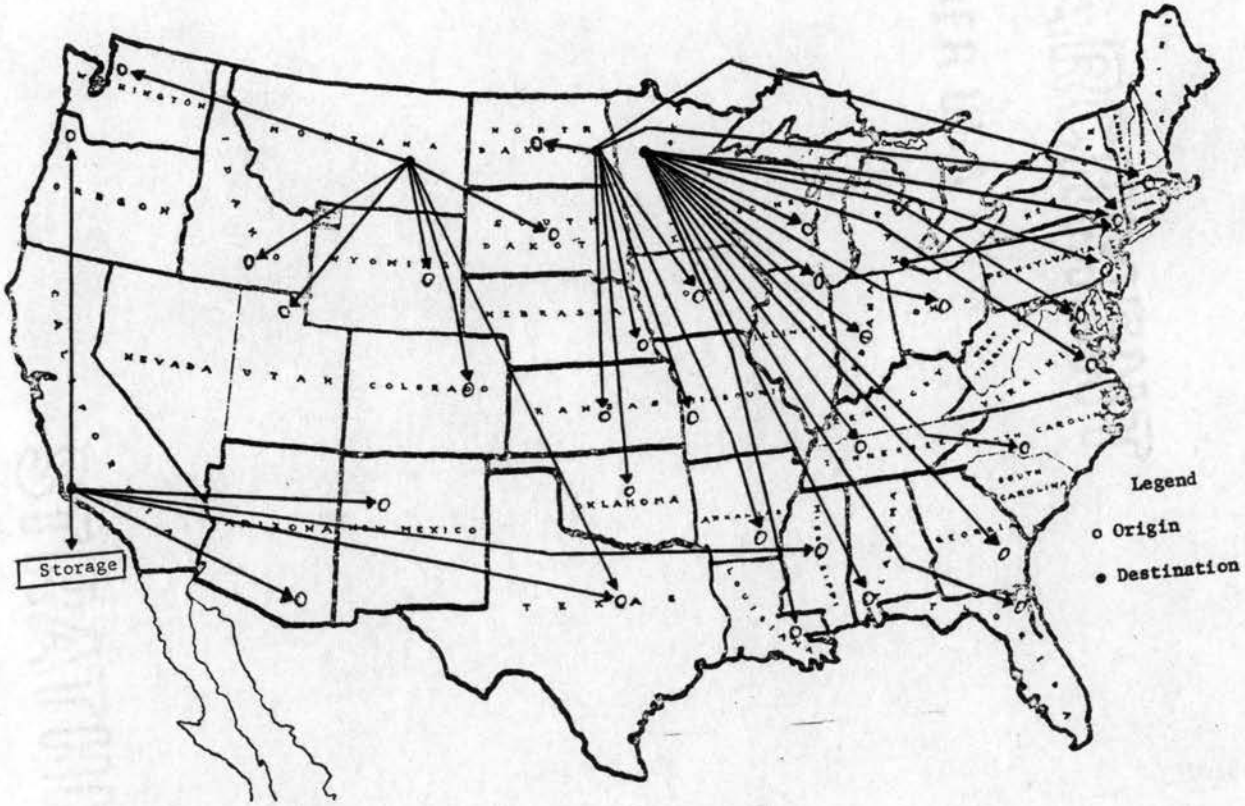

Figure 18. Optimum Flows of Durum Flour, 1962.

Summary

The results of the analysis using two demand conditions imply that optimum flow patterns for all three classes of flour may be somewhat stable, given transportation costs and the existing milling structure. Few changes were observed in optimum flow patterns when demand conditions were varied.

The results indicated that Oklahoma had a very favorable competitive position in the hard flour economy. The optimum flow pattern suggested that Oklahoma hard flour would be shipped to markets in the southeastern and southwestern United States.

Flour produced in the central, north central, and northeastern regions moved to the heavy consumption areas of the eastern United States. Flour produced in the Mid-West would be shipped both east and west, depending on demand and supply conditions for each class of flour. Flour produced in the western United States for the most part was shipped to deficit areas of the west.

CHAPTER V

SUMMARY AND CONCLUSIONS

Changing conditions affecting the wheat and flour economies initiate varied adjustment problems throughout the production and marketing systems. Lack of information useful in making adjustment decisions at all levels of the wheat and flour industries prompted this study. Needed information included optimum markets for each producing and milling region, the competitive position among regions, and the equilibrium intermarket and shipping point price differentials.

The purpose of this study was to examine the competitive position of producing, milling, and consuming regions of the United States with emphasis on Oklahoma and other southern plains states. The objective was to minimize total transportation cost of moving wheat grain and wheat flour from production areas to consumption areas, assuming a fixed distribution of flour mills.

The wheat and flour economies were examined separately. Regional supply and demand for each class of flour were estimated from published data. Each class of wheat and flour was considered as a separate product to obtain a more detailed picture of the optimum flows of wheat and flour. The transportation model was used to estimate optimum flows and the structure of equilibrium price differentials for each class of wheat and flour under alternative conditions.

Optimum flows and equilibrium intermarket and shipping point price differentials for each class of wheat were determined under two transportation alternatives. First, the least cost method of transportation was used between each pair of surplus and deficit regions without restricting the use of any mode of transportation. Second, trucks were restricted to distances of 700 miles or less.

Results presented in this study were derived on the basis of minimizing only transportation cost to the industry. Thus, the optimum markets as specified by the equilibrium solutions for any particular producing region may not be the best market if the region were considered separately. The results of the analysis indicated that Oklahoma had a very favorable competitive position in marketing wheat, especially hard red winter wheat, due to locational advantage with respect to the gulf ports. All surplus wheat produced in Oklahoma was marketed in the optimum flow solution. Surplus hard red winter wheat produced in Oklahoma moved to gulf ports at Houston and Mobile for exports. Surplus soft red winter wheat produced in Oklahoma moved to Kansas City and Fort Worth for milling purposes.

Surplus wheat produced in the southern plains area moved to gulf ports for export and to mid-western milling points. Surplus wheat in the north central regions moved to the milling centers of the northeast and north central United States, and was exported from the Great Lakes and Atlantic ports. Mountain states, for the most part, had unfavorable competitive positions due to high transportation costs and stored most of their surplus wheat. The states of Colorado, Wyoming, Montana, and parts of North Dakota, South Dakota, and Nebraska had unfavorable competitive positions for all classes of wheat produced except white wheat.

Optimum flows and equilibrium price differentials for each class of flour were determined using two demand relationships. First, regional demand for flour was estimated as a function of regional per capita disposable income and a time variable. Second, regional demand for flour was estimated as a function of only per capita disposable income. The range in regional differences in per capita consumption of flour was less in the first case than in the second, due to the damping effect of the time variable. Examination of optimum flow patterns under two demand relationships provided a test of stability of the equilibrium solutions derived.

Results of the analysis using the two demand relationships implied that the optimum flow patterns for all three classes of flour were stable, given the existing milling and transportation cost structures. Flour produced in the central, north central, and northeastern regions moved to the heavy consumption areas of the eastern United States. Flour produced in the Mid-West was shipped both east and west, depending on demand and supply conditions for each class of flour. Flour produced in the western United States for the most part was shipped to the deficit areas of the west.

Oklahoma had a very favorable competitive position in the hard flour market. Oklahoma hard flour was shipped to markets in the southeastern and southwestern United States. Oklahoma produced no soft or durum flour and was deficit in these classes.

Suggestions for Further Research

Several factors affected the precision of this study. These factors include inadequate knowledge of demand relationships in each region, lack of adequate data on flour exports and inadequate specification of regional differences in transportation cost structures. Improved estimates of these factors in further research would increase the reliability of the results derived from this type of analysis.

Considerable information about competitive conditions in the wheat and flour economies could be gained from further research. Consideration of quality differences, along with production and milling cost differences among regions, might yield significantly different results regarding a region's competitive position than when only transportation costs were considered. Consideration of the effects of shifts in milling points and milling costs and shifting production and consumption patterns would provide information regarding possible future changes in the wheat and flour sectors of the economy. This would require considerable research work in developing economy of scale relationships for the milling industry, estimation of production cost by regions, and measuring the effects of quality differences of wheat among regions. Incorporation of production cost of wheat by quality and location, assembly cost, milling cost by regions, and distribution costs would provide useful information for adjustment planning at all levels of the wheat and flour industries.

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A P P E N D I X

APPENDIX TABLE I

DISTRIBUTION OF WHEAT PRODUCTION BY CLASSES WITHIN EACH REGION, 1959

	Class of Wheat				
Region[a]	Hard Red Winter	Hard Red Spring	Soft Red Winter	White	Durum
			- Percent -		
1	13.70	.40	.30	85.60	--
2	.90	1.10	--	97.90	.10
3	--	--	--	96.42	3.58
4	44.00	4.55	--	51.45	--
5	65.40	1.80	--	32.80	--
6	90.00	.30	--	9.60	.10
7	40.82	50.31	.10	.40	8.37
8	90.84	8.15	--	1.10	--
9	99.00	1.00	--	--	--
10	93.50	--	5.50	--	1.00
11	96.00	--	4.00	--	--
12	100.00	--	--	--	--
13	100.00	--	--	--	--
14	100.00	--	--	--	--
15	99.50	--	.50	--	--
16	99.50	--	.50	--	--
17	100.00	--	--	--	--
18	100.00	--	--	--	--
19	99.23	--	.77	--	--
20	99.58	.42	--	--	--
21	99.90	.10	--	--	--
22	99.67	.19	.14	--	--
23	58.00	40.00	--	--	2.00
24	12.90	76.00	--	--	11.10
25	--	83.90	--	--	16.10
26	--	52.30	--	--	47.70
27	2.87	90.15	--	--	6.98
28	90.96	7.78	1.26	--	--
29	66.97	--	32.80	.23	--
30	9.53	--	90.47	--	--
31	.90	--	99.10	--	--
32	--	--	100.00	--	--
33	.57	--	99.43	--	--
34	.40	--	99.60	--	--
35	6.20	.10	93.00	.70	--

APPENDIX TABLE I (Continued)

Region[a]	Class of Wheat				
	Hard Red Winter	Hard Red Spring	Soft Red Winter	White	Durum
			- Percent -		
36	1.90	--	98.10	--	--
37	57.22	.20	42.58	--	--
38	5.95	45.38	48.67	--	--
39	.40	--	13.83	85.77	--
40	2.22	--	97.78	--	--
41	.21	--	99.69	.10	--
42	.63	--	98.40	.97	--
43	.20	--	99.50	.30	--
44	--	--	3.50	96.50	--
45	--	--	--	--	--

Source: USDA Statistical Bulletin 272, _Distribution of the Varieties and Classes of Wheat in the United States in 1959_.

[a]The region numbers refer to the region specified by Table I, Chapter III.

APPENDIX TABLE II

HARVESTED ACRES OF WHEAT, BY CLASS AND REGIONS, 1962[a]

Region[a]	Class of Wheat					
	Hard Red Winter	Hard Red Spring	Soft Red Spring	White	Durum	Total
			- Acres -			(1,000 Acres)
1	232,489	6,788	5,091	1,452,632	--	1,697
2	6,120	7,480	--	665,720	680	680
3	--	--	--	296,009	10,991	307
4	421,080	43,544	--	492,377	--	957
5	134,776	3,667	--	67,557	--	206
6	210,603	651	--	22,448	298	234
7	1,414,413	1,743,242	3,465	13,860	290,020	3,465
8	193,489	17,360	--	2,151	--	213
9	1,880,010	18,990	--	--	--	1,899
10	40,766	--	2,398	--	436	44
11	2,579,904	--	107,496	--	--	2,687
12	840,000	--	--	--	--	840
13	1,214,000	--	--	--	--	1,214
14	962,000	--	--	--	--	962
15	642,770	--	3,230	--	--	646
16	124,375	--	625	--	--	125
17	3,521,000	--	--	--	--	3,521
18	4,441,000	--	--	--	--	4,441
19	1,016,115	--	7,844	--	--	1,024
20	622,375	2,625	--	--	--	625
21	1,057,941	1,059	--	--	--	1,059
22	1,071,453	2,043	1,504	--	--	1,075
23	290,200	199,410	--	--	9,160	498
24	157,800	929,590	--	--	134,890	1,223
25	--	1,890,000	--	--	364,000	2,254
26	--	1,707,000	--	--	1,558,000	3,265
27	21,000	659,000	--	--	51,000	731
28	80,045	6,846	1,109	--	--	88
29	653,627	--	320,128	2,245	--	976
30	10,674	--	101,326	--	--	112
31	360	--	39,640	--	--	40
32	--	--	65,000	--	--	65
33	268	--	46,732	--	--	47
34	1,061	--	258,939	--	--	260
35	14,716	235	221,337	1,712	--	238

APPENDIX TABLE II (Continued)

Region[b]	Class of Wheat: Hard Red Winter	Hard Red Spring	Soft Red Winter	White	Durum	Total
			- Acres -			(1,000 Acres)
36	3,817	--	193,183	--	--	197
37	870,888	3,044	648,068	--	--	1,522
38	2,856	21,782	23,362	--	--	48
39	3,688	--	127,513	790,799	--	922
40	24,331	--	1,071,669	--	--	1,096
41	2,539	--	1,205,252	1,209	--	1,209
42	2,841	--	443,784	4,375	--	451
43	340	--	182,125	535	--	183
44	--	--	6,930	191,070	--	198
45	--	--	--	--	--	--

[a]Estimated from USDA Summary of Crop Production, 1962.

[b]The region numbers refer to the region specified by Table I, Chapter III.

APPENDIX TABLE III

DISTRIBUTION OF WHEAT BY CLASS FOR REGIONS HAVING A PORT OF EXIT

Region	Class of Wheat: Hard Red Winter	Hard Red Spring	Soft Red Winter	White	Durum	Weighting Factors[a]: Exports	Production
	- Percent -						
Minnesota	2.62	87.72	-	-	9.66	1	6.30
Michigan	.34	8.94	12.05	74.16	4.51	1	2.30
Illinois	57.22	0.20	42.58	-	-	1	380.50
Wisconsin	6.26	41.44	52.30	-	-	1	7.80
Ohio	0.19	-	97.12	2.69	-	1	3.30
New York	1.50	11.60	28.50	58.40	-	1	0.83
Maine	-	100.00	-	-	-	1	0.00
Massachusetts	-	29.42	70.58	-	-	1	0.00
Pennsylvania	1.72	1.55	87.23	9.50	-	1	1.70
Maryland	0.87	40.36	34.94	23.83	-	1	2.80
Virginia	15.09	3.07	64.66	17.18	-	1	0.37
Louisiana	91.18	3.51	4.93	-	.38	136.90	1.00
Alabama	93.02	2.49	4.49	-	-	52.30	1.00
Texas (10)	99.88	0.06	0.06	-	-	283.00	1.00
Mississippi	63.40	15.19	21.41	-	-	1	0.14
California	9.08	-	-	84.54	6.38	1	2.30
Washington	20.70	0.20	0.17	78.93	-	1	1.10
Oregon	25.40	0.62	-	73.96	0.02	1	0.37

[a]The weighting factors were determined by comparing total production to total exports in each region.

APPENDIX TABLE IV

CONSUMPTION OF FLOUR AND DISPOSABLE INCOME IN THE UNITED STATES, 1947-1961

Year	Consumption of Flour (Pounds Per Capita)	Disposable Income[a] (Dollars Per Capita)
1947	139	1,237
1948	137	1,256
1949	136	1,249
1950	135	1,332
1951	133	1,327
1952	131	1,339
1953	128	1,383
1954	126	1,378
1955	123	1,450
1956	121	1,499
1957	119	1,501
1958	121	1,479
1959	120	1,528
1960	118	1,529
1961	118	1,549

[a]Deflated by consumer price index (1947-49 = 100).

Source: United States Department of Agriculture, Consumption of Food in the United States, Supplement for 1962, Washington, D. C.

APPENDIX TABLE V

ESTIMATED CONSUMPTION OF FLOUR BY STATES, UNDER VARYING DEMAND CONDITIONS, 1962

State	Estimated Consumption	
	Demand Equation I	Demand Equation II
	(Pounds Per Capita)	
Maine	126	133
New Hampshire	118	120
Vermont	123	129
Massachusetts	103	96
Rhode Island	113	112
Connecticut	93	82
New York	100	92
New Jersey	99	90
Pennsylvania	113	113
Delaware	96	86
Maryland	106	101
Michigan	113	112
Ohio	113	112
Indiana	114	113
Illinois	101	93
Wisconsin	117	119
Minnesota	118	120
Iowa	118	120
Missouri	113	112
North Dakota	118	120
South Dakota	121	124
Nebraska	116	117
Kansas	119	121
Virginia	124	130
West Virginia	128	136
Kentucky	132	142
Tennessee	133	143
North Carolina	132	141
South Carolina	137	150
Georgia	132	142
Florida	123	128
Mississippi	113	113
Louisiana	132	142
Arkansas	136	149
Oklahoma	126	133
Texas	122	127

APPENDIX TABLE V (Continued)

State	Estimated Consumption	
	Demand Equation I	Demand Equation II
	(Pounds Per Capita)	
New Mexico	129	137
Alabama	137	150
Arizona	122	127
Montana	117	119
Idaho	127	134
Wyoming	119	122
Colorado	114	115
Utah	122	127
Washington	110	108
Oregon	116	117
Nevada	91	78
California	99	91

APPENDIX TABLE VI

ESTIMATES OF TRANSPORTATION CHARGES FOR WHEAT BETWEEN SPECIFIED POINTS BY REGIONS, UNITED STATES, 1962[a]

Destination	Origin 1	3	6	7	8	9	10	11	12	13	15	16	17
	- Cents Per Bushel[b] -												
2A	12.8	12.9	19.5	29.7	46.9	28.7	36.9	42.1	X	35.8	35.3	36.4	37.2
2B	12.8	12.9	19.5	29.7	46.9	28.7	36.9	43.2	X	51.2	50.4	52.0	53.2
4A	15.2	10.6	17.2	27.4	44.6	31.1	37.4	40.9	X	34.9	37.5	35.8	36.4
4B	15.2	10.6	17.2	27.4	44.6	31.1	37.4	40.9	55.7	49.8	51.1	51.1	52.0
5A	39.7	34.4	29.7	25.4	27.4	41.3	36.5	37.8	33.7	30.8	31.6	32.9	32.8
5B	39.7	34.4	29.7	25.4	27.4	41.3	36.5	37.8	48.1	35.4	38.2	42.8	42.8
7B	39.3	38.4	30.9	X	45.6	37.0	38.2	36.5	X	29.4	28.4	34.3	35.8
12A	61.1	59.8	55.7	X	28.3	49.5	41.3	33.5	X	21.7	24.3	19.7	17.5
14B	57.9	55.7	49.1	X	22.0	42.0	33.8	26.0	X	14.2	16.8	12.3	10.7
23B	47.1	46.9	40.3	X	23.8	31.3	23.0	17.3	X	16.5	13.0	10.3	12.0
27B	45.6	46.8	40.2	X	30.4	29.7	22.3	20.0	X	23.2	19.7	16.7	18.3
32B	44.0	49.7	45.7	X	39.1	28.2	27.9	28.6	38.5	32.4	29.0	26.1	27.5
33B	48.8	50.7	44.1	X	34.2	33.0	25.8	23.9	X	26.6	23.3	19.7	20.4
34B	51.2	51.2	44.6	36.1	28.4	35.3	27.1	21.8	X	20.8	17.6	14.0	14.6
37A	64.8	63.1	59.4	X	36.9	51.9*	44.5*	39.0*	14.8	28.9	30.0	25.8	23.5
38A	64.2	65.2	61.4	X	39.6	54.9	50.9	43.4	X	29.3	31.1	28.4	26.1
40B	77.2	78.8	72.2	X	51.6	61.3	54.8	49.4	X	43.6	43.4	38.0	36.2
41B	67.3	67.3	60.7	52.3	40.0	51.5	43.2	38.0	X	32.0	31.5	26.2	24.6
42B	56.0	60.3	53.7	X	42.6	40.2	34.7	33.5	X	34.6*	31.4*	27.8*	27.8
45B	62.6	66.6	60.0	51.5	47.8	46.7	41.2	39.7	X	39.8	37.1	32.7	32.4
47B	65.7	68.5	64.9	65.7	57.6	57.1	55.5	52.4	X	34.9	34.5	33.0	32.8
48B	71.1	75.1	68.5	60.0	55.4	55.2	49.7	47.8	X	47.2	45.1	40.3	40.0
49A	67.0	69.0	66.3	62.3	59.1	58.6	54.5	54.5	X	35.4	34.5	33.6	33.4
51A	65.4	67.9	64.6	60.6	57.3	57.0	52.6	50.5	X	34.2	33.7	32.8	32.5
52A	68.5	70.4	67.8	X	61.3	60.3	60.9	56.4	X	X	X	X	X
54A	57.3	60.1	56.5	X	48.9	47.7	42.2	40.8	31.9	X	X	X	X
54B	63.6	67.8	61.1	X	49.4	47.7	42.2	40.8	40.9	X	X	X	X
55A	67.9	71.8	66.9	62.8	57.2	59.4	54.5	54.5	X	34.9	38.7	33.6	33.3

APPENDIX TABLE VI (Continued)

Destination	Origin 18	19	20	21	22	24	25	26	28	29	30	31	35
	- Cents Per Bushel[b] -												
2A	36.7	37.4	41.0	47.1	46.5	40.0	42.2	44.7	38.8	43.3	X	X	48.6
2B	52.4	53.4	51.8	57.6	57.6	42.0	47.1	53.2	39.5	49.6	32.2	37.7	63.5
4A	36.6	37.0	42.7	45.4	44.7	39.6	41.3	43.7	39.9	44.2	39.3	41.6	47.8
4B	52.3	52.8	49.5	55.3	55.3	41.1	45.0	51.5	41.9	52.0	42.7	48.3	61.3
5A	33.1	33.7	39.1	41.2	42.8	39.1	41.0	43.2	40.8	44.8	X	X	45.4
5B	41.5	46.9	41.2	45.3	49.7	40.2	44.1	50.6	43.9	53.4	X	X	54.8
7B	35.5	39.3	27.1	33.0	34.3	20.0	23.9	30.4	23.7	33.2	31.6	37.2	40.3
12A	16.7	18.1	26.0	22.4	25.3	37.1	32.4	29.2	40.0	35.2	42.6	40.5	27.0
14B	9.2	12.0	18.5	15.4	19.3	29.6	24.9	22.4	34.2	28.5	X	X	21.3
23B	14.4	13.8	10.8	7.1	7.8	17.9	12.8	9.8	22.1	15.8	X	X	13.9
27B	20.8	16.6	17.2	13.5	9.4	17.5	12.5	6.3	19.4	9.9	21.1	16.7	14.7
32B	30.3	25.0	26.0	22.9	19.2	24.9	21.0	15.7	20.9	11.3	16.9	11.3	19.0
33B	23.3	18.0	21.1	16.6	20.6	21.4	16.4	10.3	22.6	12.5	23.6	18.0	12.4
34B	17.5	12.2	15.7	10.8	6.6	21.9	16.9	10.8	25.2	15.6	X	X	8.9
37A	23.9	22.6	32.4	27.9	23.8*	39.7*	34.7	28.5*	41.6*	32.1*	33.1*	27.5*	25.8
38A	26.6	23.7	34.9	30.3	30.4	41.7	39.3	34.7	43.1	38.8	43.6	40.0	25.1
40B	38.1	32.9	42.5	36.7	34.2	49.6	44.6	38.2	51.3	41.1	X	X	28.1
41B	26.5	21.3	30.5	24.7	22.8	38.1	33.0	26.9	41.1	31.1	40.6	35.0	16.8
42B	30.7	24.9	29.5*	24.6*	20.4*	31.0	25.9	19.9	30.3	20.1	28.9	23.3	15.6
45B	35.3	29.5	35.2	30.3	26.1	37.3	32.3	26.2	36.8	26.7	X	X	21.0
47B	33.5	41.3	41.9	39.7	38.0	44.0	41.9	38.5	44.0	39.5	49.8	42.2	33.0
48B	42.9	37.1	43.2	38.3	34.1	45.8	40.8	34.5	45.3	35.1	43.9	38.3	28.8
49A	33.9	33.0	42.8	40.8	39.1	44.9	42.8	39.8	44.8	40.5	43.1	41.0	35.2
51A	33.3	31.9	41.4	39.3	36.4	43.3	41.1	38.0	43.1	38.6	41.9	39.6	31.1
52A	X	X	X	X	X	46.8	44.9	41.1	46.6	42.6	44.2	42.1	X
54A	X	X	X	X	X	38.3	33.3	27.2	35.0	27.7	35.4	30.8	X
54B	X	X	X	X	X	38.3	33.3	27.2	37.8	27.7	36.4	30.8	X
55A	33.2	32.4	43.3	40.7	X	45.0	43.0	41.0	45.3	41.1	X	X	34.9

APPENDIX TABLE VI (Continued)

Destination	Origin 36	39	40	43	44	46	47	50	51	52	53	54
	- Cents Per Bushel[b] -											
2A	38.5	25.9	X	22.8	22.5	23.7	X	24.2	X	X	22.8	33.0
2B	55.0	37.3	37.2	32.6	32.2	33.9	34.9	34.6	36.0	35.5	32.5	32.9
4A	38.1	26.0	X	22.7	22.2	23.8	X	24.4	X	X	23.1	23.2
4B	54.4	37.1	X	32.4	31.7	34.0	X	34.8	X	X	33.0	33.2
5A	34.9	23.7	X	22.4	22.8	23.3	X	24.4	X	X	22.6	23.2
5B	49.8	33.9	X	32.0	32.5	33.3	X	34.9	X	X	32.3	33.2
7B	45.6	32.4	X	28.5	29.2	30.6	X	32.2	X	X	29.6	30.2
12A	17.1	15.2	16.8	18.2	19.3	19.9	20.5	21.0	18.6	21.6	18.4	19.5
14B	15.2	23.2	24.2	24.9	26.6	25.2	20.9	29.5	26.3	30.7	25.4	27.1
23B	20.1	26.1	24.6	19.8	23.9	25.0	28.4	27.6	25.4	30.0	23.4	25.7
27B	21.9	25.0	X	15.2	18.7	24.3	X	26.9	X	X	21.3	23.6
32B	27.9	26.4	X	16.7	14.5	24.0	X	26.4	X	X	21.8	22.8
33B	20.8	24.8	23.3	11.8	14.8	22.5	26.7	26.1	25.3	28.0	17.8	21.6
34B	16.0	23.6	22.8	14.6	20.1	23.3	27.1	26.7	23.9	28.5	18.4	23.2
37A	16.9	12.3	14.4	12.8*	17.9	18.5	19.1	20.0	16.5	23.4	17.1	18.3
38A	17.2	11.3	13.0	17.1	17.9	17.5	18.5	19.7	15.6	19.9	16.6	17.9
40B	26.4	15.8	X	25.6	28.3	18.1	X	24.3	X	X	20.6	23.5
41B	14.8	17.9	16.5	16.4	19.6	15.9	24.4	25.1	19.4	25.4	12.9	20.1
42B	23.0	22.8	20.4	7.6*	7.1	13.4	24.2	23.4	23.7	23.7	9.8	12.2
45B	27.0	22.4	19.5	19.5	13.7	8.4	19.2	18.8	16.9	17.3	10.8	6.3
47A	30.7	14.6	X	17.1	24.8	15.0	X	13.0	X	X	16.4	15.8
48B	34.5	23.8	20.0	22.8	22.2	14.0	15.0	10.2	14.3	14.9	18.4	14.8
49A	31.4	15.3	12.2	18.2	17.9	15.7	7.4	11.3	7.0	10.2	16.8	15.8
51A	29.9	13.9	X	17.1	17.2	14.8	X	13.9	X	X	16.0	15.6
52A	X	X	X	18.7	X	X	X	12.2	X	X	X	X
54A	X	X	X	13.0	X	X	X	14.2	X	X	X	X
54B	X	X	X	15.9	X	X	X	20.3	X	X	X	X
55A	29.9	13.3	X	13.0	18.1	16.0	12.0	16.0	8.3	16.0	16.7	16.9

[a]An X indicates transportation charges between these regions were not needed

[b]Underlining denotes truck charges; underlining with an asterisk denotes combination of truck and barge charges; an asterisk alone denotes barge charges; rail charges are the nonunderlined numbers.

VITA

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Master of Science

Thesis: AN ANALYSIS OF INTERREGIONAL COMPETITION IN THE WHEAT AND FLOUR ECONOMIES

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