Optimum Distribution Patterns for Feeder Cattle

Max F. Bowser

John W. Goodwin

OKLAHOMA STATE UNIVERSITY
EXTENSION RESEARCH INSTRUCTION
SCIENCE SERVING AGRICULTURE
1891
EXPERIMENT STATION

Technical Bulletin
T-123

June, 1968

Contents

Optimum Distribution Patterns For Feeder Cattle

Max F. Bowser
John W. Goodwin

Cattle feeding in the United States has expanded rapidly during the past twenty years. The most rapid growth has been in areas outside the traditional North Central feeding states. Consequently, the market patterns for feeder cattle have changed substantially. As the number of different markets increases, feeder cattle producers must keep up with the changing conditions in order to optimize their marketing patterns. Only by keeping "on top" can they realize maximum profits.

Transportation costs from production areas to feeding areas are of major importance in the stocker-feeder business. Thus, any method which might help lower transportation costs would be especially important to the Western States where beef cattle are an important part of the agricultural economy.

In 1965 beef cattle and calves accounted for 22.7 percent of the agricultural cash income in the United States. Twenty-one states had cash income from beef cattle and calves greater than one-fifth of their agricultural receipts. Eleven states depended upon beef cattle and calves sales for more than one-third of their agricultural income. In Oklahoma beef cattle is the number one agricultural commodity. Only Texas had more beef cows in the two-year-old and over category in 1965 than did Oklahoma. With the exception of the Northeastern states, substantial numbers of feeder cattle are produced in all sections of the country, and cattle feeding is commonplace in thirty-two states. Many states have a surplus of feeder cattle while other states are deficit.

This study is oriented toward the importance of the relative advantages or disadvantages of different feeder cattle producing regions as they market cattle in the various demand regions, with given transportation rates. Truck costs were estimated for purposes of defining the minimum rates at which a trucker can haul feeder cattle.

Feeder Cattle Distribution in 1965

The existing patterns of feeder cattle distribution in the United States in 1965 show the traditional patterns of movement and the recently observed changes. Traditionally, the Corn-Belt area of the North

Central Region of the United States has fed most of the cattle fattened for slaughter in the large terminal market areas of Sioux City, Chicago, Kansas City, etc.

Feeder cattle were shipped from the large grazing areas of Montana, the Dakotas, Wyoming, Kansas, Oklahoma, Texas and the Rocky Mountains states. With the advent of the local auction market and direct sales from ranch to feedlot, the numbers of cattle sold through the large terminal market have declined.

The Western States have increased their feeding capacities tremendously within the last decade. Thus, the large excess supply of feeder cattle once available has declined. The South and Southeastern regions of the United States now supply a large portion of feeder cattle into the Northern and Western feeding regions.

Another trend in cattle feeding is the emphasis on larger-sized feedlots. Sixteen states report the number of feedlots by size and number of cattle on hand January 1 each year. There were 56,191 cattle feeders in those sixteen states on January 1, 1965. Two and one-half percent of the feeders in the sixteen states had feedlots with a capacity of more than 1,000 head, but that two and one-half percent marketed sixty-five percent of the fed cattle in those states.

As the feeder cattle supply area expanded from the Great Plains and Rocky Mountain states to include the South and Southeastern states, the commercial feedlots, especially those in California, Arizona, Nebraska, and Colorado, began feeding many of the light weight mixed breeds or so-called "Okie" cattle from the South and Southeast. The pattern in 1965 showed higher quality calves from the Great Plains and Mountain states were still shipped to Midwestern feedlots. But the lower quality feeders from the South and Southeast move West and North to California, Arizona, Colorado, and Nebraska.

These feeding areas demand High Good to Choice finished beef, but results of experiments show that finished beef can be produced successfully from the so-called "lower grades" of feeder cattle. It seems entirely possible that more profits can be made from feeding "lower grade" feeder cattle into High Good or Low Choice grade slaughter cattle than from Choice grade feeder cattle because of existing price differentials.

The Problem

During the 1960's the numbers of slaughter cattle marketed from feedlots increased tremendously throughout the United States. Not all regions enjoyed the same rate of increase in fed-cattle production. The greatest relative increases have occurred in the Southern Plains and Western states. The North Central states, encompassing the traditional Corn-Belt production region, continue to produce a large share of the nation's fed beef, but their relative percentage of the total market has decreased within the past five years. The impact of this relative shift in production on feeder cattle distribution patterns may be of great interest to cattle men and cattle haulers alike as they strive to minimize transportation costs from production areas to feedlots.

Further, the development of the Interstate Highway System has made trucks the most frequently used mode of shipping cattle. Therefore, the problem is twofold. First, where should the producing areas ship their excess feeder cattle to minimize shipping costs and maximize profits? Second, what type transportation should be utilized?

Objectives

The overall objective is concerned with defining the optimal shipping patterns and the changes that occur in those patterns as truck rates change. A secondary objective is to compare the optimal shipping patterns to the patterns of feeder cattle distribution as now established within the cattle feeding industry. Included in the total objective are several intermediate objectives:

(1) to define a regional demarcation of the United States for feeder cattle,

(2) to ascertain which feeding regions are deficit in feeder cattle production,

(3) to estimate the number of feeder cattle exported from or imported into each region,

(4) to show the differences between railroad rates and motor truck costs of transferring feeder cattle from production regions to alternative feeding regions,

(5) to find the volume and direction of trade between the surplus and deficit feeder cattle regions,

(6) to hypothesize what market patterns should become feasible as motor truck rates change, and,

(7) to project recent trends in the feeder cattle and cattle feeding industries to 1970 and predict the least-cost patterns of distribution under the conditions that might be expected to prevail in 1970.

Method of Analysis

The linearly programmed transportation model was the main technique used to analyze the data collected. There are five basic assumptions associated with the transportation model.

1. The product or resources are homogeneous. This means that one unit of feeder cattle from one supply region will satisfy the demand in a deficit region just as well as will one unit of feeder cattle from an alternative source of supply. It is recognized that homogeneity of feeder cattle among all regions in the United States is the ideal rather than the actual situation of existing quality differences among regions. The cattle from the Southern and Southeastern states are reputed to have less feedlot potential than the range cattle from the Northern and Southern Plains' states. Since these suspected quality differences among regions cannot be accurately measured and quantified, the alternative assumption of homogeneity among regions was used. It is recognized that any real quality differences among regions might cause the true pattern of distribution to differ from the theoretical models.
2. The supplies of resources or products that are available at the various origins and the demand for the various destinations are known; total demand must equal total supply.
3. The cost (or profit) of (or from) converting resources to products or moving the commodity from origins to destinations is known and is independent of the number of units converted or moved.
4. There is an objective to be maximized or minimized. In this study the objective is to minimize transportation costs and to maximize profits for shipping feeder cattle to market.
5. Transportation from origins to alternative destinations can be carried on only at non-negative levels. This means that a region cannot ship more than it produces and that demand regions will not ship to other demand regions.

The above five assumptions can be also shown in equation form;

$$\sum_{j=1}^{n} \sum_{i=1}^{m} X_{ij} C_{ij} = \text{minimum}$$

Subject to:

$$\sum_{j=1}^{n} X_{ij} = s_i; \quad i = 1, \ldots, \quad m$$

$$\sum_{i=1}^{m} X_{ij} = d_j; \; j = 1, \ldots, n$$

$$\sum_{i=1}^{m} s_j = \sum_{j=1}^{n} d_j$$

and

$$X_{ij} \geqslant 0 \text{ for all } i, j.$$

Where:

X_{ij} represents the number of feeder cattle shipped from the i^{th} surplus region to the j^{th} deficit region;

s_i represents the number of feeder cattle available for export from the i^{th} surplus region;

d_j is the number of feeder cattle demanded in the j^{th} deficit region; and

C_{ij} is the cost of shipping from the i^{th} surplus to the j^{th} deficit region.

In this study, the entire United States is considered for potential feeder cattle production and feeding. The potential numbers of feeder cattle which are expected to contribute the greatest share of the beef transportation problem will be emphasized. Therefore, the discussion in the following section eliminates most of the cattle which are not considered to contribute materially to the feeder cattle distribution problem.

Demand and Supply Areas

Demand Areas

The demand for feeder cattle for a given year is represented by the total number of fed cattle marketed the following year. That is, the demand for feeder cattle in 1964 can be closely estimated by the number of fed cattle marketed in 1965.

It is assumed that each region will supply its own demand before it ships cattle to other regions. If a region cannot satisfy its own demand, then it is referred to as a deficit supply area or a demand region. A region with a surplus of feeder cattle will ship to the deficit supply area (s) for which it has the greatest advantage or least disadvantage in shipping cost, relative to other surplus regions.

Supply Areas

The supply is an estimated figure of the potential number of feeder cattle which each region, under current feeding practices and technology, would have available for meeting the feeder cattle requirements in the demand regions.

The potential supply of feeder cattle was computed in the following manner. First, it was assumed that all "other" cows two years of age and over, as reported in the January 1 inventory report, supplied the calves for beef feeding. It was further assumed that all commercial calf slaughter was of dairy cow origin because many of the dairy states exhibit high calf slaughter numbers. A state-by-state estimate was made by multiplying the number of two-year-old-and-over other cows by the percent calving rate reported for all cows in each state in 1964. This produced a raw figure which had to be corrected to give a more realistic supply of feeder cattle in 1965. The death loss of calves as reported by the United States Department of Agriculture was deducted, an allowance for herd bull replacements, and then replacement heifers were considered at twenty percent of the reported numbers of "other" cows in the two-year-old-and-over category.

The second basic assumption of the general transportation model, which requires the total demand to equal the total supply, does not always exist for a given time period. An inequality of total demand and supply can easily be handled with a small modification to the transportation model. By using a dummy variable for either demand or supply, the equality condition is restored to the problem. The dummy variable is useful for handling imperfections in estimates or in available market data. If the total demand exceeds the total supply, a dummy supply variable will ship to any deficit region when all other supply is used up but there remains some unfulfilled demand. A high cost is associated with the use of the dummy supply so that the least profitable demand areas will be forced to use the higher cost supply.

In a similar manner, a dummy demand variable is used when the total supply exceeds the total demand. Unlike the dummy supply variable cost, the dummy demand has a zero cost associated with it. This simply means that once all real demand is satisfied, the excess supply is not shipped and thus adds no additional cost to the transportation solution. If the transportation problem is solved by linear programming techniques, the slack or disposal variable replaces the dummy demand variable, but the dummy supply variable must be inserted in the linear programming problem if all demand is to be satisfied.

For this study, the continental United States is divided into eighteen regions. Each region represents a geographical area somewhat homogeneous in its production and feeding capabilities and practices. Additional criteria considered for the regional demarcation included: (1) the natural barriers to transportation such as the Rocky Mountains, (2) the availability of data—in this case by whole states, and (3) the shipping distances. The smallest region by political breakdown is a single state, but most of the regions encompass two or more contiguous states. Figure 1 depicts the regional breakdown which was used for this study.

Where all of the above criteria could not be met for every region, a compromise was made among the dominant criteria affecting the particular region. It was also necessary to select a set of shipping points for each region. Ideally, the point should be near the center of the region's production or feeding area. It is assumed that the production units or feedlots are uniformly distributed about the representative point of each region. Table I gives the demarcation of states with the respective regional central shipping points.

Transfer Cost Models

The total cost of transfer must be used in any analysis of transportation costs if realistic predictions of shipment patterns are to be made.

The price paid for feeder cattle at the point of origin is important because it represents the cost of an input for the demand region. If two

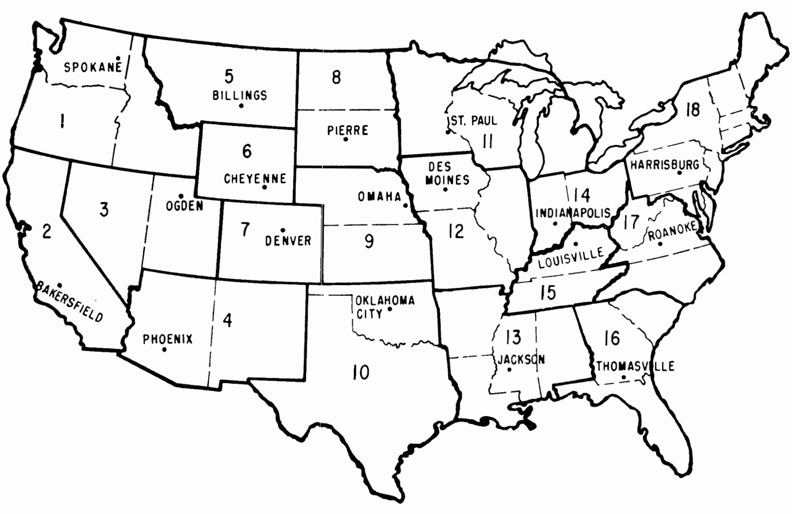

Figure 1. Regional Demarcation of the United States.

Table I—Regional Demarcation and Central Shipping Points

Region	States	Shipping Center
1	Idaho, Oregon, Washington	Bakersfield, California
2	California	Spokane, Washington
3	Nevada, Utah	Ogden, Utah
4	Arizona, New Mexico	Phoenix, Arizona
5	Montana	Billings, Montana
6	Wyoming	Cheyenne, Wyoming
7	Colorado	Denver, Colorado
8	North Dakota, South Dakota	Pierre, South Dakota
9	Kansas, Nebraska	Omaha, Nebraska
10	Oklahoma, Texas	Oklahoma City, Oklahoma
11	Michigan, Minnesota, Wisconsin	St. Paul, Minnesota
12	Illinois, Iowa, Missouri	Des Moines, Iowa
13	Alabama, Arkansas, Louisiana, Mississippi	Jackson, Mississippi
14	Indiana, Ohio	Indianapolis, Indiana
15	Kentucky, Tennessee	Louisville, Kentucky
16	Florida, Georgia, South Carolina	Thomasville, Georgia
17	North Carolina, West Virginia, Virginia	Roanoke, Virginia
18	Conn., Maine, Maryland, Mass., New Hampshire, New York, New Jersery, Pennsylvania, Rhode Island, Vermont, Delaware	Harrisburg, Pennsylvania

supply points are equidistant from a demand point, but the price of feeder cattle is higher at one supply point than the other, then the lower-priced supply point would have an advantage in shipping feeder cattle to the demand point in question.

The cash cost of production is a second transfer cost variable. Some regions have certain advantages for producing feeder cattle. Economies of size and small winter hay requirements, two factors which cause differences in cash cost of production, might be expected to cause one region to have an advantage over another region which is relatively the same distance from a specified demand point.

The third transfer cost variable, and probably the most important, is the enroute cost of shipping feeder cattle from the supply regions to demand regions. Where a supply region will ship its surplus feeder cattle depends to a large extent upon the distance to the demand region. Small differences in the price or cash cost of production cannot offset the shipping cost when differences in distances from supply to demand regions are several hundred miles. Not only is the hauling cost substantially different, but longer distances means additional shrinkage losses, and in many cases, longer return trips without a payload.

The three transportation cost variables can easily be incorporated into the transportation model. One can analyze the transportation cost by using one, two or all three of the variables. To use the price and cash cost of production, simply choose one shipping center as a base and set it's price and/or cash costs equal to zero. Then compute the price and cash cost for every other region as the deviation from the price and cash cost in the base region.

The total transfer cost for each alternative shipping route for each supply region would be the summation of the variable costs considered in each region. Therefore, this study incorporates four transfer cost models to depict the impact of each cost variable separately and then together to predict the different patterns of distribution under the different transfer cost assumptions.

Model I. Model I simultaneously considered all three variables expected to affect the profitability of transferring feeder cattle from surplus to deficit regions. In this model, the analysis of optimum distribution patterns included the price, the cash cost of production, and the transportation charges for hauling the cattle between alternative supply and demand regions.

Model II. Model II considered only the price for feeder cattle plus the transportation charges between supply and demand regions.

Model III. Model III considered the cash cost of production for feeder cattle plus the transportation charges between supply and demand regions.

Model IV. Model IV analyzed the optimum pattern for distribution when just the transportation charges between surplus and deficit regions were considered.

Each of the four models has been used to analyze optimum patterns of shipment given the 1965 distributions of feeder cattle production and feeding. In addition, these models have been used to estimate optimal patterns for the expected 1970 distributions of feeder cattle production and feeding. The differences in these two sets of optima should give some indication of the areas which might be expected to have competitive strength or weakness for future marketing of feeder cattle.

The Data

The reported number of cattle on feed marketed in 1965, which represented the demand for feeder cattle during 1964, was 17,593,000 head. Fed cattle marketings during 1965 represented an increase of thirty-six percent over the number marketed in 1960 (see Table II). The estimated number of feeder cattle potentially available for feeding in 1965 was 17,978,543 head — an increase of 24.9 percent over the numbers of feeder cattle potentially available in 1960 (see Table III).

Table II—Estimated Demand for Feeder Cattle by Regions, 1960-65

Region	1960	1961	1962	1963	1964	1965
				1,000 Head		
1. Spokane	568	612	627	636	688	745
2. Bakersfield	1595	1699	1844	1899	2061	2282
3. Ogden	162	146	142	148	171	175
4. Phoenix	581	613	697	753	766	823
5. Billings	115	113	100	98	128	141
6. Cheyenne	82	74	72	64	59	62
7. Denver	747	790	815	900	951	1144
8. Pierre	540	705	621	639	812	752
9. Omaha	1950	2284	2365	2640	3122	3073
10. Oklahoma-Texas	620	711	942	1114	1241	1394
11. St. Paul	952	977	962	987	1076	1045
12. Des Moines	4250	4291	4267	4522	4717	4649
13. Jackson	—	10	64	58	101	135
14. Indianapolis	580	587	580	612	657	631
15. Louisville	—	—	—	—	155	141
16. Thomasville	—	20	121	95	246	285
17. Roanoke	—	—	—	—	—	—
18. Harrisburg	146	141	142	124	123	116
Total	12888	13773	14361	15289	17074	17593

Table III—Potential Feeder Cattle Supply by Regions, 1960-65

Region	1960	1961	1962	1963	1964	1965
				1,000 Head		
1. Spokane	701	732	772	815	852	864
2. Bakersfield	524	527	516	536	534	559
3. Ogden	335	297	292	306	311	295
4. Phoenix	588	520	542	576	589	576
5. Billings	718	713	740	741	804	800
6. Cheyenne	319	338	341	347	374	351
7. Denver	459	481	492	522	549	536
8. Pierre	1230	1246	1314	1347	1442	1500
9. Omaha	1631	1701	1801	1917	2045	2081
10. Oklahoma-Texas	2742	3289	3392	3638	3825	3741
11. St. Paul	243	351	367	383	417	435
12. Des Moines	1540	1749	1813	1863	1975	2013
13. Jackson	1627	1505	1528	1572	1642	1639
14. Indianapolis	304	356	366	372	382	378
15. Louisville	187	606	673	744	819	847
16. Thomasville	801	652	678	749	800	798
17. Roanoke	326	402	417	447	465	445
18. Harrisburg	120	120	114	128	125	120
Total	14275	15585	16158	17003	17950	17978

The relatively larger increase in the numbers of cattle demanded for feeding, compared with the percentage increase in the supply of feeders over the same period, is easily explained. Consumers have required progressively higher average grades of beef at the retail level. Fed beef tends to be much more uniform in quality than does non-fed beef. Cattle feeding has also helped to stabilize the supply and the sources of beef for meat packers and chain food stores. More than half of all slaughtered beef in 1965 was fed beef. The remaining portion of slaughtered beef (or non-fed beef) was comprised of cull cows, cull bulls, and dairy cows. Grass-fat or range beef is a very small and declining portion of the beef industry.

Demarcation of Regions

Each of the eighteen regions had regional supply and demand for feeder cattle (with the exception of Region 17 — the northeast — for which there was no available information concerning demand). The differences between the supply and demand were computed within each region. Seven of the regions had an insufficient local supply of feeder cattle for their feeding needs. The remaining eleven regions, while they did report feeding activity within their regions (except Region 17), produced a potential supply of feeder cattle in excess of what was being fed within their regions in 1965. Table IV gives the estimated potential regional supply and demand and the net differences within each region for feeder cattle in 1965. Figure 2 shows the geographical distribution of supply and demand regions in 1965 after aggregating the total supply and demand for feeder cattle within each region.

Table IV—Estimated Regional Potential Supply and Demand for Feeder Cattle, 1965

Region	Estimated Potential Supply	Estimated Demand	Net Supply (+) or Demand (—)
	— — — —	(1,000 head)	— — — —
1. Spokane	864	745	119
2. Bakersfield	559	2282	-1723
3. Ogden	295	175	120
4. Phoenix	576	823	-247
5. Billings	800	141	659
6. Cheyenne	351	62	289
7. Denver	536	1144	-608
8. Pierre	1500	752	748
9. Omaha	2081	3073	-992
10. Oklahoma City	3741	1394	2347
11. St. Paul	435	1045	-610
12. Des Moines	2013	4649	-2636
13. Jackson	1643	135	1508
14. Indianapolis	378	631	-253
15. Louisville	847	141	706
16. Thomasville	798	285	513
17. Roanoke	445	0	445
18. Harrisburg	120	116	4

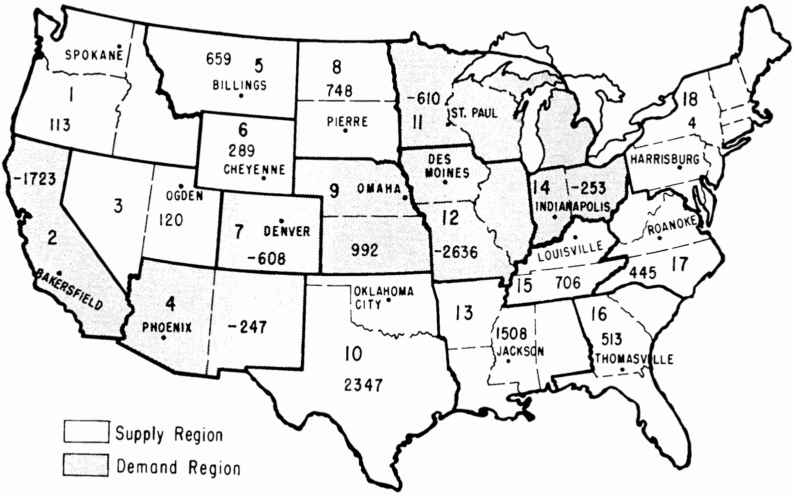

Figure 2. Estimated Regional Net Inmovement and Net Outmovement of Feeder Cattle, 1965 (1000 Head).

Truck Rates and Backhauls

The most common type of long haul rig used by cattle haulers in Oklahoma is the drop-center (or "possum-belly") semi-trailer with diesel tractor power. On short hauls, both the open-top semi-trailer and the "bob-tail" truck types are utilized.

Most of the cattle haulers interviewed in Oklahoma indicated that they were averaging in excess of 100,000 miles per truck annually. This large annual mileage greatly reduces the per mile costs for depreciation, federal use tax, licenses, insurance, administrative help, and capital investment.

The majority of long distance cattle haulers surveyed charged sixty cents per mile one-way for distances in excess of three hundred miles in length. Therefore, sixty cents per mile, one-way, has been used as the beginning point for this analysis.

A field survey was conducted to estimate the per mile cost of operating a possum belly-trailer combination headquartered in the Oklahoma area. The results of interviews with cattle haulers across Oklahoma, with two major manufacturers of tractors, and with three trailer manufacturers are shown in Table V. These cost estimates were for diesel trucks running an average of 100,000 miles per year. Information on operating

Table V—Operating Cost for Trucks

	Cost/Mile (cents)
Tractor:	
Maintenance and Repairs	.030
Fuel (plus fuel use tax—$.055/gal.)	.051
Depreciation	.022
Tires	.010
Wash and Lube	.003
Interest	.004
Substitute tractor ("down time")	.004
	.124
Trailer:	
Maintenance and Repairs	.005
Depreciation	.015
Tires	.008
Wash and Lube	.003
Interest	.002
	.033
Fixed Unit Costs:	
Driver	.080
License	.007
Federal Use Tax	.002
Insurance	
Public Liability and Property Damage	.010
Collision and Comprehensive	.008
Cargo (2½% of load value)	.002
Workman's conpensation (6.5% of income)	.005
Other overhead — office, etc.	.020
	.134
Total Cost Per Mile	.291

costs of smaller trucks and for trucks traveling less annual mileage may be found in the appropriate references in the bibliography. Since this study is concerned with interstate and interregional movements, the cost estimates for trucks operating under conditions similar to the data in Table V are considered to be the most relevant.

A per-mile operating cost of $.29 for operating the truck and semi-trailer leaves little room for profit at a $.60 per mile one-way rate if the trucker does not have backhauls.

Backhauls are desirable, but unfortunately are irregular, inconvenient, or seasonal in nature for many of the truckers. In addition, a small operator usually does not have the necessary contacts to insure regular backhauls.

Because backhauls definitely affect the competitive position of motor truck versus railroads, and because the carriers interviewed indicated that backhauls were available on about one-third of the cases, a backhaul frequency of one-third was assumed. Without any backhauls the trucker would get $.60 for each mile, one-way. If he were able to get backhauls one-third of the time, he could charge a one-way rate of $.46 per mile, and still earn the same per mile income as with the $.60 rate without backhauls. Thus, the $.46 per mile rate was an alternative motor truck rate for which optimum solutions were computed. This reduction in rate recognizes that independent truckers will — when the possibility of backhauls exists — cut rates substantially in order to compete with other carriers for the available freight.

It also is appropriate to consider trucks to be fully loaded for long distance hauls. The forty-foot possum belly semi-trailer has the equivalent of a sixty-foot single deck trailer. An average weight of five hundred pounds per animal is assumed for all feeder cattle. Thus, sixty-five head will constitute a full load.

Rail Rates

Although motor truck transportation accounts for most of the intrastate movement of cattle (Table VI), railroads still compete for the longer haul destinations. Actual point-to-point price rates were obtained for cattle shipments by rail.[4] The standard for comparing railway charges with motor truck rates was a forty-foot by eight foot boxcar with a capacity for fifty head of five hundred-pound feeder cattle.

Price of Feeder Cattle and Cash Cost of Production Variables

A second variable considered to affect the pattern of regional shipments was the price of the feeder animal. The prices for Good 500-800 pound feeder steers were determined from price data for markets in each region. The Good grade price was used because price data for Choice grade feeder steers were not available for all regions. The price used for each region was a nine-year average for 1956-64. The price at Oklahoma City was defined as the base price. The prices for other regions were computed in terms of the differential from the price of feeder cattle in Oklahoma City (Table VII).

Theoretically, price differences between market points should approximate the transportation cost. This means that the further an area is from the terminal market, the lower the price must be in the shipping region to allow for the increased transportation cost. If this condition does not exist for two sales points, then either these sales points are in

[4]Railroad charges were furnished by Lowell Waitman, General Livestock Agent, the Atchison, Topeka and Santa Fe Railway Company, Wichita, Kansas. (See Appendix A).

Table VI—Method of Transporting Beef Cattle, Twelve Western States, 1962

State	Truck (Percent)	Rail (Percent)
Arizona	91.0	9.0
California	73.0[1]	27.0[1]
Colorado	NA	NA
Idaho	NA	NA
Montana	65.0	35.0
Nevada	88.0	12.0
New Mexico	61.0	39.0
Oregon	NA	NA
Utah	72.0	28.0
Washington	95.0[2]	5.0[2]
Wyoming	93.0	7.0
Texas	72.0	28.0
Total	74.3[3]	25.7[3]

[1]Inshipments only.
[2]Estimate
[3]Weighted by state marketings of cattle and calves, 1961

Table VII—Regional Price and Cash Cost of Production Estimates, 1965

Region	Price/cwt. (Ave. 1956-64)	Price Dif.	Cash cost/cwt.	Cash Cost Dif.
1	$21.80	$ -.60	$23.70	$11.66
2	22.37	-.03	24.31	12.27
3	21.68	-.72	14.95	2.91
4	21.95	-.45	9.32	-2.72
5	22.65	.25	9.39	-2.65
6	21.76	-.64	13.62	1.58
7	22.37	-.03	13.62	1.58
8	22.80	.40	12.10	.06
9	23.06	.66	16.95	4.91
10	22.40	0	12.04	0
11	22.75	.35	16.95	4.91
12	23.32	.92	16.95	4.91
13	21.50	-.90	17.09	5.05
14	21.67	-.73	21.13	9.09
15	21.58	-.82	21.13	9.09
16	21.13	-1.27	17.09	5.05
17	23.43[1]	1.03	19.10	7.06
18	23.43[1]	1.03	21.13	9.09

[1]Estimated

separate market areas or there are other factors compensating for the transportation cost differential.

A third variable potentially affecting the competitive position of each region was the cash cost per hundred pounds of feeder animal produced. The cash cost is the most relevant comparative index of interregional production efficiency and comparative advantage for feeder cattle production. To compute the cash cost of production, the following procedure was used. First, all annual inputs of expenditures were determined for a hundred-cow production unit. These annual inputs included: Native range, improved pasture, hay, feed supplement, minerals, veterinarian and medicine, bull depreciation, hauling and marketing cost, miscellaneous costs, interest, repairs and depreciation, taxes, and insurance.

Second, the value of the sale of cull cows was subtracted from the annual input expense. Third, the number of pounds of feeder cattle produced for sale was determined. Fourth, the annual input cost minus the value of cull cows was divided by the total pounds of feeder cattle to get the cash cost per pound of feeder animal. The cost of land was not considered because that cost often includes other factors such as mineral rights which have little to do with the agricultural productivity of that land. Oklahoma City was defined as the base point and the cash costs of production in other regions were computed as differentials from the cash cost in the region represented by Oklahoma City. Table VII gives the cash cost of production for each region. Figure 3 shows the specific areas for which the cash cost of production was computed. The cost of the specific areas within each region was used to represent the cash cost for the entire region.

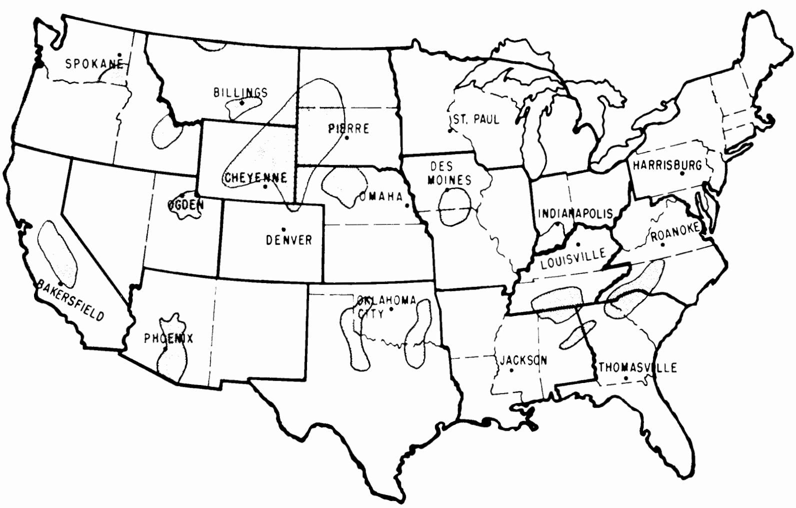

Figure 3. Areas within Regions Used to Calculate Cash Cost of Production for Entire Region.

Feeder Cattle Production

Feeder cattle are produced throughout the United States but production in the Northeastern and Lake States is small compared with that in other regions (Figure 4). The Southern Plains produce the largest share of feeder cattle, followed by the Central Plains and Western Corn Belt Regions. The South Central States and Northern Plains complete the five main areas of feeder cattle production.

The top ten potential feeder cattle producing states in 1965 were: Texas, Nebraska, Oklahoma, South Dakota, Kansas, Missouri, Montana, Iowa, California, and Colorado. However, the picture changes drastically when the individual state demands for feeder are considered. The heavy-feeding states such as California, Colorado, Iowa, and Nebraska actually are deficit supply regions since they feed more cattle than they produce. This problem is concerned only with surplus feeder cattle production which may potentially be shipped via interstate or interregional channels.

Projection for 1970

A five-year projection of the trends in demand and supply represents a hypothesis of the relative shifts expected to occur in the regional production and utilization of feeder cattle. The projection of the numbers of cattle demanded for 1970 was derived by first considering the

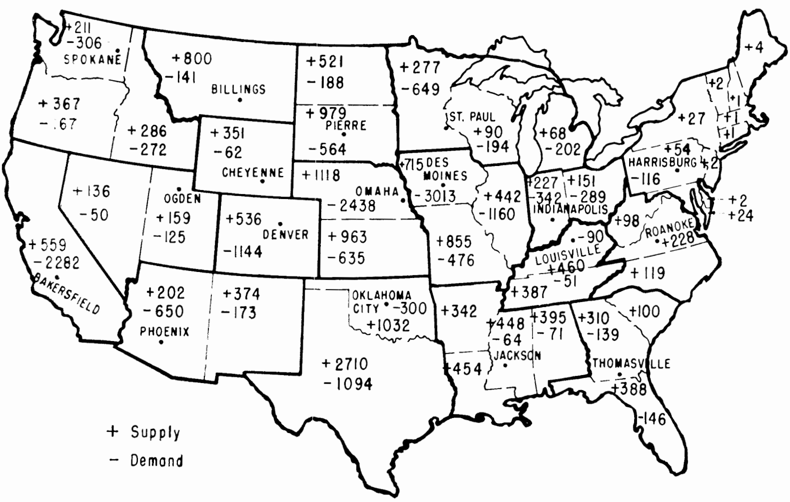

Figure 4. Estimated Potential Supply and Demand for Feeder Cattle, 1965 (1000 Head).

numbers of feeder cattle demanded within the eighteen regions and for the United States for 1960 through 1965. A least squares regression function was fitted to these data. The trend was limited to 1960-65 data since data for some regions were unavailable prior to 1960.

More data were available for analyzing the trend in production. Potential supply data were used for the years 1945 through 1964. Again a least squares regression function trend line was fitted to the data by regions and for the United States as a whole.

Production and utilization projections were computed for 1970 for each region and for the United States. Since the sum of the parts must equal the whole, the regional trend estimates were adjusted on a percentage basis such that the sum of the individual regional predictions would equal the expected total United States trend in both production and utilization (Table VIII and Figure 5).

Results For 1965

Model I

Model I analyzed the impact on the feeder cattle market pattern distribution from the eleven supply regions to the seven demand regions using simultaneous consideration of all three transport-comparative supply cost variables: mileage cost, local market price differential, and production cost differential.

Table VIII—Estimated Projected Regional Potential Supply and Demand for Feeder Cattle, 1970

Region	Estimated Potential Supply	Estimated Demand	Net Supply (+) or Demand (−)
	— — — —	(1,000 head)	— — — —
1. Spokane	1005	892	113
2. Bakersfield	635	2895	-2260
3. Ogden	351	190	161
4. Phoenix	545	1082	-537
5. Billings	945	154	791
6. Cheyenne	399	36	363
7. Denver	586	1447	-861
8. Pierre	1747	984	763
9. Omaha	2288	4401	-2113
10. Oklahoma City	4104	2225	1879
11. St. Paul	492	1176	-684
12. Des Moines	2331	5238	-2907
13. Jackson	2065	305	1760
14. Indianapolis	477	719	-242
15. Louisville	941	15	926
16. Thomasville	992	681	311
17. Roanoke	559	0	559
18. Harrisburg	159	85	74

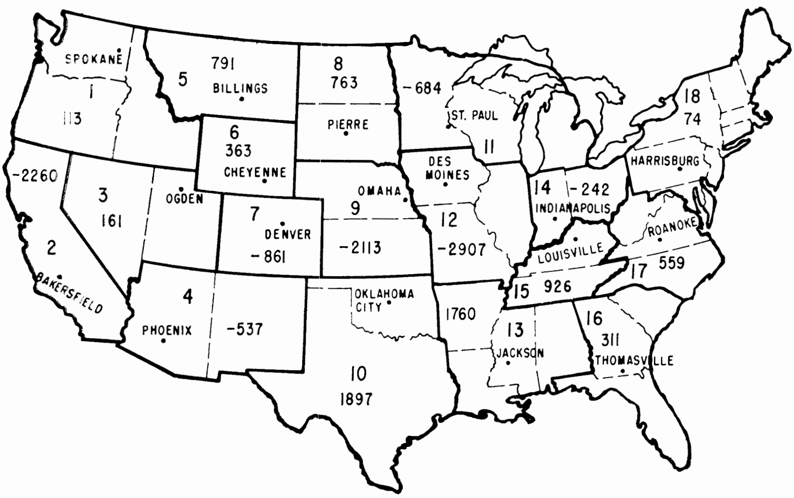

Figure 5. Estimated Regional Net Inmovement and Net Outmovement of Feeder Cattle, 1970 (1000 Head).

The rate for trucks was set at sixty cents per load mile, assuming no backhauls, and the problem of whether to ship by motor truck or by railroad and in what quantities was analyzed in each case. The results show that the railroads have a definite advantage in the cost of transportation in the absence of motor truck backhauls and should be utilized for all interstate movements except the relatively short ones. Figure 6 shows the geographic directions and the magnitudes of movements.

The Far West (Bakersfield) would be expected to receive about forty-five percent of its feeder cattle from the Billings and Ogden supply regions and the remaining fifty-five percent from the Oklahoma-Texas supply region. Phoenix would optimally receive all of its supply of feeders from the Oklahoma-Texas area. Oklahoma and Texas should also account for more than half of Denver's inshipments while Cheyenne should ship all of its available supply to Denver to fulfill Denver's demand.

In the Midwestern demand region of Omaha, the Oklahoma-Texas supply region would optimally account for eighty-four percent of the inshipments with the remainder coming from Pierre in the North and Jackson in the South. St. Paul would be supplied solely by the Pierre supply region. In the heart of the Corn-Belt states, Des Moines would draw heavily from the Southeastern quarter of the United States represented by the Louisville, Jackson and Thomasville supply regions. The

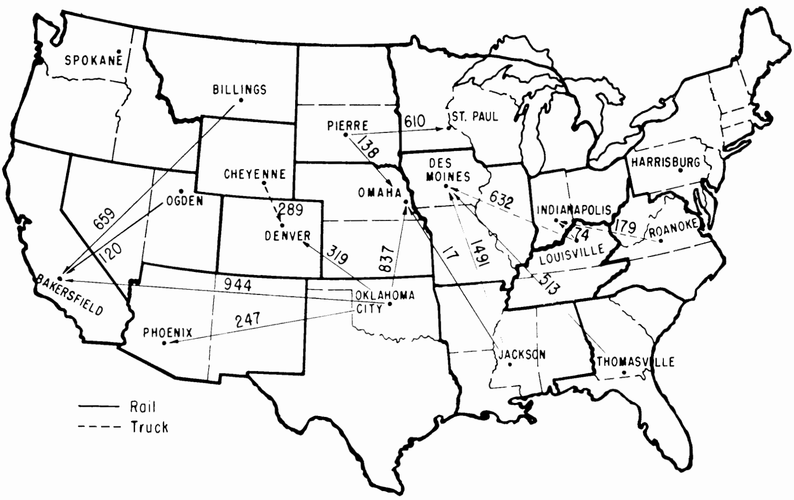

Figure 6. Interregional Flows of Feeder Cattle According to Model I with Truck Rate of $.60 Per Mile, 1965 (1000 Head).

Eastern Corn-Belt region of Indianapolis would be supplied by Louisville and Roanoke.

Because the total supply exceeded the total demand (that is, more cattle were produced than were fed), two supply regions would not have a feasible market for their small supplies under the postulated conditions. Spokane in the Northwest and Harrisburg in the Northeast would ship no feeder cattle at all in Model I.

Model II

Model II analyzed the impact upon the optimum distribution pattern of feeder cattle when only the price differentials and transportation charges were used as determinants, assuming no motor truck backhauls and a truck rate of $.60 per load mile. The analysis of Model II indicated that without consideration for the cash cost of production, optimum shipping patterns are altered slightly. Railroads continued to have a substantial advantage in transportation cost over motor trucks except for the very short hauls. Figure 7 shows the geographic directions of the optimal distribution.

Bakersfield would be supplied by the Spokane, Ogden, Billings and Oklahoma-Texas regions with eighty-six percent of the inshipments coming from the Billings and Oklahoma-Texas regions. Again, the Oklahoma-Texas region should account for all needs in the Phoenix area.

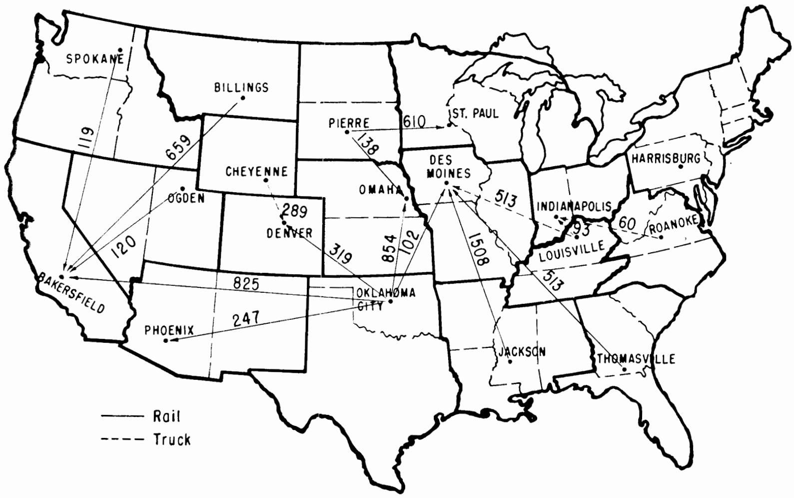

Figure 7. Interregional Flows of Feeder Cattle According to Model II with Truck Rate of $.60 Per Mile, 1965 (1000 Head).

Denver would be supplied by the Oklahoma-Texas and Cheyenne supply regions as in Model I. In the Midwest, Omaha would continue to depend upon the Oklahoma-Texas supply region for most of its inshipments of feeder cattle, with Pierre supplying about fourteen percent of the feeder cattle for Omaha. Pierre was the only supply region expected to ship into the St. Paul demand area. In Model II, the Des Moines demand region again would receive most if its supply from the South and Southeastern regions of Louisville, Jackson, and Thomasville, but the Oklahoma-Texas region would also supply more than 100,000 head of feeder cattle to this region. The Eastern Corn-Belt region of Indianapolis again would optimally receive inshipments of feeder cattle only from the Louisville and Roanoke supply regions.

Without the cash cost of production differentials considered in the model, the transportation cost overshadows the relatively small price differentials among regions. Therefore, Spokane is close enough to Bakersfield to competitively supply Bakersfield. The Oklahoma-Texas region would ship fewer feeder cattle to Bakersfield under the conditions of Model II than those of Model I because of the entrance of the Spokane shipments to Bakersfield in Model II. Thus, the Oklahoma-Texas region has more feeder cattle available to ship to the Omaha and Des Moines regions in Model II.

Another difference in the results from Model II compared with Model I is that Louisville ships more feeder cattle to Indianapolis under the conditions of Model II. Jackson ships its entire supply to the Des Moines region in Model II while discontinuing its shipments to Omaha. The Oklahoma-Texas region in Model II replaces the quantity supplied to Omaha by Jackson in Model I and in addition, Oklahoma-Texas exhausts its remaining supply by shipping to the Des Moines region. Because Oklahoma-Texas has taken part of the Des Moines market in Model II, a part which Louisville had in Model I, Louisville increases its shipments to Indianapolis, thereby decreasing the share of the Indianapolis market available for Roanoke.

The Northeastern supply region of Harrisburg still would not ship its small supply of feeder cattle under the conditions of Model II.

Model III

Model III analyzes the impact of the differentials in cash costs of production and the transportation rate on the optimum pattern of distribution of feeder cattle marketings. Ignoring the possibility of truck backhauls, the results of the optimum problem solution for Model III show essentially the same distribution of feeder cattle as Model I except that Roanoke would ship to Des Moines as well as Indianapolis (Figure 8). The only other change is that Louisville would ship only to Des Moines in Model III rather than to both Des Moines and Indianapolis.

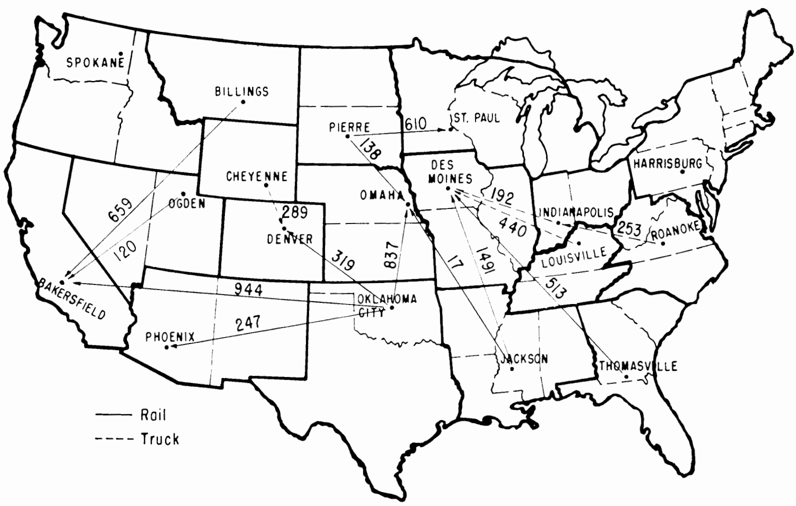

Figure 8. Interregional Flows of Feeder Cattle According to Model III with Truck Rate of $.60 Per Mile, 1965 (1000 Head).

As in Model I, neither Spokane in the Northwest nor Harrisburg in the Northeast would make any shipments under the conditions of Model III.

Model IV

In Model IV the optimum feeder cattle market distribution was estimated using only the enroute costs of transportation. This model defines the least-cost array of shipments, with a truck rate of $.60 per load mile. The optimum solution for Model IV was identical with the distribution defined by Model II. This indicates either that the existing price differentials are in fact compatible with the optimum pattern that should theoretically prevail (i.e., that the price differentials do reflect transportation costs) according to the transportation cost, or that the influence of the transportation cost is such a dominant determinant of market patterns of feeder cattle shipments that the price differentials are inconsequential. Figure 9 shows the geographical directions of the distribution.

Influence of Backhauls on the Optimum Solution

To this point, the optimum solution has been considered under the assumption that no backhauls were available to alter the revenue picture

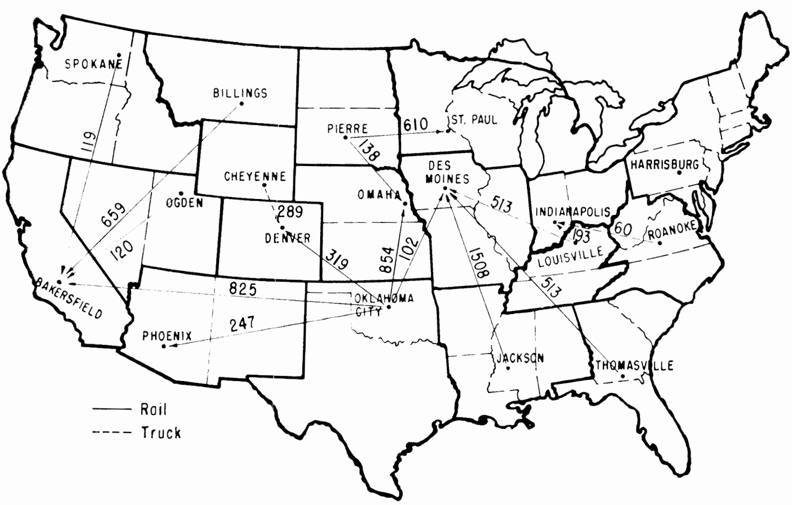

Figure 9. Interregional Flows of Feeder Cattle According to Model IV with Truck Rate of $.60 Per Mile, 1965 (1000 Head).

for the motor truck carriers. Without backhauls, the trucker must charge enough when the truck is loaded to pay for the return trip.

The results of the $.46 per load mile charge for trucks, accounting for the presence of backhauls in about one-third of the cases while keeping the rail rate constant, suggest that current shipping practices of hauling most of the feeder cattle by truck are generally consistent with the expected economic optimum. Generally, the optimum shipping direction and patterns remain about the same as the $.60 per load mile charge for motor trucks, but with trucks replacing railroads in the majority of interregional shipments. Figures 10 through 13 give the results of the optimum model solutions with a truck rate of $.46 per load mile.

When the truck rate was decreased from $.60 to $.46 per load mile, some significant changes are worth noting in addition to the fact that most of the hauls shift to truck transportation at the $.46 per load mile rate. In the West, Bakersfield would be expected to receive only forty percent of Billings' supply of feeder cattle under the $.46 rate whereas it would receive all of Billings' supply at the $.60 truck rate. The Oklahoma-Texas region would substantially increase its supply shipments to Bakersfield to replace the reduced supply from Billings. Billings replaces the Oklahoma-Texas region as a source of supply for part of Denver's demand. The Bakersfield and Phoenix demand regions continue to be supplied entirely via railroad while the remainder of the United States is served by trucks except for a small shipment to Omaha from Jackson

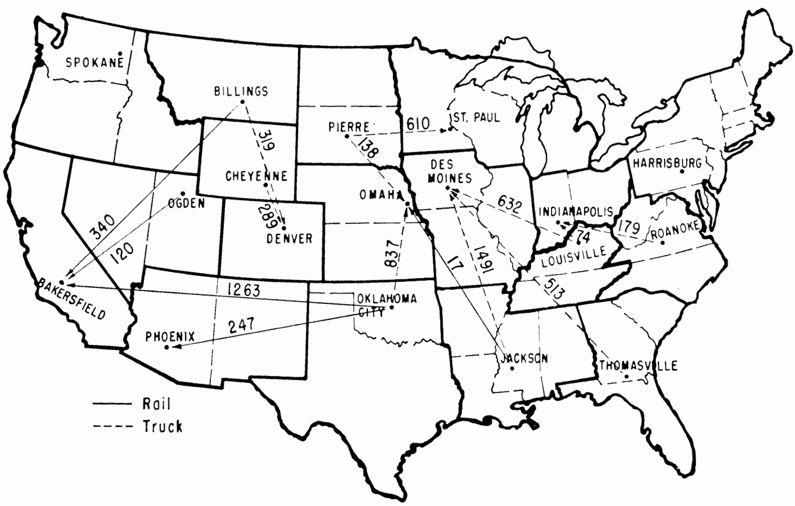

Figure 10. Interregional Flows of Feeder Cattle According to Model I with Truck Rate of $.46 Per Mile, 1965 (1000 Head).

in Models I and III and a small shipment to Des Moines from Oklahoma-Texas in Models II and IV. Except for the specific cases just pointed out, the optimum solutions at the $.46 truck rate are identical with the quantities and patterns of shipments as the $.60 rate optimum solutions.

Regional Patterns of Actual Feeder Cattle Distribution in 1965

California, (represented by Bakersfield in the analytical model) actually shipped very few nonfed or feeder cattle out of state in 1965. It had many more inshipments than outshipments and, therefore, was a deficit supply area. It received forty percent of its feeder cattle from Texas, sixteen percent from Arizona, ten percent from Oregon, eight percent from Nevada, four percent from New Mexico, three percent from Idaho, Oklahoma, and Utah, a few from Colorado and Kansas, and about ten percent from miscellaneous sources which were mainly the Southern states.

Arizona and New Mexico (Phoenix in the model) received the majority of their inshipments of feeder cattle from the Southern Plains and the Southeast. Arizona actually shipped over eighty percent of its 331,000 head of exported stocker-feeders into California and most of its inshipments moved into the two principal feeding areas around Phoenix and Yuma. New Mexico exported more feeder cattle than it

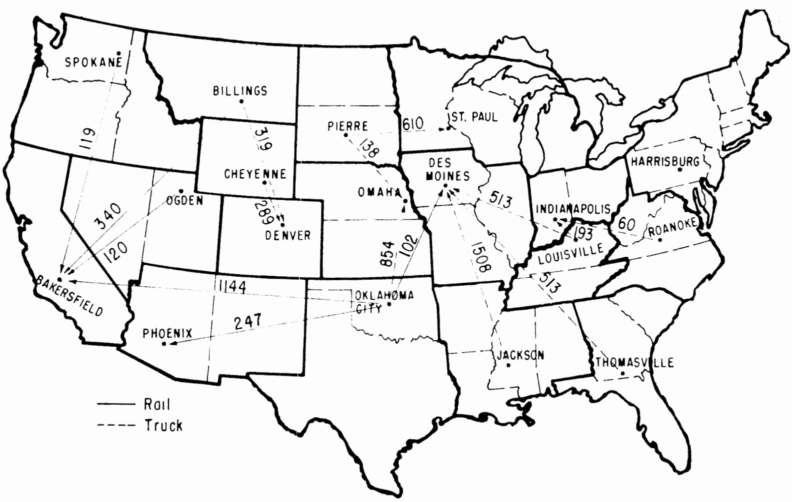

Figure 11. Interregional Flows of Feeder Cattle According to Model II with Truck Rate of $.46 Per Mile, 1965 (1000 Head).

imported in 1965. Texas supplied fifty-five percent of Arizona's inshipments. The remainder of Arizona's inshipments came mostly from four other sources: about seven percent each from New Mexico and Oklahoma, fifteen percent from Old Mexico, and fourteen percent from the Gulf States. Texas supplied most of the inshipments to New Mexico while New Mexico exported the majority of its stocker-feeders into Colorado, Kansas, Oklahoma, and Texas feedlots.

Colorado (Region 7, represented by Denver in the analytical model), exported feeder cattle into every state bordering it but the main pattern of shipments moved east into Nebraska, Kansas and the Western Corn-Belt region. Colorado actually imports more stocker-feeder cattle than it exports which makes it a demand region as shown in the model. Colorado received thirty-nine percent of its inshipments from Texas, fourteen percent from Kansas, thirteen percent from New Mexico, nine percent from Nebraska, eight percent from Wyoming, seven percent from Oklahoma, small inshipments from Idaho and Montana, and seven percent from other sources in 1965.

The Nebraska-Kansas feeding region (Omaha) shipped very few feeder cattle to points outside its area but received large numbers of feeder cattle from Colorado, Texas-Oklahoma, Wyoming, and Montana in 1965.

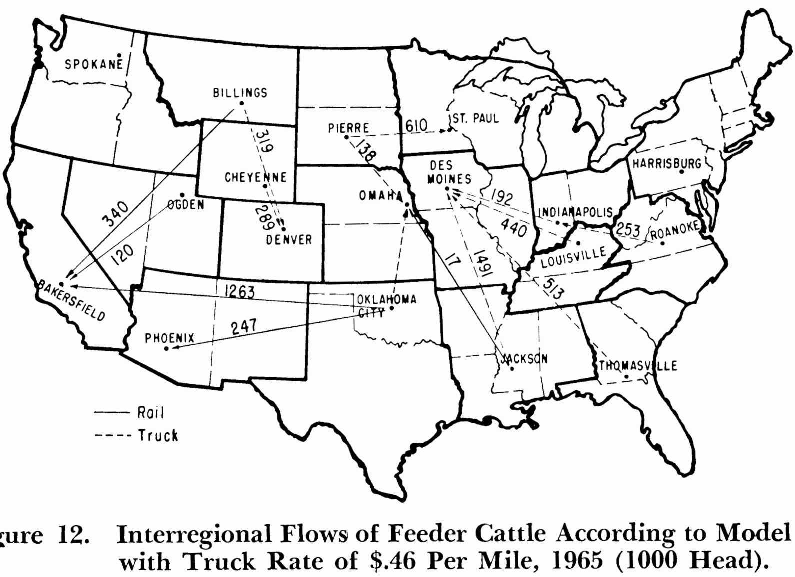

Figure 12. Interregional Flows of Feeder Cattle According to Model III with Truck Rate of $.46 Per Mile, 1965 (1000 Head).

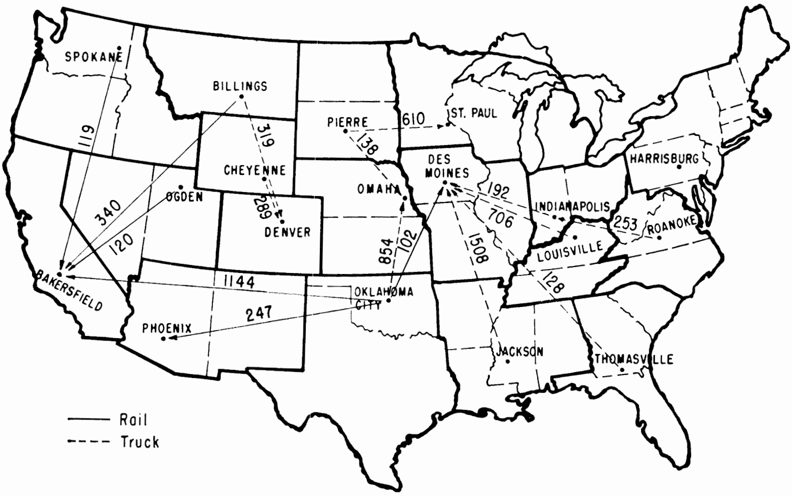

Figure 13. Interregional Flows of Feeder Cattle According to Model IV with Truck Rate of $.46 Per Mile, 1965 (1000 Head).

The Corn-Belt states which comprise Region 12 (Des Moines) and Region 14 (Indianapolis) received inshipments of feeder cattle from Montana, Wyoming, the Dakotas, Colorado, Oklahoma, Texas, New Mexico, Alabama, Mississippi, and Tennessee in 1965. Table IX shows the trend of feeder cattle shipments into the North Central states by state or origin during recent years.

The results from the computer analysis of the transportation problem for 1965 — with but two exceptions — follow rather accurately the overall shift actually observed in the market pattern for shipping feeder cattle in the United States. The analytical model indicates that Montana should be expected to ship much of its supply into California. The data on livestock movements show that Montana in fact ships most of its cattle into the Midwest or North Central states and very small amounts into California.

The model also shows that Wyoming (Region 6) should ship mostly into Colorado but the movement data indicate that Wyoming has its largest market in Nebraska and the Western Corn-Belt region. These differences between the actual shipping patterns and the theoretical model are most likely explained as a weakness of the assumption concerning homogeneity of feeder cattle among regions. As was indicated previously, the homogeneity assumption represents an *ideal* situation rather than one which actually exists.

Table IX—Direct Shipments of Stocker-Feeder Cattle and Calves into Selected North Central States by State of Origin

	1959	1960	1961	1962	1963	1964	1965
Alabama	—	—	—	27,923	27,852	30,374	29,539
Arizona	2,784	661	3,413	2,561	3,327	6,683	2,830
California	4,971	1,902	3,003	8,730	21,504	5,115	4,196
Colorado	132,819	154,712	137,350	181,139	163,613	209,590	117,870
Idaho	30,241	20,784	26,333	38,334	25,761	48,450	50,264
Illinois	15,874	16,064	16,409	14,025	32,557	37,552	25,207
Iowa	44,356	44,857	40,695	61,845	63,598	68,410	66,046
Kansas	448,984	351,528	355,187	473,952	545,421	554,708	431,243
Kentucky	—	—	—	59,602	92,511	105,745	121,149
Minnesota	—	—	—	44,092	41,334	44,944	77,397
Mississippi	—	—	—	54,012	69,775	75,435	61,584
Missouri	218,715	190,560	216,219	285,591	303,300	290,281	353,391
Montana	458,903	543,217	516,475	499,490	412,942	507,541	541,395
Nebraska	360,401	372,861	348,722	394,436	377,966	426,276	349,173
Nevada	7,006	3,048	4,578	7,410	3,024	5,391	4,534
New Mexico	58,276	71,296	48,150	143,766	104,446	96,895	65,315
North Dakota	—	—	—	213,458	165,832	196,815	242,041
Ohio	—	—	—	4,713	5,514	6,708	8,776
Oklahoma	148,139	113,112	156,801	209,425	199,281	209,339	207,685
Oregon	18,520	11,630	16,480	39,220	13,193	36,490	40,494
South Dakota	577,317	497,140	508,543	476,592	464,759	510,916	544,899
Tennessee	—	—	—	34,650	32,271	34,440	35,814
Texas	354,022	391,302	416,599	562,573	526,765	448,943	386,173
Utah	6,589	4,417	4,199	6,228	6,119	6,245	6,587
Washington	4,593	1,443	3,420	8,023	2,810	8,005	10,739
Wisconsin	—	—	—	50,958	66,365	55,537	39,474
Wyoming	183,986	195,340	198,772	206,298	203,234	214,139	222,361
Other States	752,712	761,406	968,699	272,285	260,262	215,969	185,835
Canada	—	—	—	222,380	124,875	81,165	329,261
Total	3,829,208	3,747,280	3,990,047	4,603,711	4,360,211	4,538,101	4,561,272

The feeder cattle from the Northern Plains region tend to be the high quality, "reputation" type of animals which have traditionally been placed on feed in the Corn-Belt. The tendency of Corn-Belt feeders to demand the higher quality animals is partially illustrated by the fact that Corn-Belt terminal markets have normally exhibited the highest average prices of any region in the United States (see Figure 14). California's average price for the higher grades of feeder cattle is lower than the average price for those grades in the Corn-Belt region; therefore, Montana tends to ship her high quality cattle to the higher priced area. For the same reason, Wyoming ships into the Corn-Belt region rather than into Colorado. California and Colorado both have adequate sources of feeder cattle inshipments at lower prices than Montana and Wyoming.

Thus, the Southern Plains are in a very favorable position to supply California and Colorado. The analytical model considers only the net movement of feeder cattle between regions, and, therefore, the solution will only show the particular region either as a deficit or surplus region.

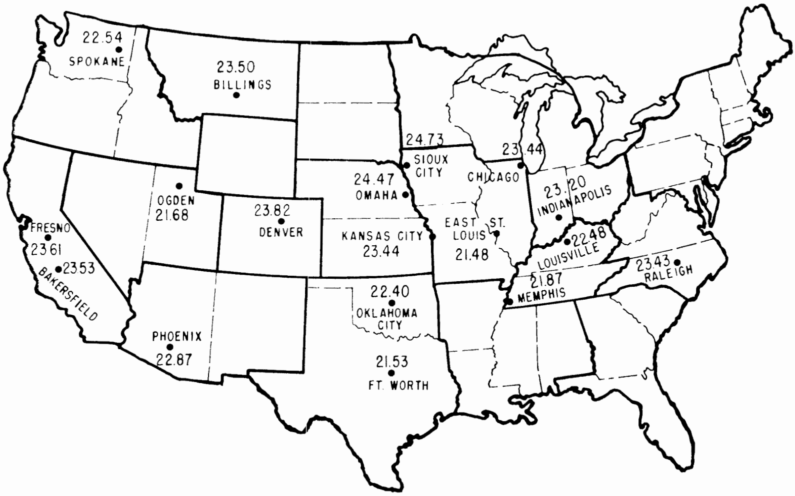

Figure 14. Average Prices for Good 500-800 Pound Feeder Cattle From 1956-64 for Various Markets in the United States. Source: U. S. Department of Agriculture, AMS, Livestock Division Market News Service.

This assumes that local demand will be supplied by local supply, if it exists, before requiring inshipments. There is no accurate means for analytically estimating the extent to which different regions exchange supplies. Obviously, those cattle produced near state lines can be marketed in either of the two states concerned with about equal facility.

Cost Analysis of Models for 1965

The preceding discussion outlined the general optimum shipment patterns for the different models in terms of quantities shipped and the geographical distribution. Each of the optimum solutions also specified the transfer cost per hundredweight and the cost ranges over which the optimum solution remains unchanged.

A detailed explanation of two model solutions will illustrate the usefulness of the cost ranging information contained in the linear programming solution. The illustration will begin with a truck rate of $.60 per mile for 1965 quantities and then compare the changes which occur as the truck rate decreases to $.46 per mile for 1965 quantities.

The first model solution considered is Model IV with a truck rate of $.60 per mile. Starting from the left side of Table X the first three columns of Origin, Destination, and Quantity Shipped are self-explana-

Table X—Cost Analysis of Model IV Optimum Solution with Truck Rate of $.60 Per Mile, 1965

				Cost Range over which Optimum Solution Remains Unchanged			
Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/cwt. ($)	Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Spokane	Indianapolis	659*	1.59	INFINITE	UNBOUNDED	2.11	Spokane-Bakersfield
Ogden	Des Moines	825*	1.59	1.44	UNBOUNDED	1.42	Ogden-Bakersfield
Billings	Denver	247*	1.28	INFINITE	UNBOUNDED	1.74	Billings-Denver*
Oklahoma City	Indianapolis	289	.19	INFINITE	Billings-Denver*	1.78	Jackson-Bakersfield*
Oklahoma City	Bakersfield	119*	1.38	INFINITE	UNBOUNDED	1.41	Jackson-Phoenix*
Cheyenne	Bakersfield	120*	.97	INFINITE	UNBOUNDED	.38	Cheyenne UNUSE
Oklahoma City	Bakersfield	138*	.67	.52	Cheyenne-Bakersfield*	.84	Pierre-Denver*
Pierre	Bakersfield	854*	.68	.66	Jackson-St. Paul*	.70	Pierre-Denver*
Oklahoma City	Phoenix	610*	.68	INFINITE	Pierre-Denver*	.75	Jackson-Omaha*
Pierre	Denver	513	1.06	.94	UNBOUNDED	.73	Pierre-St. Paul
Louisville	Omaha	102*	.74	.67	Thomasville UNUSE	1.17	Roanoke-Des Moines
Oklahoma City	Omaha	1508*	1.16	INFINITE	Jackson-Omaha*	.78	Pierre-Des Moines*
Jackson	St. Paul	513*	1.56	INFINITE	UNBOUNDED	1.23	Jackson-Omaha*
Thomasville	Des Moines	193	.21	.09	UNBOUNDED	1.65	Thomasville-Omaha
Louisville	Des Moines	60	.83	.71	Roanoke-Des Moines	.32	Thomasville UNUSE
Roanoke	Des Moines	319*	.82	.46	Thomasville UNUSE	.95	Roanoke-Des Moines

*Railroad shipments.

tory. The column headed "Transfer Cost/Cwt." gives the present transfer cost for shipping one hundred pounds of feeder cattle from the corresponding origin to the designated demand point. The next four columns come under the general heading "Cost Range over which Optimum Solution Remains Unchanged." In other words, the last four columns give the interval within which the transfer cost may vary without generating a change in the optimum solution.

Should the cost of transfer be outside the specified interval, the sixth and eighth columns define the first change that would be made in reaching a new optimum. If, for example, the cost of shipping from Oklahoma City to Bakersfield should decrease by $.15 (i.e., if the cost should fall from $1.55 to $1.44) per hundredweight, Billings will begin shipping to Denver by rail.

At the other end of the interval, if the rate from Oklahoma City to Bakersfield should increase to $1.78 per hundredweight (an increase of $0.19), Jackson will begin to ship to Bakersfield by rail, thus partially replacing Oklahoma City in the Bakersfield market. When an incoming vector gives the name of the shipping point followed by the word "UNUSE," this indicates that that particular shipping point is forced out of competition and has no feasible market to which to ship its feeder cattle. Any shipment route which has an "INFINITE" lower limit will continue to ship to the same point as in the current optimum solution regardless of any decrease in the shipping cost.

Two generalizations may be drawn concerning the cost range from the West Coast to the Eastern Corn-Belt. For all model solutions, the cost ranges over which the optimum solution remained unchanged were very wide on the West and East coasts but very narrow (i.e., sensitive to change) through the mid-section of the country. If the rates were to increase or decrease by $.05 per hundredweight or less for five different shipments into the Great Plains or the Corn-Belt, the optimum solution would change. The second generalization is that the optimum solution is more sensitive to change from rate increases than rate decreases.

The optimum solution for Model IV with a truck rate of $.46 per mile for 1965 quantities gives the same general geographic distribution of shipping as with the $.60 per mile rate for trucks (Table XI). The primary difference with the lower truck rate is that most of the shipping is done by trucks whereas the $.60 truck rate caused most shipments to be sent by railroad. Another difference (other than a reduction in the "transfer cost per cwt." column) is that as the truck rate is decreased, the interval for cost changes is likewise reduced.

Table XI—Cost Analysis of Model IV Optimum Solution with Truck Rate of $.46 Per Mile, 1965

Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/ cwt. ($)	Cost Range over which Optimum Solution Remains Unchanged			
				Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Spokane	Bakersfield	119*	1.38	INFINITE	UNBOUNDED	1.62	Spokane-Bakersfield
Ogden	Bakersfield	120*	.97	INFINITE	UNBOUNDED	1.09	Ogden-Bakersfield
Billings	Bakersfield	340*	1.59	1.58	Oklahoma-Denver*	1.94	Billings-Bakersfield
Oklahoma City	Bakersfield	1144*	1.59	1.24	Ogden-Phoenix	1.60	Oklahoma-Denver*
Oklahoma City	Phoenix	247*	1.28	INFINITE	UNBOUNDED	1.40	Oklahoma-Phoenix*
Billings	Denver	319	.81	.46	Cheyenne-Bakersfield	.82	Oklahoma-Denver*
Cheyenne	Denver	289	.14	INFINITE	UNBOUNDED	.38	Cheyenne UNUSE
Pierre	Omaha	138	.55	.55	Pierre-St. Paul*	.59	Pierre-Denver
Oklahoma City	Omaha	854	.67	.65	Pierre-Denver*	.68	Oklahoma-Omaha*
Pierre	St. Paul	610	.56	INFINITE	UNBOUNDED	.56	Pierre-St. Paul*
Jackson	Des Moines	1508	1.16	INFINITE	UNBOUNDED	1.16	Jackson UNUSE
Louisville	Des Moines	706	.81	INFINITE	UNBOUNDED	.90	Louisville-Indianapolis
Thomasville	Des Moines	128	1.50	1.45	Louisville UNUSE	1.52	Harrisburg-Indianapolis
Roanoke	Des Moines	192	1.37	1.35	Harrisburg-Indianapolis	1.50	Roanoke UNUSE
Oklahoma City	Des Moines	102*	.74	.67	Harrisburg-St. Paul	.76	Pierre-Des Moines*
Roanoke	Indianapolis	253	.64	INFINITE	UNBOUNDED	.66	Harrisburg-Indianapolis

*Railroad shipments.

The second model considered in detail is Model III. The overall geographic distribution for Model III as shown in Table XII is much the same as Model IV. However, the cost figures per hundredweight transferred include an additional cost variable — cash cost of production. In general, the costs for Model III are greater than Model IV because of the inclusion of this variable. However, the same pattern as for Model IV was exhibited by Model III. There were wide transfer cost ranges along within which the solution was stable. But very small changes in transfer costs in the nation's midsection would generate a new solution. Model III also exhibits a greater sensitivity to truck rate increases than to rate decreases.

Much the same conclusions can be drawn from the Model III solution as the truck rate is decreased to $.46 per mile as for the Model IV solution at the $.46 per mile truck rate. The Model III solution cost analysis for 1965 with a truck rate of $.46 per mile is given in Table XIII.

The transition from the linear programming results of the optimum shipment pattern to the transportation problem type of tableau can be made easily. Table XIV illustrates the otpimum shipments of Model IV, with the $.46 truck rate, for 1965 quantities in the general transportation type tableau. To determine the supply of each origin, merely sum across the columns for a particular row. The total supply from each origin is given in the right-hand column of the table. The demand for each destination is found by summing down the rows for a particular column. The total demand of the deficit feeder cattle regions is given in the bottom row of the table. If the bottom row and the right-hand column are each summed, the totals should be identical. Therefore, the condition exists that total demand equals total supply.

The shadow prices which are associated with the optimum solutions are useful for defining which supply regions are very near to entering the least cost solutions. In other words, if a region is hard pressed to purchase feeder cattle from normal sources, the shadow price will suggest the next best alternative source of supply. The cost analyses indicated the cost ranges over which the activities in the optimum solution could vary, but do not indicate how competitive alternative shipping routes are with respect to the ones appearing in the optimum solution. This information may be obtained from the shadow prices included in Appendix C.

Table XII—Cost Analysis of Model III Optimum Solution with Truck Rate of $.60 Per Mile, 1965

Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/cwt. ($)	Cost Range over which Optimum Solution Remains Unchanged: Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Ogden	Bakersfield	120*	3.88	INFINITE	UNBOUNDED	4.33	Ogden-Bakersfield
Billings	Bakersfield	659*	-1.06	INFINITE	UNBOUNDED	-.91	Billings-Denver*
Oklahoma City	Bakersfield	944*	1.59	1.44	Billings-Denver*	1.62	Roanoke-Bakersfield*
Oklahoma City	Phoenix	247*	1.28	1.26	Roanoke-Bakersfield	1.34	Jackson-Phoenix*
Cheyenne	Denver	289	1.77	INFINITE	UNBOUNDED	1.96	Cheyenne UNUSE
Oklahoma City	Denver	318*	.82	.46	Cheyenne-Bakersfield*	.84	Pierre-Denver*
Pierre	Omaha	138*	.73	.65	Jackson-St. Paul*	.76	Pierre-Denver*
Oklahoma City	Omaha	837*	.68	.66	Pierre-Denver*	.71	Roanoke-Omaha*
Jackson	Omaha	17*	6.22	6.15	Oklahoma-Des Moines*	6.24	Thomasville-Omaha*
Pierre	St. Paul	610*	.74	INFINITE	UNBOUNDED	.79	Pierre-St. Paul
Louisville	Des Moines	440	10.15	8.98	Roanoke UNUSE	10.26	Louisville-Indianapolis
Roanoke	Des Moines	192	8.85	8.73	Louisville-Indianapolis	8.95	Roanoke-St. Paul
Jackson	Des Moines	1491*	6.21	6.19	Thomasville-Omaha	6.28	Oklahoma-Des Moines*
Thomasville	Des Moines	513*	6.61	INFINITE	UNBOUNDED	6.63	Thomasville-Omaha*
Roanoke	Indianapolis	253	7.89	INFINITE	UNBOUNDED	8.01	Louisville-Indianapolis

*Railroad shipments.

Table XIII—Cost Analysis of Model III Optimum Solution with Truck Rate of $.46 Per Mile, 1965

Origin	Destination	Quantity Shipped (1,000 Head)	Trans-fer Cost/ cwt. ($)	Cost Range over which Optimum Solution Remains Unchanged			
				Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Ogden	Bakersfield	120*	3.88	INFINITE	UNBOUNDED	4.00	Ogden-Bakersfield
Billings	Bakersfield	340*	-1.06	-1.07	Oklahoma-Denver	-.71	Billings-Bakersfield
Oklahoma City	Bakersfield	1263*	1.59	1.24	Ogden-Phoenix	1.60	Oklahoma-Denver*
Oklahoma City	Phoenix	247*	1.28	INFINITE	UNBOUNDED	1.33	Jackson-Phoenix*
Billings	Denver	319	-1.84	-2.18	Cheyenne-Bakersfield*	-1.83	Oklahoma-Denver*
Cheyenne	Denver	289	1.72	INFINITE	UNBOUNDED	1.96	Cheyenne UNUSE
Pierre	Omaha	138	.61	.61	Pierre-St. Paul*	.65	Pierre-Denver
Oklahoma City	Omaha	837	.67	.75	Pierre-Denver*	.68	Oklahoma-Omaha*
Jackson	Omaha	17*	6.22	6.13	Oklahoma-Des Moines*	6.24	Thomasville-Omaha*
Pierre	St. Paul	610	.62	INFINITE	UNBOUNDED	.62	Pierre-St. Paul*
Jackson	Des Moines	1491	6.21	6.19	Thomasville-Omaha*	6.21	Jackson-Des Moines*
Louisville	Des Moines	400	9.90	8.92	Roanoke UNUSE	9.91	Louisville-Indianapolis
Thomasville	Des Moines	513	6.55	INFINITE	UNBOUNDED	6.61	Thomasville UNUSE
Roanoke	Des Moines	192	8.43	8.34	Louisville-Indianapolis	8.48	Roanoke-Phoenix*
Roanoke	Indianapolis	253	7.70	7.65	Roanoke-Phoenix*	7.78	Louisville-Indianapolis

*Railroad shipments.

Table XIV—Transportation Tableau for Optimum Solution for Estimated 1965 Quantities

Origins (Surplus Regions)	Destinations (Deficit Regions) 2	4	7	9	11	12	14	Dummy Demand	Feeder Cattle (1,000 Head)
1	119								119
3	120								120
5	340		319						659
6			289						289
8				138	610				748
10	1114	247		854		102			2,347
13						1508			1,508
15						706			706
16						128		385	513
17						192	253		445
18								4	4
Dummy Supply									
Feeder Cattle (1,000 Head)	1723	247	608	992	610	2636	253	389	7,458

Analysis Of Results For 1970

Because the rate of increase in the demand for feeder cattle has been greater than the rate at which supply has increased, demand as projected for 1970 exceeds the projected supply for that year. Demand and supply could be forced into equality either by adjusting demand downward or by adjusting supply upward. The reasoning underlying such an assumption would be that no more cattle could be fed than were supplied. However, equating demand and supply by this means to a degree perdetermines the results and does not adequately show which regions have the greatest competitive strength for purchasing or supplying feeder cattle.

An alternative manner of handling the problem of demand exceeding supply and the one selected for use in this study is to assume that each region will continue its present trend in demand until 1970, with no adjustment forcing total demand to equal total supply. This assumption allows the most profitable demand or feeding areas to use all available supplies of feeder cattle first. A dummy supply activity is placed in the model in order to equate total demand with total supply. Since the model requires that all demand must be satisfied, the dummy supply is needed to satisfy the demand in the less competitive regions. A high cost is associated with the use of the dummy supply in order to show that the region which uses it must endure abnormal costs to maintain their projected feeding rate. The high-cost demand areas will be forced either to scale down their feeding activity or increase local production in order to meet their needs.

The Model Solutions

Models I, II, III, and IV all gave identical geographical optimum patterns of distribution of feeder cattle without regard to truck rates. The shift from predominantly rail to truck transportation again occurred when the truck rate decreased from $.60 to $.46 per load mile. This indicates a stable pattern of distribution over a substantial range in the rates for truck transportation (see Figures 15 and 16).

The results of the optimum solution for the 1970 projection and the geographical directional distribution are shown in Figure 15. The Bakersfield (California) and Phoenix (Arizona and New Mexico) regions are likely to be the least profitable regions to which to ship cattle by 1970. In fact, three-quarters of the shipments to Bakersfield come from the high-cost dummy variable. Phoenix receives forty percent of its supply from the dummy activity. Oklahoma-Texas no longer finds it profitable to ship feeder cattle to California under the conditions of this model. However, California, Arizona and New Mexico are still likely to have access to a limited supply of feeder cattle not considered in the model — those from Mexico.

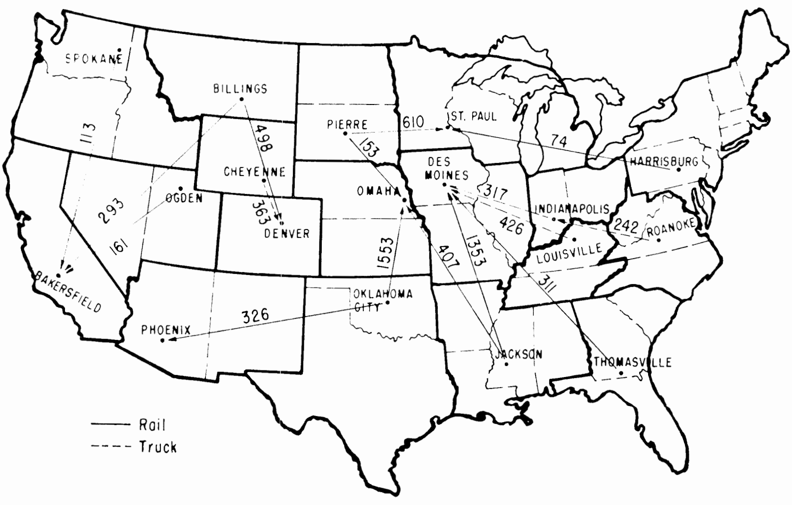

Figure 15. Interregional Flows of Feeder Cattle According to Models I, II, III, and IV with Truck Rate of $.60 Per Mile, 1970 (1000 Head).

The Northwest and Ogden would be expected to ship all available surplus supplies into California. Billings would ship to California only after Colorado requirements had been satisfied. Oklahoma City would supply Phoenix with limited quantities of feeder cattle, but only after exhausting its market opportunities in the Omaha region. Denver would receive all of its supply from Wyoming and Montana. The Oklahoma-Texas area would supply about three-fourths of Omaha's demand for more than two million feeder cattle, with the remainder coming from Pierre and Jackson. St. Paul still receives the majority of its supply from Pierre but Harrisburg ships all of its available supply to St. Paul. The Corn-Belt regions of Des Moines and Indianapolis receive their entire supply of inshipments of feeder cattle from the southeastern areas — designated in the model as Jackson, Louisville, Thomasville, and Roanoke.

The potential total supply of feeder cattle for 1970 is expected to increase about fifteen percent over that of 1965. However, the total demand for feeders is expected to increase by about twenty-eight percent over the same five-year period. Not all regions are expected to show demand and supply shifts parallel with the total shifts. Some regions will continue to increase but decrease in relative standings with the other regions. Other regions will actually decrease in their demand or supply potential. The expected relative shifts in regional supply and demand are shown in Table XV.

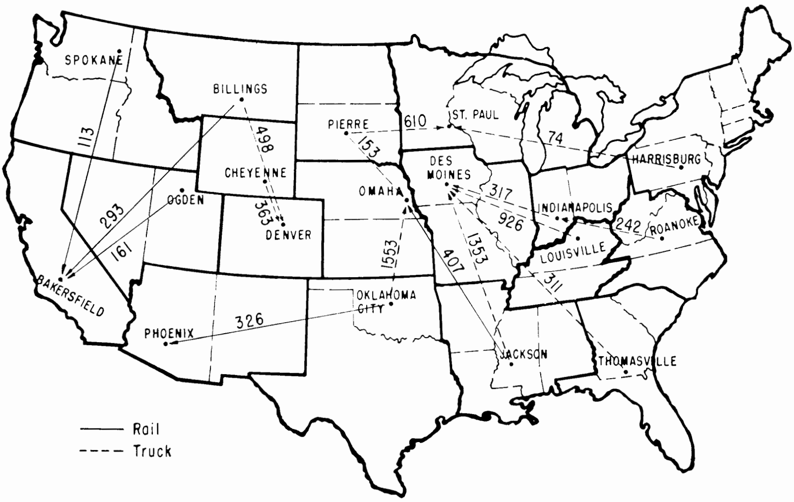

Figure 16. Interregional Flows of Feeder Cattle According to Models I, II, III, and IV with Truck Cost of $.46 Per Mile, 1970 (1000 Head).

Table XV—Regional Percent of Total Demand and Supply, 1965-1970

Region	1965 Percent	1970 Percent	Net Percent Change
		Demand	
Bakersfield	24.4	23.5	-.9
Phoenix	3.5	5.6	2.1
Denver	8.6	9.0	.4
Omaha	14.0	22.0	8.0
St. Paul	8.6	7.1	-1.5
Des Moines	37.3	30.3	-7.0
Indianapolis	3.6	2.5	-1.1
		Supply	
Spokane	1.6	1.5	-.1
Ogden	1.6	2.1	.5
Billings	8.8	10.3	1.5
Cheyenne	3.9	4.7	.8
Pierre	10.0	9.9	-.1
Oklahoma City	31.5	24.4	-7.1
Jackson	20.2	22.8	2.6
Louisville	9.4	12.0	2.6
Thomasville	6.9	4.0	-2.9
Roanoke	6.0	7.3	1.3
Harrisburg	.1	1.0	.9

Cost Analysis of Models for 1970

When the Model III and Model IV optimum solutions for the projected 1970 quantities are examined in a manner similar to that discussed for 1965, the cost ranges suggest that when demand exceeds supply, the optimum solution is stable within somewhat smaller intervals than when supply exceeds demand. The 1970 Models III and IV optimum solution analyses are shown in Tables XVI, XVII, XVIII, and XIX.

Table XX illustrates the optimum shipments of Model III and IV for 1970 quantities in the general transportation type tableau which was previously explained for the 1965 results.

Summary

This study was made to analyze the U.S. feeder cattle industry and to estimate the present and future optimum patterns of feeder cattle distribution. The United States was segmented into eighteen regions for which the potential supply (production) and demand (feeding) quantities of feeder cattle were computed. Each of the eighteen regions was designated either as a "supply" region (with local production of feeder cattle exceeding local feedlot needs) or as a "demand" region (with the volume of feeder cattle used in feedlots exceeding local feeder

Table XVI—Cost Analysis of Model III Optimum Solution with Truck Rate of $.60 Per Mile, 1970

				Cost Range over which Optimum Solution Remains Unchanged			
Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/cwt. ($)	Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Dummy Supply	Bakersfield	1693	9999.00	9998.95	Billings-Omaha*	9999.00	Dummy-Bakersfield*
Spokane	Bakersfield	113*	13.04	INFINITE	UNBOUNDED	13.52	Spokane-Phoenix*
Ogden	Bakersfield	161*	3.89	INFINITE	UNBOUNDED	4.24	Ogden-Phoenix
Billings	Bakersfield	293*	-1.06	-1.22	Oklahoma-Denver*	-1.02	Billings-Omaha*
Dummy Supply	Phoenix	211	9999.00	9998.84	Oklahoma-Denver*	9999.00	Dummy-Phoenix*
Oklahoma City	Phoenix	326*	1.28	1.24	Billings-Omaha*	1.34	Jackson-Phoenix*
Billings	Denver	498*	-1.68	-2.00	Cheyenne-Phoenix*	-1.59	Billings-Denver
Cheyenne	Denver	363	1.77	INFINITE	UNBOUNDED	1.96	Cheyenne UNUSE
Pierre	Omaha	153*	.73	.68	Billings-St. Paul*	.73	Pierre-Omaha
Oklahoma City	Omaha	1553*	.68	.62	Jackson-Phoenix*	.72	Billings-Omaha*
Jackson	Omaha	407*	6.22	6.17	Harrisburg-Des Moines*	6.24	Thomasville-Omaha*
Pierre	St. Paul	610*	.74	.74	Pierre-Omaha	.79	Pierre UNUSE
Harrisburg	St. Paul	74*	10.90	INFINITE	UNBOUNDED	10.94	Harrisburg-Des Moines*
Jackson	Des Moines	1353*	6.21	6.19	Thomasville-Omaha*	6.26	Harrisburg-Des Moines*
Louisville	Des Moines	926	10.15	INFINITE	UNBOUNDED	10.26	Louisville-Indianapolis
Thomasville	Des Moines	311*	6.61	INFINITE	UNBOUNDED	6.63	Thomasville-Omaha*
Roanoke	Des Moines	317	8.85	8.80	Harrisburg-Indianapolis	8.95	Roanoke-St. Paul
Roanoke	Indianapolis	242	7.89	INFINITE	UNBOUNDED	7.94	Harrisburg-Indianapolis

Table XVII—Cost Analysis of Model III Optimum Solution with Truck Rate of $.46 Per Mile, 1970

Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/cwt. ($)	Cost Range over which Optimum Solution Remains Unchanged			
				Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Dummy Supply	Bakersfield	1693	9999.00	9998.95	Ogden-Phoenix	9999.00	Dummy-Bakersfield*
Spokane	Bakersfield	113*	13.04	INFINITE	UNBOUNDED	13.28	Spokane-Bakersfield
Ogden	Bakersfield	161*	3.88	INFINITE	UNBOUNDED	3.93	Ogden-Phoenix
Billings	Bakersfield	293*	-1.06	-1.37	Oklahoma-Denver*	-1.00	Billings-Omaha*
Dummy Supply	Phoenix	211	9999.00	9998.69	Okla.-Bakersfield*	9999.00	Dummy-Phoenix*
Oklahoma City	Phoenix	326*	1.28	1.23	Billings-Omaha*	1.33	Jackson-Phoenix
Billings	Denver	498	-1.84	-2.00	Cheyenne-Phoenix*	-1.68	Billings-Denver*
Cheyenne	Denver	363	1.72	INFINITE	UNBOUNDED	1.96	Cheyenne-UNUSE
Pierre	Omaha	153	.61	.61	Pierre-St. Paul*	.65	Harrisburg-Indianapolis
Oklahoma City	Omaha	1553	.67	.62	Jackson-Phoenix*	.68	Oklahoma-Omaha*
Jackson	Omaha	407*	6.22	6.18	Harrisburg-Indianapolis	6.24	Thomasville-Omaha*
Pierre	St. Paul	610	.62	.58	Harrisburg-Indianapolis	.62	Pierre-St. Paul*
Harrisburg	St. Paul	74	10.59	INFINITE	UNBOUNDED	10.63	Harrisburg-Indianapolis
Jackson	Des Moines	1353	6.21	6.19	Thomasville-Omaha*	6.21	Jackson-Des Moines*
Louisville	Des Moines	926	9.90	INFINITE	UNBOUNDED	9.99	Louisville-Indianapolis
Thomasville	Des Moines	311	6.55	INFINITE	UNBOUNDED	6.61	Thomasville-UNUSE
Roanoke	Des Moines	317	8.43	8.39	Harrisburg-Indianapolis	8.48	Roanoke-Phoenix*
Roanoke	Indianapolis	242	7.70	7.65	Roanoke-Phoenix*	7.74	Harrisburg-Indianapolis

*Railroad shipments.

Table XVIII—Cost Analysis of Model IV Optimum Solution with Truck Rate of $.60 Per Mile, 1970

				Cost Range over which Optimum Solution Remains Unchanged			
Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/ cwt. ($)	Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Dummy Supply	Bakersfield	1693	9999.00	9998.95	Billings-Omaha*	9999.00	Dummy-Bakersfield*
Spokane	Bakersfield	113*	1.38	INFINITE	UNBOUNDED	1.86	Spokane-Phoenix*
Ogden	Bakersfield	161*	.97	INFINITE	UNBOUNDED	1.33	Ogden-Phoenix
Billings	Bakersfield	293*	1.59	1.44	Oklahoma-Denver*	1.64	Billings-Omaha*
Dummy Supply	Phoenix	211	9999.00	9998.84	Oklahoma-Denver	9999.00	Dummy-Phoenix*
Oklahoma City	Phoenix	326*	1.28	1.26	Roanoke-Omaha*	1.34	Jackson-Phoenix*
Billings	Denver	498*	.97	.65	Cheyenne-Phoenix*	1.06	Billings-Denver
Cheyenne	Denver	363	.19	INFINITE	UNBOUNDED	.38	Cheyenne-UNUSE
Pierre	Omaha	153*	.67	.62	Billings-St. Paul*	.72	Pierre-Omaha
Oklahoma City	Omaha	1553*	.68	.62	Jackson-Phoenix*	.71	Roanoke-Omaha*
Jackson	Omaha	407*	1.17	1.12	Harrisburg-Des Moines*	1.19	Thomasville-Omaha*
Pierre	St. Paul	610*	.68	.63	Harrisburg-Des Moines*	.73	Pierre-St. Paul
Harrisburg	St. Paul	74*	1.80	INFINITE	UNBOUNDED	1.86	Harrisburg-Des Moines*
Jackson	Des Moines	1353*	1.16	1.14	Thomasville-Omaha*	1.21	Harrisburg-Des Moines
Louisville	Des Moines	926	1.06	INFINITE	UNBOUNDED	1.17	Louisville-Indianapolis
Thomasville	Des Moines	311*	1.56	INFINITE	UNBOUNDED	1.58	Thomasville-Omaha*
Roanoke	Des Moines	317	1.79	1.74	Harrisburg-Indianapolis	1.89	Roanoke-St. Paul
Roanoke	Indianapolis	242	.83	INFINITE	UNBOUNDED	.88	Harrisburg-Indianapolis

*Railroad shipments.

Table XIX—Cost Analysis of Model IV Optimum Solution with Truck Rate of $.46 Per Mile, 1970

				Cost Range over which Optimum Solution Remains Unchanged			
Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/cwt. ($)	Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Dummy Supply	Bakersfield	1693	9999.00	9998.95	Ogden-Phoenix	9999.00	Dummy-Bakersfield*
Spokane	Bakersfield	113*	1.38	INFINITE	UNBOUNDED	1.62	Spokane-Bakersfield
Ogden	Bakersfield	161*	.97	INFINITE	UNBOUNDED	1.02	Ogden-Phoenix
Billings	Bakersfield	293*	1.59	1.28	Oklahoma-Denver*	1.65	Billings-Omaha*
Dummy Supply	Phoenix	211	9999.00	9998.69	Okla.-Bakersfield*	9999.00	Dummy-Phoenix*
Oklahoma City	Phoenix	326*	1.28	1.23	Billings-Omaha*	1.33	Jackson-Phoenix*
Billings	Denver	498	.81	.65	Cheyenne-Phoenix*	.97	Billings-Denver*
Cheyenne	Denver	363	.14	INFINITE	UNBOUNDED	.38	Cheyenne UNUSE
Pierre	Omaha	153	.55	.55	Pierre-St. Paul*	.59	Harrisburg-Indianapolis
Oklahoma City	Omaha	1553	.67	.62	Jackson-Phoenix*	.68	Oklahoma-Omaha*
Jackson	Omaha	407*	1.17	1.13	Harrisburg-Indianapolis	1.19	Thomasville-Omaha*
Pierre	St. Paul	610	.56	.52	Harrisburg-Indianapolis	.56	Pierre-St. Paul*
Harrisburg	St. Paul	74	1.50	INFINITE	UNBOUNDED	1.54	Harrisburg-Indianapolis
Jackson	Des Moines	1353	1.16	1.14	Thomasville-Omaha	1.16	Jackson-Des Moines*
Louisville	Des Moines	926	.81	INFINITE	UNBOUNDED	.90	Louisville-Indianapolis
Thomasville	Des Moines	311	1.50	INFINITE	UNBOUNDED	1.56	Thomasville UNUSE
Roanoke	Des Moines	317	1.37	1.3	Harrisburg-Indianapolis	1.42	Roanoke-Phoenix*
Roanoke	Indianapolis	242	.64	.59	Roanoke-Phoenix*	.68	Harrisburg-Indianapolis

*Railroad shipments.

Table XX—Transportation Tableau for Optimum Solution for Estimated 1970 Quantities

Origins (Surplus Regions	Destinations (Deficit Regions) 2	4	7	9	11	12	14	Dummy Demand	Feeder Cattle (1000 head)
1	113								113
3	161								161
5	293		498						791
6			363						363
8				153	610				763
10		326		1553					1879
13				407		1353			1760
15						926			926
16						311			311
17						317	242		559
18					74				74
Dummy Supply	1693	211							1904
Feeder Cattle (1000 head)	2260	537	861	2113	684	2907	242	0	9604

cattle production). When the supplies and demands for feeder cattle within each of the eighteen regions were aggregated, there were eleven surplus and seven deficit feeder cattle regions.

The analysis was conducted using both truck and rail transportation. The primary motor truck used for this study was the diesel tractor with a forty foot possum-belly semi-trailer. Cattle haulers were interviewed to determine the prevailing motor truck rates for hauling feeder cattle. Rail rates were obtained from the regional offices of the A T & S F Railway in Wichita, Kansas.

Simultaneous transportation solutions for truck and rail transport were obtained for the distributions of feeder cattle production and cattle feeding as observed in 1965. Although a specific study on backhauls was not made, their importance is considered to be a prominent factor in present competitive conditions in the transportation of feeder cattle. Backhauls were available to the surveyed truckers about one-third of the time and were reflected by an appropriate adjustment in the hauling rate.

Four theoretical models were used to analyze optimum distribution patterns. The optimum distributions of Models I, II, III, and IV depicted patterns that were very similar for both the truck rate of $.60 and $.46 per mile. Since the quantity transported and the transportation charges were included in all four models, and since the optimum patterns were essentially the same for all models, the overwhelming factors for determining optimum patterns of feeder cattle distribution are the weight of the shipment and the distance between the supply region and alternative demand areas.

In general, variables such as production costs and price differentials did not alter the pattern. For 1965, the optimum patterns for feeder cattle shipments is generally as follows: The Pacific Northwest, Utah, and Nevada should ship all of their export supply of feeder cattle into California feedlots. If feeder cattle were in fact homogeneous among regions, the Montana area should also ship its feeder cattle by rail into California and by truck into Colorado, but because of quality differences, this area has in fact shipped most of its cattle into the Nebraska and Iowa areas.

The Southern Plains region, the largest supplier of feeder cattle, would be expected to ship about half of its feed cattle exports into California, ten percent into the Arizona-New Mexico region, thirty-six percent into the Kansas-Nebraska area, and about four percent into the Western Corn-Belt region.

Other studies have shown that more than half of the Southern Plains' outshipments of feeder cattle actually moved into California, Arizona, and Colorado during 1965. More than thirty percent of Texas' outshipments were shipped into California, but the remaining portion of the Southern Plains' outshipments moved North and Northeast into Kansas, Nebraska, Iowa, and Illinois.

The Model solutions and the actual data both show that the Dakotas ship feeder cattle into Minnesota, Nebraska and the Western Corn-Belt regions. Optimally, Colorado should be supplied by Montana and Wyoming. It appears however, that Colorado receives about sixty percent of its inshipments from Texas, New Mexico, and Oklahoma. For the most part, the South Central and Southeastern regions should ship feeder cattle into the Western Corn-Belt feedlots while the Mid-Atlantic and Appalachian regions should ship into the Eastern Corn-Belt feedlots. Under the conditions in which supply of feeder cattle exceeded demand for them, the small supplies of feeder cattle in the Northeastern states did not have a feasible market.

The main difference in the 1970 optimum pattern of distribution from the 1965 optimum pattern is that shipments from the Oklahoma-Texas area into California would be expected to virtually cease. However, estimated shipments from the Oklahoma-Texas region into the Kansas-Nebraska area would nearly double. Arizona and California may experience disadvantages in obtaining feeder cattle by 1970. The importance of the feeder cattle supply from the South Central and Southeastern states will become increasingly important to the Corn-Belt regions by 1970. With the abundant supply of local feeder cattle, large efficient feedlot operations, adequate feed grain supplies, and excellent nearby markets for both excess feeder cattle and fed beef, the Texas-Oklahoma region occupies a very prominent position in the beef sector of our economy in the 1965 and 1970 optimum solutions.

The growth of the cattle feeding industry in the Southwestern states during the last five years tends to coincide with the results of this study. According to studies made by Goodwin and Uvacek, Oklahoma and Texas have increased their cattle feeding capabilities tremendously from 1960 to 1965, and are expected to continue to increase even more rapidly in the near future. The large supplies of good feeder cattle, which were once available from the Texas-Oklahoma region for shipment into the Corn-Belt and California regions, will be greatly reduced as local feeding increases within the Texas-Oklahoma region. The Southern Plains are in an excellent location to utilize the large supplies of local feed grains necessary for feeding locally produced cattle.

Appendix A—Railroad Rates Between Points Per Hundredweight of Feeder Cattle*

	Destination						
Origin	Bakersfield	Phoenix	Denver	Omaha	St. Paul	Des Moines	Indianapolis
Spokane	1.38	1.86	1.40	1.63	1.52	1.74	2.32
Ogden	.92	1.05	.70	1.24	1.97	1.48	2.21
Billings	1.59	1.75	.97	1.03	1.04	1.24	1.92
Cheyenne	1.50	1.32	.38	.78	1.12	.92	1.62
Pierre	2.21	1.63	.84	.67	.68	.76	1.44
Oklahoma City	1.59	1.28	.82	.68	.88	.74	1.20
Jackson	2.20	1.83	1.34	1.17	1.26	1.16	1.46
Louisville	2.61	2.28	1.73	1.54	1.64	1.45	1.46
Thomasville	2.74	2.37	1.80	1.59	1.70	1.56	1.56
Roanoke	2.87	2.54	2.34	1.96	2.25	2.00	1.12
Harrisburg	2.99	2.69	2.22	1.98	1.80	1.84	1.25

*Based on 25,000 pounds per carload which is approximately 50 head of 500-lb. feeders.

Appendix B, Table I—Cost Analysis of Model I Optimum Solution with Truck Rate of $.60 Per Mile, 1965

Origin	Destination	Quantity Shipped (1,000 Head)	Trans-fer Cost/ cwt. ($)	Cost Range over which Optimum Solution Remains Unchanged			
				Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Ogden	Bakersfield	120*	3.16	INFINITE	UNBOUNDED	3.61	Ogden-Bakersfield
Billings	Bakersfield	659*	-.81	INFINITE	UNBOUNDED	-.66	Billings-Denver*
Oklahoma City	Bakersfield	944*	1.59	1.44	Billings-Denver*	1.72	Jackson-Bakersfield*
Oklahoma City	Phoenix	247*	1.28	INFINITE	UNBOUNDED	1.34	Jackson-Phoenix*
Cheyenne	Denver	289	1.13	INFINITE	UNBOUNDED	1.32	Cheyenne UNUSE
Oklahoma City	Denver	319*	.82	.46	Cheyenne-Bakersfield*	.84	Pierre-Denver*
Pierre	Omaha	138*	1.13	1.05	Jackson-St. Paul*	1.16	Pierre-Denver*
Oklahoma City	Omaha	837	.68	.66	Pierre-Denver*	.75	Oklahoma-Des Moines*
Jackson	Omaha	17*	5.32	5.25	Oklahoma-Des Moines*	5.34	Thomasville-Omaha*
Pierre	St. Paul	610*	1.14	INFINITE	UNBOUNDED	1.19	Pierre-St. Paul
Louisville	Des Moines	632	9.33	9.29	Louisville UNUSE	9.44	Roanoke-Des Moines*
Jackson	Des Moines	1491*	5.31	5.29	Thomasville-Omaha*	5.38	Oklahoma-Des Moines*
Thomasville	Des Moines	513*	5.34	INFINITE	UNBOUNDED	5.36	Thomasville-Omaha*
Louisville	Indianapolis	74	8.48	8.36	Roanoke-Des Moines	8.52	Louisville UNUSE
Roanoke	Indianapolis	179	8.92	8.88	Louisville UNUSE	9.04	Roanoke-Des Moines

*Railroad shipments.

Appendix B, Table II—Cost Analysis of Model II Optimum Solution with Truck Rate of $.60 Per Mile, 1965

				Cost Range over which Optimum Solution Remains Unchanged			
Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/cwt. ($)	Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Spokane	Bakersfield	119*	.78	INFINITE	UNBOUNDED	1.51	Spokane-Bakersfield
Ogden	Bakersfield	120*	.25	INFINITE	UNBOUNDED	.70	Ogden-Bakersfield
Billings	Bakersfield	659*	1.84	INFINITE	UNBOUNDED	1.99	Billings-Denver*
Oklahoma City	Bakersfield	825*	1.59	1.44	Billings-Denver	1.78	Jackson-Bakersfield*
Oklahoma City	Phoenix	247*	1.28	INFINITE	UNBOUNDED	1.41	Jackson-Phoenix*
Cheyenne	Denver	289	-.45	INFINITE	UNBOUNDED	-.26	Cheyenne UNUSE
Oklahoma City	Denver	319*	.82	.46	Cheyenne-Bakersfield*	.84	Pierre-Denver*
Pierre	Omaha	138*	1.07	.92	Jackson-St. Paul*	1.10	Pierre-Denver*
Oklahoma City	Omaha	854*	.68	.66	Pierre-Denver*	.75	Jackson-Omaha*
Pierre	St. Paul	610*	1.08	INFINITE	UNBOUNDED	1.13	Pierre-St. Paul
Louisville	Des Moines	513	.24	-.59	Thomasville-Des Moines	.35	Roanoke-Des Moines
Oklahoma City	Des Moines	102*	.74	.67	Jackson-Omaha*	.78	Pierre-Des Moines*
Jackson	Des Moines	1508*	.26	INFINITE	UNBOUNDED	.33	Jackson-Omaha*
Thomasville	Des Moines	513*	.29	INFINITE	UNBOUNDED	.38	Thomasville-Omaha*
Louisville	Indianapolis	193	-.61	-.73	Roanoke-Des Moines	.22	Thomasville - Indianapolis
Roanoke	Indianapolis	60	1.86	.28	Pierre UNUSE	1.98	Roanoke-Des Moines

*Railroad shipments.

Appendix B, Table III—Cost Analysis of Model I Optimum Solution with Truck Rate of $.46 Per Mile, 1965

				Cost Range over which Optimum Solution Remains Unchanged			
Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/ cwt. ($)	Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Ogden	Bakersfield	120*	3.16	INFINITE	UNBOUNDED	3.28	Ogden-Bakersfield
Billings	Bakersfield	340*	-.81	-.82	Oklahoma-Denver*	-.46	Billings-Bakersfield
Oklahoma City	Bakersfield	1263*	1.59	1.24	Ogden-Phoenix	1.60	Oklahoma-Denver*
Oklahoma City	Phoenix	247*	1.28	INFINITE	UNBOUNDED	1.33	Jackson-Phoenix*
Billings	Denver	319	-1.59	-1.94	Cheyenne-Bakersfield*	-1.58	Oklahoma-Denver*
Cheyenne	Denver	289	1.08	INFINITE	UNBOUNDED	1.32	Cheyenne UNUSE
Pierre	Omaha	138	1.01	1.01	Pierre-St. Paul*	1.05	Pierre-Denver
Oklahoma City	Omaha	837	.67	.65	Pierre-Denver*	.68	Oklahoma-Omaha*
Jackson	Omaha	17*	5.32	5.23	Oklahoma-Des Moines	5.34	Thomasville-Omaha*
Pierre	St. Paul	610	1.02	INFINITE	UNBOUNDED	1.02	Pierre-St. Paul*
Jackson	Des Moines	1491	5.31	5.29	Thomasville-Omaha*	5.31	Jackson-Des Moines*
Louisville	Des Moines	632	9.08	8.75	Thomasville-Indianapolis	9.17	Roanoke-Des Moines
Thomasville	Des Moines	513	5.28	INFINITE	UNBOUNDED	5.34	Thomasville UNUSE
Louisville	Indianapolis	74	8.43	8.34	Roanoke-Des Moines	8.73	Louisville UNUSE
Roanoke	Indianapolis	179	8.73	8.43	Louisville UNUSE	8.81	Roanoke-Des Moines

*Railroad shipments.

Appendix B, Table IV—Cost Analysis of Model II Optimum Solution with Truck Rate of $.46 Per Mile, 1965

Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/cwt. ($)	Cost Range over which Optimum Solution Remains Unchanged			
				Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Spokane	Bakersfield	119*	.78	INFINITE	UNBOUNDED	1.02	Spokane-Bakersfield
Ogden	Bakersfield	120*	.25	INFINITE	UNBOUNDED	.37	Ogden-Bakersfield
Billings	Bakersfield	340*	1.84	1.83	Oklahoma-Denver*	2.19	Billings-Bakersfield
Oklahoma City	Bakersfield	1144*	1.59	1.24	Ogden-Phoenix	1.60	Oklahoma-Denver*
Oklahoma City	Phoenix	247*	1.28	INFINITE	UNBOUNDED	1.40	Oklahoma-Phoenix
Billings	Denver	319	1.06	.72	Cheyenne-Bakersfield*	1.07	Cheyenne UNUSE
Cheyenne	Denver	289	-.50	INFINITE	UNBOUNDED	-.26	Pierre-Denver
Pierre	Omaha	138	.95	.95	Pierre-St. Paul*	.99	Oklahoma-Omaha*
Oklahoma City	Omaha	854	.67	.65	Pierre-Denver*	.68	Oklahoma-Denver*
Pierre	St. Paul	610	.96	INFINITE	UNBOUNDED	.96	Pierre-St. Paul*
Jackson	Des Moines	1508	.26	INFINITE	UNBOUNDED	.26	Jackson UNUSE
Louisivlle	Des Moines	513	-.01	-.34	Thomasville-Indianapolis	.08	Roanoke-Des Moines
Thomasville	Des Moines	513	.23	INFINITE	UNBOUNDED	.29	Thomasville UNUSE
Oklahoma City	Des Moines	102*	.74	.66	Jackson-Omaha*	.76	Pierre-Des Moines*
Louisville	Indianapolis	193	-.66	-.75	Roanoke-Des Moines	-.33	Thomasville - Indianapolis
Roanoke	Indianapolis	60	1.67	.50	Pierre UNUSE	1.75	Roanoke-Des Moines

*Railroad shipments.

Appendix B, Table V—Cost Analysis of Model I Optimum Solution with Truck Rate of $.60 Per Mile, 1970

				Cost Range over which Optimum Solution Remains Unchanged			
Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/cwt. ($)	Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Dummy Supply	Bakersfield	1693	9999.00	9998.95	Billings-Omaha*	9999.00	Dummy-Bakersfield*
Spokane	Bakersfield	113*	12.44	INFINITE	UNBOUNDED	12.92	Spokane-Phoenix*
Ogden	Bakersfield	161*	3.16	INFINITE	UNBOUNDED	3.52	Ogden-Phoenix
Billings	Bakersfield	293*	-.81	-.96	Oklahoma-Denver*	-.76	Billings-Omaha*
Dummy Supply	Phoenix	211	9999.00	9998.84	Oklahoma-Denver*	9999.00	Dummy-Phoenix*
Oklahoma City	Phoenix	326*	1.28	1.26	Roanoke-Omaha*	1.34	Jackson-Phoenix*
Billings	Denver	498*	-1.43	-1.75	Cheyenne-Phoenix*	-1.34	Billings-Denver
Cheyenne	Denver	363	1.13	INFINITE	UNBOUNDED	1.32	Cheyenne UNUSE
Pierre	Omaha	153*	1.13	1.08	Billings-St. Paul*	1.18	Pierre-Omaha
Oklahoma City	Omaha	1553	.68	.62	Jackson-Phoenix*	.71	Roanoke-Omaha*
Jackson	Omaha	407*	5.32	5.27	Harrisburg-Des Moines*	5.34	Thomasville-Omaha*
Pierre	St. Paul	610*	1.14	1.09	Harrisburg-Des Moines*	1.19	Pierre-St. Paul
Harrisburg	St. Paul	74*	11.92	INFINITE	UNBOUNDED	11.98	Harrisburg-Des Moines*
Jackson	Indianapolis	1353*	5.31	5.29	Thomasville-Omaha*	5.36	Harrisburg-Des Moines*
Louisville	Des Moines	926	9.33	INFINITE	UNBOUNDED	9.44	Louisville-Indianapolis
Thomasville	Des Moines	311*	5.34	INFINITE	UNBOUNDED	5.36	Thomasville-Omaha*
Roanoke	Des Moines	317	9.88	9.76	Louisville-Indianapolis	9.98	Roanoke-St. Paul
Roanoke	Des Moines	242	8.92	INFINITE	UNBOUNDED	9.04	Louisville-Indianapolis

*Railroad shipments.

Appendix B, Table VI—Cost Analysis of Model II Optimum Solution with Truck Rate of $.60 Per Mile, 1970

				Cost Range over which Optimum Solution Remains Unchanged			
Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/ cwt. ($)	Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Dummy Supply	Bakersfield	1693	9999.00	9998.95	Billings-Omaha*	9999.00	Dummy-Bakersfield*
Spokane	Bakersfield	113*	.78	INFINITE	UNBOUNDED	1.26	Spokane-Phoenix*
Ogden	Bakersfield	161*	.25	INFINITE	UNBOUNDED	.61	Ogden-Phoenix
Billings	Bakersfield	293*	1.84	1.68	Oklahoma-Denver*	1.88	Billings-Omaha*
Dummy Supply	Phoenix	211	9999.00	9998.84	Oklahoma-Denver*	9999.00	Dummy-Phoenix*
Oklahoma City	Phoenix	326*	1.28	1.26	Roanoke-Omaha*	1.34	Jackson-Phoenix*
Billings	Denver	498*	1.22	.90	Cheyenne-Phoenix*	1.31	Billings-Denver*
Cheyenne	Denver	363	-.45	INFINITE	UNBOUNDED	-.26	Cheyenne UNUSE
Pierre	Omaha	153	1.07	1.02	Billings-St. Paul*	1.12	Pierre-Omaha
Oklahoma City	Omaha	1553*	.68	.62	Jackson-Phoenix*	.71	Roanoke-Omaha*
Jackson	Omaha	407*	.27	.22	Harrisburg-Des Moines*	.29	Thomasville-Omaha*
Pierre	St. Paul	610*	1.08	1.03	Harrisburg-Des Moines*	1.13	Pierre-St. Paul
Harrisburg	St. Paul	74*	2.84	INFINITE	UNBOUNDED	2.88	Harrisburg-Des Moines*
Jackson	Des Moines	1353*	.26	.24	Thomasville-Omaha*	.31	Harrisburg-Des Moines*
Louisville	Des Moines	926	.24	INFINITE	UNBOUNDED	.35	Louisville-Indianapolis
Thomasville	Des Moines	311*	.29	INFINITE	UNBOUNDED	.31	Thomasville-Omaha*
Roanoke	Des Moines	317	2.82	2.70	Louisville-Indianapolis	2.92	Roanoke-St. Paul
Roanoke	Indianapolis	242	1.86	INFINITE	UNBOUNDED	1.98	Louisville-Indianapolis

*Railroad shipments.

Appendix B, Table VII—Cost Analysis of Model I Optimum Solution with Truck Rate of $.46 Per Mile, 1970

Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/ cwt. ($)	Cost Range over which Optimum Solution Remains Unchanged			
				Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Dummy Supply	Bakersfield	1693	9999.00	9998.95	Ogden-Phoenix	9999.00	Dummy-Bakersfield*
Spokane	Bakersfield	113*	12.44	INFINITE	UNBOUNDED	12.68	Spokane-Bakersfield
Ogden	Bakersfield	161*	3.16	INFINITE	UNBOUNDED	3.21	Ogden-Phoenix
Billings	Bakersfield	293*	-.81	-1.12	Oklahoma-Denver*	-.75	Billings-Omaha*
Dummy Supply	Phoenix	211	9999.00	9998.69	Okla.-Bakersfield*	9999.00	Dummy-Phoenix*
Oklahoma City	Phoenix	326*	1.28	1.23	Billings-Omaha*	1.33	Jackson-Phoenix*
Billings	Denver	498	-1.59	-1.75	Cheyenne-Phoenix*	-1.43	Billings-Denver*
Cheyenne	Denver	363	1.08	INFINITE	UNBOUNDED	1.32	Cheyenne UNUSE
Pierre	Omaha	153	1.01	1.01	Pierre-St. Paul*	1.05	Harrisburg-Indianapolis
Oklahoma City	Omaha	1553	.67	.62	Jackson-Phoenix*	.68	Oklahoma-Omaha*
Jackson	Omaha	407*	5.32	5.28	Harrisburg-Indianapolis	5.34	Thomasville-Omaha*
Pierre	St. Paul	610	1.02	.98	Harrisburg-Indianapolis	1.02	Pierre-St. Paul*
Harrisburg	St. Paul	74	11.62	INFINITE	UNBOUNDED	11.66	Harrisburg-Indianapolis
Jackson	Des Moines	1353	5.31	5.29	Thomasville-Omaha	5.31	Jackson-Des Moines
Louisville	Des Moines	926	9.08	INFINITE	UNBOUNDED	9.17	Louisville-Indianapolis
Thomasville	Des Moines	311	5.28	INFINITE	UNBOUNDED	5.34	Thomasville UNUSE
Roanoke	Des Moines	317	9.46	9.42	Harrisburg-Indianapolis	9.51	Roanoke-Phoenix*
Roanoke	Indianapolis	242	8.73	8.68	Roanoke-Phoenix*	8.77	Harrisburg-Indianapolis

*Railroad shipments.

Appendix B, Table VIII—Cost Analysis of Model II Optimum Solution with Truck Rate of $.46 Per Mile, 1970

Origin	Destination	Quantity Shipped (1,000 Head)	Transfer Cost/cwt. ($)	Cost Range over which Optimum Solution Remains Unchanged			
				Lower Limit ($)	Incoming Vector at Lower Limit	Upper Limit ($)	Incoming Vector at Upper Limit
Dummy Supply	Bakersfield	1693	9999.00	9998.95	Ogden-Phoenix	9999.00	Dummy-Bakersfield*
Spokane	Bakersfield	113*	.78	INFINITE	UNBOUNDED	1.02	Spokane-Bakersfield
Ogden	Bakersfield	161*	.25	INFINITE	UNBOUNDED	.30	Ogden-Phoenix
Billings	Bakersfield	293*	1.84	1.53	Oklahoma-Denver*	1.90	Billings-Omaha*
Dummy Supply	Phoenix	211	9999.00	9998.69	Okla.-Bakersfield*	9999.00	Dummy-Phoenix*
Oklahoma City	Phoenix	326*	1.28	1.23	Billings-Omaha*	1.33	Jackson-Phoenix*
Billings	Denver	498	1.06	.90	Cheyenne-Phoenix*	1.22	Billings-Denver*
Cheyenne	Denver	363	-.50	INFINITE	UNBOUNDED	-.26	Cheyenne UNUSE
Pierre	Omaha	153	.95	.95	Pierre-St. Paul*	.99	Harrisburg-Indianapolis
Oklahoma City	Omaha	1553	.67	.62	Jackson-Phoenix*	.68	Oklahoma-Omaha*
Jackson	Omaha	407*	.27	.23	Harrisburg-Indianapolis	.29	Thomasville-Omaha*
Pierre	St. Paul	610	.96	.92	Harrisburg-Indianapolis	.96	Pierre-St. Paul*
Harrisburg	St. Paul	74	2.53	INFINITE	UNBOUNDED	2.57	Harrisburg-Indianapolis
Jackson	Des Moines	1353	.26	.24	Thomasville-Omaha*	.26	Jackson-Des Moines*
Louisville	Des Moines	926	-.01	INFINITE	UNBOUNDED	.08	Louisville-Indianapolis
Thomasville	Des Moines	311	.23	INFINITE	UNBOUNDED	.29	Thomasville UNUSE
Roanoke	Des Moines	317	2.40	2.36	Harrisburg-Indianapolis	2.45	Roanoke-Phoenix*
Roanoke	Indianapolis	242	1.67	1.62	Roanoke-Phoenix*	1.71	Harrisburg-Indianapolis

*Railroad shipments.

APPENDIX C

The following code information will interpret the numerical and alphabetical regional designations of Appendix G tables on the shadow prices for the optimum model solutions for this study. Any three-digit number beginning with a "three" will indicate a rail supply shipment. A three-digit number beginning with a "two" will indicate a truck supply shipment. All three-digit numbers beginning with a "one" will indicate a demand region. An asterisk to the left of a shipment will indicate that activity is in the optimum solution. The plus signs preceeding the shipment designations indicate the slack activity for each of the supply regions. A slack which has an asterisk preceeding it shows that all of that region's supply was shipped.

	Code Name	**Demand Regions** **Region**
	101	Bakersfield
	102	Phoenix
	103	Denver
	104	Omaha
	105	St. Paul
	106	Des Moines
	107	Indianapolis
		Supply Regions
Truck	201 or 201SPK	Spokane
	202 or 202OGD	Ogden
	203 or 203BIL	Billings
	204 or 204CHE	Cheyenne
	205 or 205PIE	Pierre
	206 or 206OKC	Oklahoma City
	207 or 207JAC	Jackson
	208 or 208LOU	Louisville
	209 or 209THM	Thomasville
	210 or 210ROA	Roanoke
	211 or 211HAR	Harrisburg
Rail	301 or 301SPK	Spokane
	302 or 302OGD	Ogden
	303 or 303BIL	Billings
	304 or 304CHE	Cheyenne
	305 or 305PIE	Pierre
	306 or 306OKC	Oklahoma City
	307 or 307JAC	Jackson
	308 or 308LOU	Louisville
	309 or 309THM	Thomasville
	310 or 310ROA	Roanoke
	311 or 311HAR	Harrisburg

For example: 201101 2.36929000

This states that an additional truck shipment from Spokane to Bakersfield would add $2.36929, per hundredweight of feeder cattle shipped, to the optimum least cost solution.

Appendix C, Table I—Shadow Prices for Optimum Shipments of Feeder Cattle from Supply to Demand Regions Using Model I Estimated Costs with Truck Rate of $.60 Per Mile, 1965

201101	2.48934800	202101	.44388200	203101	.93717400	204101	1.19968200
205101	1.31083600	206101	.89471600	207101	1.27233600	208101	1.91176400
209101	1.67719200	210101	2.51540600	211101	4.28696600	201102	3.20600600
202102	.66396600	203102	.89881800	204102	1.04502800	205102	1.20048600
206102	.53884800	207102	.88324000	208102	1.55220400	209102	1.28071200
210102	1.68511600	211102	3.92730600	201103	3.17812400	202103	.80037800
203103	.24145000	* 204103	.	205103	.15361200	206103	.31713600
207103	.89597000	208103	.86899200	209103	1.17529800	210103	1.22711600
211103	3.19435200	201104	3.85900200	202104	1.73046600	203104	.86325600
204104	.86178600	205104	.04994000	206104	.18762000	207104	.43232800
208104	.21521200	209104	.57320600	210104	.21705800	211104	2.43535000
201105	3.76593200	202105	2.20042600	203105	.77018600	204105	1.41850800
205105	.04547800	206105	.81818200	207105	.76014600	208105	.22736400
209105	.69427200	210105	.21259600	211105	2.29243800	201106	4.17913000
202106	1.95275600	203106	1.18338400	204106	1.12099600	205106	.24823200
206106	.37299000	207106	.35002800	* 208106	.	209106	.39676000
210106	.11629800	211106	3.29635600	201107	5.74269200	202107	3.63077000
203107	2.74694600	204107	2.79901000	205107	1.94101400	206107	1.55443000
207107	.87983000	* 208107	.	209107	.82687800	* 210107	.
211107	2.22752200	301101	1.76067800	* 302101	.	* 303101	.
304101	.35500000	305101	.63000000	* 306101	.	307101	.12500000
308101	.23600000	309101	.26500000	310101	.27567800	311101	2.42407800
301102	2.53567800	302102	.78700000	303102	.46500000	304102	.47500000
305102	.35500000	* 306102	.	307102	.05500000	308102	.21100000
309102	.19500000	310102	.25067800	311102	2.42987800	301103	2.55067800
302103	.53700000	303103	.15000000	* 304103	.	305103	.02500000

Appendix C, Table I (Cont'd.)

* 306103	.	307103	.03000000	308103	.12600000	309103	.09000000
310103	.51567800	311103	2.43067800	301104	2.91567800	302104	1.18100000
303104	.35000000	304104	.54000000	* 305104	.	* 306104	.
* 307104	.	308104	.07600000	309104	.02000000	310104	.28067800
311104	2.32567800	301105	2.79567800	302105	1.89800000	303105	.35500000
304105	.87000000	* 305105	.	306105	.19000000	307105	.08000000
308105	.17100000	309105	.12000000	310105	.55567800	311105	2.14067800
301106	3.04067800	302106	1.42500000	303106	.57000000	304106	.69000000
305106	.10500000	306106	.07000000	* 307106	.	* 308106	.
* 309106	.	310106	.33067800	311106	2.19067800	301107	4.46614600
302107	3.00646800	303107	2.10046800	304107	2.24046800	305107	1.62546800
306107	1.37546800	307107	1.15046800	308107	.84646800	309107	.85046800
310107	.29114600	311107	2.45114600	* +201SPK	.	* +202OGD	.
* +203BIL	.	+204CHE	.19170800	* +205PIE	.	* +206OKC	.
* +207JAC	.	+208LOU	.39808800	* +209THM	.	* +210ROA	.
* +211HAR	.	* +301SPK	.	* +302OGD	.	* +303BIL	.
* +304CHE	.	* +305PIE	.	* +306OKC	.	* +307JAC	.
* +308LOU	.	* +309THM	.	* +310ROA	.	* +311HAR	.

Appendix C, Table II—Shadow Prices for Optimum Shipments of Feeder Cattle from Supply to Demand Regions Using Model II Estimated Costs with Truck Rate of $.60 Per Mile, 1965

	201101	.72867000		202101	.44388200		203101	.93717400		204101	1.19968200
	205101	1.31083600		206101	.89471600		207101	1.34233600		208101	1.98176400
	209101	1.74719200		210101	2.58540600		211101	2.32696600		201102	1.44532800
	202102	.66396600		203102	.89881800		204102	1.04502800		205102	1.20048600
	206102	.53884800		207102	.95324000		208102	1.62220400		209102	1.35071200
	210102	1.75511600		211102	1.96740600		201103	1.41744600		202103	.80037800
	203103	.24145000	*	204103	.		205103	.15361200		206103	.31713600
	207103	.96597000		208103	.93899200		209103	1.24529800		210103	1.29711600
	211103	1.23435200		201104	2.09832400		202104	1.73046600		203104	.86325600
	204104	.86178600		205104	.04994000		206104	.18762000		207104	.50232800
	208104	.28521200		209104	.64320600		210104	.28705800		211104	.47535000
	201105	2.00525400		202105	2.20042600		203105	.77018600		204105	1.41850800
	205105	.04547800		206105	.81818200		207105	.83014600		208105	.29736400
	209105	.76427200		210105	.28259600		211105	.33243800		201106	2.34845200
	202106	1.88275600		203106	1.11338400		204106	1.05099600		205106	.17823200
	206106	.30299000		207106	.35002800	*	208106	.		209106	.39676000
	210106	.11629800		211106	1.26635600		201107	3.91201400		202107	3.56077000
	203107	2.67694600		204107	2.72901000		205107	1.87101400		206107	1.48443000
	207107	.87983000	*	208107	.		209107	.82687800	*	210107	.
	211107	.19752200	*	301101	.	*	302101	.	*	303101	.
	304101	.35500000		305101	.63000000	*	306101	.		307101	.19500000
	308101	.30600000		309101	.33500000		310101	.34567800		311101	.46407800
	301102	.77500000		302102	.78700000		303102	.46500000		304102	.47500000
	305102	.35500000	*	306102	.		307102	.12500000		308102	.28100000
	309102	.26500000		310102	.32067800		311102	.46987800		301103	.79000000
	302103	.53700000		303103	.15000000	*	304103	.		305103	.02500000
*	306103	.		307103	.10000000		308103	.19600000		309103	.16000000

Appendix C, Table II (Cont'd.)

310103	.58567800	311103	.47067800	301104	1.15500000	302104	1.18100000
303104	.35000000	304104	.54000000	* 305104	.	* 306104	.
307104	.07000000	308104	.14600000	309104	.09000000	310104	.35067800
311104	.36567800	301105	1.03500000	302105	1.89800000	303105	.35500000
304105	.87000000	* 305105	.	306105	.19000000	307105	.15000000
308105	.24100000	309105	.19000000	310105	.62567800	311105	.18067800
301106	1.21000000	302106	1.35500000	303106	.50000000	304106	.62000000
305106	.03500000	* 306106	.	* 307106	.	* 308106	.
* 309106	.	310106	.33067800	311106	.16067800	301107	2.63546800
302107	2.93646800	303107	2.03046800	304107	2.17046800	305107	1.55546800
306107	1.30546800	307107	1.15046800	308107	.84646800	309107	.85046800
310107	.29114600	311107	.42114600	* +201SPK	.	* +202OGD	.
* +203BIL	.	+204CHE	.19170800	* +205PIE	.	* +206OKC	.
* +207JAC	.	+208LOU	.39808800	* +209THM	.	* +210ROA	.
* +211HAR	.	* +301SPK	.	* +302OGD	.	* +303BIL	.
* +304CHE	.	* +305PIE	.	* +306OKC	.	* +307JAC	.
* +308LOU	.	* +309THM	.	* +310ROA	.	* +311HAR	.

Appendix C, Table III—Shadow Prices for Optimum Shipments of Feeder Cattle from Supply to Demand Regions Using Model III Estimated Costs with Truck Rate of $.60 Per Mile, 1965

	201101	2.70775800		202101	.44388200		203101	.93717400		204101	1.19968200
	205101	1.31083600		206101	.89471600		207101	1.27233600		208101	1.91176400
	209101	1.67719200		210101	2.39910800		211101	2.87537600		201102	2.42441600
	202102	.66396000		203102	.89881800		204102	1.04502800		205102	1.20048600
	206102	.53884800		207102	.88324000		208102	1.55220400		209102	1.28071200
	210102	1.56881800		211102	2.51581600		201103	3.39653400		202103	.80037800
	203103	.24145000	*	204103	.		205103	.15361200		206103	.31713600
	207103	.89597000		208103	.86899200		209103	1.17529800		210103	1.11081800
	211103	1.78276200		201104	4.07741200		202104	1.73046600		203104	.86325600
	204104	.86178600		205104	.04994000		206104	.18762000		207104	.43232800
	208104	.21512120		209104	.57320600		210104	.10076000		211104	1.02376000
	201105	3.98434200		202105	2.20042600		203105	.77018600		204105	1.41850800
	205105	.04547800		206105	.81818200		207105	.76014600		208105	.22736400
	209105	.69427200		210105	.09629800		211105	.88084800		201106	4.39754000
	202106	1.95275600		203106	1.18338400		204106	1.12099600		205106	.24823200
	206106	.37299000		207106	.35002800	*	208106	.		209106	.39676000
*	210106	.		211106	1.88476600		201107	6.07740000		202107	3.74706800
	203107	2.86324400		204107	2.91530800		205107	2.05731200		206107	1.67072800
	207107	.99612800		208107	.11629800		209107	.94317600	*	210107	.
	211107	.93223000		301101	1.97908800	*	302101	.	*	303101	.
	304101	.35500000		305101	.63000000	*	306101	.		307101	.12500000
	308101	.63408800		309101	.26500000		310101	.02500000		311101	1.01248800
	301102	2.75408800		302102	.78700000		303102	.46500000		304102	.47500000
	305102	.35500000	*	306102	.		307102	.05500000		308102	.60908800
	309102	.19500000	*	310102	.		311102	1.01828800		301103	2.76908800
	302103	.53700000		303103	.15000000	*	304103	.		305103	.02500000

Appendix C, Table III (Cont'd.)

* 306103	.	307103	.03000000	308103	.52408800	309103	.09000000
310103	.26500000	311103	1.01908800	301104	3.13408800	302104	1.18100000
303104	.35000000	304104	.54000000	* 305104	.	* 306104	.
* 307104	.	308104	.47408800	309104	.02000000	310104	.03000000
311104	.91408800	301105	3.01408800	302105	1.89800000	303105	.35500000
304105	.87000000	* 305105	.	306105	.19000000	307105	.08000000
308105	.56908800	309105	.12000000	310105	.30500000	311105	.72908800
301106	3.25908800	302106	1.42500000	303106	.57000000	304106	.69000000
305106	.10500000	306106	.07000000	* 307106	.	308106	.39808800
* 309106	.	310106	.08000000	311106	.77908800	301107	4.80085400
302107	3.12276600	303107	2.21676600	304107	2.35676600	305107	1.74176600
306107	1.49176600	307107	1.26676600	308107	1.36085400	309107	.96676600
310107	.15676600	311107	1.15585400	* +201SPK	.	* +202OGD	.
* +203BIL	.	+204CHE	.19170800	* +205PIE	.	* +206OKC	.
* +207JAC	.	* +208LOU	.	* +209THM	.	+210ROA	.13438000
* +211HAR	.	* +301SPK	.	* +302OGD	.	* +303BIL	.
* +304CHE	.	* +305PIE	.	* +306OKC	.	* +307JAC	.
* +308LOU	.	* +309THM	.	* +310ROA	.	* +311HAR	.

Appendix C, Table IV—Shadow Prices for Optimum Shipments of Feeder Cattle from Supply to Demand Regions Using Model IV Estimated Costs with Truck Rate of $.60 Per Mile, 1965

	201101	.72867000		202101	.44388200		203101	.93717400		204101	1.19968200
	205101	1.31083600		206101	.89471600		207101	1.34233600		208101	11.98176400
	209101	1.74719200		210101	2.58540600		211101	2.32696600		201102	1.44532800
	202102	.66396600		203102	.89881800		204102	1.04502800		205102	1.20048600
	206102	.53884800		207102	.95324000		208102	1.62220400		209102	1.35071200
	210102	1.75511600		211102	1.96740600		201103	1.41744600		202103	.80037800
	203103	.24145000	*	204103	.		205103	.15361200		206103	.31713600
	207103	.96597000		208103	.93899200		209103	1.24529800		210103	1.29711600
	211103	1.23435200		201104	2.09832400		202104	1.73046600		203104	.86325600
	204104	.86178600		205104	.04994000		206104	.18762000		207104	.50232800
	208104	.28521200		209104	.64320600		210104	.28705800		211104	.47535000
	201105	2.00525400		202105	2.20042600		203105	.77018600		204105	1.41850800
	205105	.04547800		206105	.81818200		207105	.83014600		208105	.29736400
	209105	.76427200		210105	.28259600		211105	.33243800		201106	2.34845200
	202106	1.88275600		203106	1.11338400		204106	1.05099600		205106	.17823200
	206106	.30299000		207106	.35002800	*	208106	.		209106	.39676000
	210106	.11629800		211106	1.26635600		201107	3.91201400		202107	3.56077000
	203107	2.67694600		204107	2.72901000		205107	1.87101400		206107	1.48443000
	207107	.87983000	*	208107	.		209107	.82687800	*	210107	.
	211107	.19752200	*	301101	.	*	302101	.	*	303101	.
	304101	.35500000		305101	.63000000	*	306101	.		307101	.19500000
	308101	.30600000		309101	.33500000		310101	.34567800		311101	.46407800
	301102	.77500000		302102	.78700000		303102	.46500000		304102	.47500000
	305102	.35500000	*	306102	.		307102	.12500000		308102	.28100000
	309102	.26500000		310102	.32067800		311102	.46987800		301103	.79000000
	302103	.53700000		303103	.15000000	*	304103	.		305103	.02500000
	306103	.		307103	.10000000		308103	.19600000		309103	.16000000

Appendix C, Table IV (Cont'd.)

	310103	.58567800		311103	.47067800		301104	1.15500000		302104	1.18100000
	303104	.35000000		304104	.54000000	*	305104	.	*	306104	.
	307104	.07000000		308104	.14600000		309104	.09000000		310104	.35067800
	311104	.36567800		301105	1.03500000		302105	1.89800000		303105	.35500000
	304105	.87000000	*	305105	.		306105	.19000000		307105	.15000000
	308105	.24100000		309105	.19000000		310105	.62567800		311105	.18067800
	301106	1.21000000		302106	1.35500000		303106	.50000000		304106	.62000000
	305106	.03500000	*	306106	.	*	307106	.	*	308106	.
*	309106	.		310106	.33067800		311106	.16067800		301107	2.63546800
	302107	2.93646800		303107	2.03046800		304107	2.17046800		305107	1.55546800
	306107	1.30546800		307107	1.15046800		308107	.84646800		309107	.85046800
	310107	.29114600		311107	.42114600	*	+201SPK	.	*	+202OGD	.
*	+203BIL	.		+204CHE	.19170800	*	+205PIE	.	*	+206OKC	.
*	+207JAC	.		+208LOU	.39808800	*	+209THM	.	*	+210ROA	.
*	+211HAR	.	*	+301SPK	.	*	+302OGD	.	*	+303BIL	.
*	+304CHE	.	*	+305PIE	.	*	+306OKC	.	*	+307JAC	.
*	+308LOU	.	*	+309THM	.	*	+310ROA	.	*	+311HAR	.

Appendix C, Table V—Shadow Prices for Optimum Shipments of Feeder Cattle from Supply to Demand Regions Using Model II Estimated Costs with Truck Rate of $.46 Per Mile, 1965

201101	2.36929000	202101	.11330500	203101	.34713500	204101	.73343000
205101	.73909000	206101	.31459000	207101	.47469000	208101	1.23313000
209101	.74920000	210101	1.69583500	211101	3.52773500	201102	2.98983500
202102	.35321500	203102	.38894500	204102	.68609500	205102	.72571500
206102	.11302000	207102	.24765000	208102	1.02873000	209102	.51650000
210102	1.13061000	211102	3.32333500	201103	3.08340500	202103	.57272000
* 203103	.	* 204103	.	205103	.03820500	206103	.05801500
207103	.37235000	208103	.61997500	209103	.55064000	210103	.89448500
211103	2.87637500	201104	3.64657500	202104	1.32691500	203104	.51789000
204104	.70184000	* 205104	.	* 206104	.	207104	.05822000
208104	.16010000	209104	.13038500	210104	.16151500	211104	2.33584500
201105	3.57865500	202105	1.69057000	203105	.44997000	204105	1.13200000
* 205105	.	206105	.48676000	207105	.31292000	208105	.17283500
209105	.22660500	210105	.16151500	211105	2.22972000	201106	3.89682500
202106	1.50217000	203106	.76814000	204106	.90539500	205106	.15686000
206106	.14695500	* 207106	.	* 208106	.	* 209106	.
210106	.08914500	211106	3.00069000	201107	5.09533000	202107	2.78840500
203107	1.96664500	204107	2.19163000	205107	1.45441500	206107	1.05255500
207107	.40610500	* 208107	.	209107	.32969500	* 210107	.
211107	2.18140500	301101	2.13411500	* 302101	.	* 303101	.
304101	.34862500	305101	.61505000	* 306101	.	307101	.11005000
308101	.56911500	309101	.24752000	310101	.64911500	311101	2.79751500
301102	2.90911500	302102	.78700000	303102	.46500000	304102	.46862500
305102	.34005000	* 306102	.	307102	.04005000	308102	.54411500
309102	.17752000	310102	.62411500	311102	2.80331500	301103	2.93049000
302103	.54337500	303103	.15637500	* 304103	.	305103	.01642500

Appendix C, Table V (Cont'd.)

306103	.00637500	307103	.02142500	308103	.46549000	309103	.07889500
310103	.89549000	311103	2.81049000	301104	3.30406500	302104	1.19595000
303104	.36495000	304104	.54857500	* 305104	.	306104	.01495000
* 307104	.	308104	.42406500	309104	.01747000	310104	.66906500
311104	2.71406500	301105	3.18982000	302105	1.91870500	303105	.37570500
304105	.88433000	305105	.00575500	306105	.21070500	307105	.08575500
308105	.52482000	309105	.12322500	310105	.94982000	311105	2.53482000
301106	3.43159500	302106	1.44248000	303106	.58748000	304106	.70110500
305106	.10753000	306106	.08748000	307106	.00253000	308106	.35059500
* 309106	.	310106	.72159500	311106	2.58159500	301107	4.65966500
302107	2.82655000	303107	1.92055000	304107	2.05417500	305107	1.43060000
306107	1.19555000	307107	.95560000	308107	.99966500	309107	.65307000
310107	.48466500	311107	2.64466500	* +201SPK	.	* +202OGD	.
* +203BIL	.	+204CHE	.23567000	+205PIE	.11815000	* +206OKC	.
* +207JAC	.	+208LOU	.29402500	+209THM	.06010000	* +210ROA	.
* +211HAR	.	* +301SPK	.	* +302OGD	.	* +303BIL	.
* +304CHE	.	* +305PIE	.	* +306OKC	.	* +307JAC	.
* +308LOU	.	* +309THM	.	* +310ROA	.	* +311HAR	.

Appendix C, Table VI—Shadow Prices for Optimum Shipments of Feeder Cattle from Supply to Demand Regions Using Model II Estimated Costs with Truck Rate of $.46 Per Mile, 1965

	201101	.23517500		202101	.11330500		203101	.34713500		204101	.73343000
	205101	.73909000		206101	.31459000		207101	.56217000		208101	1.32061000
	209101	.83668000		210101	1.78331500		211101	1.58521500		201102	.85572000
	202102	.35321500		203102	.38894500		204102	.68609500		205102	.72571500
	206102	.11302000		207102	.33513000		208102	1.11621000		209102	.60398000
	210102	1.21809000		211102	1.38081500		201103	.94929000		202103	.57272000
*	203103	.	*	204103	.		205103	.03820500		206103	.05801500
	207103	.45983000		208103	.70745500		209103	.63812000		210103	.98196500
	211103	.93385500		201104	1.51246000		202104	1.32691500		203104	.51789000
	204104	.70184000	*	205104	.	*	206104	.		207104	.14570000
	208104	.24758000		209104	.21786500		210104	.24899500		211104	.39332500
	201105	1.44454000		202105	1.69057000		203105	.44997000		204105	1.13200000
*	205105	.		206105	.48676000		207105	.40040000		208105	.26031500
	209105	.31408500		210105	.24899500		211105	.28720000		201106	1.67523000
	202106	1.41469000		203106	.68066000		204106	.81791500		205106	.06938000
	206106	.05947500	*	207106	.	*	208106	.	*	209106	.
	210106	.08914500		211106	.97069000		201107	2.87373500		202107	2.70092500
	203107	1.87916500		204107	2.14150000		205107	1.36693500		206107	.96507500
	207107	.40610500	*	208107	.		209107	.32969500	*	210107	.
	211107	.15140500	*	301101	.	*	302101	.	*	303101	.
	304101	.34862500		305101	.61505000	*	306101	.		307101	.19500000
	308101	.30600000		309101	.33500000		310101	.73659500		311101	.85499500
	301102	.77500000		302102	.78700000		303102	.46500000		304102	.46862500
	305102	.34005000	*	306102	.		307102	.12500000		308102	.28100000
	309102	.26500000		310102	.71159500		311102	.86079500		301103	.79637500
	302103	.54337500		303103	.15637500	*	304103	.		305103	.01642500
	306103	.00637500		307103	.10637500		308103	.20237500		309103	.11637500

Appendix C, Table VI (Cont'd.)

310103	.98297000	311103	.86797000	301104	1.16995000	302104	1.19595000
303104	.36495000	304104	.54857500	* 305104	.	306104	.01495000
307104	.08495000	308104	.16095000	309104	.10495000	310104	.75654500
311104	.77154500	301105	1.05570500	302105	1.91870500	303105	.37570500
304105	.88433000	305105	.00575500	306105	.21070500	307105	.17070500
308105	.26170500	309105	.21070500	310105	1.03730000	311105	.59230000
301106	1.21000000	302106	1.35500000	303106	.50000000	304106	.61362500
305106	.02005000	* 306106	.	* 307106	.	* 308106	.
* 309106	.	310106	.72159500	311106	.55159500	301107	2.43807000
302107	2.739070000	303107	1.833070000	304107	1.96669500	305107	1.34312000
306107	1.10807000	307107	.95307000	308107	.64907000	309107	.65307000
310107	.48466500	311107	.61466500	* +201SPK	.	* +202OGD	.
* +203BIL	.	+204CHE	.23567000	+205PIE	.11815000	* +206OKC	.
+207JAC	.00253000	+208LOU	.64462000	+209THM	.06010000	* +210ROA	.
* +211HAR	.	* +301SPK	.	* +302OGD	.	* +303BIL	.
* +304CHE	.	* +305 PIE	.	* +306OKC	.	* +307JAC	.
* +308LOU	.	* +309THM	.	* +310ROA	.	* +311HAR	.

Appendix C, Table VII—Shadow Prices for Optimum Shipments of Feeder Cattle from Supply to Demand Regions Using Model III Estimated Costs with Truck Rate of $.46 Per Mile, 1965

	201101	2.44331500		202101	.11330500		203101	.34713500		204101	.73343000
	205101	.73909000		206101	.31459000		207101	.47469000		208101	1.23313000
	209101	.74920000		210101	1.60669000		211101	1.97176000		201102	3.06386000
	202102	.35321500		203102	.38894500		204102	.68609500		205102	.72571500
	206102	.11302000		207102	.24765000		208102	1.02873000		209102	.51650000
	210102	1.04146500		211102	1.7673600		201103	3.15743000		202103	.57272000
*	203103	.	*	204103	.		205103	.03820500		206103	.05801500
	207103	.37235000		208103	.61997500		209103	.55064000		210103	.80534000
	211103	1.32040000		201104	3.72060000		202104	1.32691500		203104	.51789000
	204104	.70184000	*	205104	.	*	206104	.		207104	.05822000
	208104	.16010000		209104	.13038500		210104	.07237000		211104	.77987000
	201105	3.65268000		202105	1.69057000		203105	.44997000		204105	1.13200000
*	205105	.		206105	.48676000		207105	.31292000		208105	.17283500
	209105	.22660500		210105	.07237000		211105	.67374500		201106	3.97085000
	202106	1.50217000		203106	.76814000		204106	.90539500		205106	.15686000
	206106	.14695500	*	207106	.	*	208106	.	*	209106	.
*	210106	.		211106	1.44471500		201107	5.25850000		202107	2.87755000
	203107	2.05579000		204107	2.28077500		205107	1.54356000		206107	1.14170000
	207107	.49525000		208107	.08914500		209107	.41884000	*	210107	.
	211107	.71457500		301101	2.20814000	*	302101	.	*	303101	.
	304101	.34862500		305101	.61505000	*	306101	.		307101	.11005000
	308101	.86314000		309101	.24752000		310101	.07530500		311101	1.24154000
	301102	2.98314000		302102	.78700000		303102	.46500000		304102	.46862500
	305102	.34005000	*	306102	.		307102	.04005000		308102	.83814000
	309102	.17752000		310102	.05030500		311102	1.24734000		301103	3.00451500
	302103	.54337500		303103	.15637500	*	304103	.		305103	.01642500

Appendix C, Table VIII (Cont'd.)

306103	.00637500	307103	.02142500	308103	.75951500	309103	.07889500
310103	.32168000	311103	1.25451500	301104	3.37809000	302104	1.19595000
303104	.36495000	304104	.54857500	* 305104	.	306104	.01495000
* 307104	.	308104	.71809000	309104	.01747000	310104	.09525500
311104	1.15809000	301105	3.26384500	302105	1.91870500	303105	.37570500
304105	.88433000	305105	.00575500	306105	.21070500	307105	.08575500
308105	.81884500	309105	.12322500	310105	.37601000	311105	.97884500
301106	3.50562000	302106	1.44248000	303106	.58748000	304106	.70110500
305106	.10753000	306106	.08748000	307106	.00253000	308106	.64462000
* 309106	.	310106	.14778500	311106	1.02562000	301107	4.82283500
302107	2.91569500	303107	2.00969500	304107	2.14332000	305107	1.51974500
306107	1.28469500	307107	1.04474500	308107	1.38283500	309107	.74221500
* 310107	.	311107	1.17783500	* +201SPK	.	* +202OGD	.
* +203BIL	.	+204CHE	.23567000	+205PIE	.11815000	* +206OKC	.
* +207JAC	.	* +208LOU	.	+209THM	.06010000	+210ROA	.48466500
* +211HAR	.	* +301 SPK	.	* +302OGD	.	* +303BIL	.
* +304CHE	.	* +305PIE	.	* +306OKC	.	* +307JAC	.
* +308LOU	.	* +309THM	.	* +310ROA	.	* +311HAR	.

Appendix C, Table VIII—Shadow Prices for Optimum Shipments of Feeder Cattle from Supply to Demand Regions Using Model IV Estimated Costs with Truck Rate of $.46 Per Mile, 1965

	201101	.23517500		202101	.11330500		203101	.34713500		204101	.73343000
	205101	.73909000		206101	.31459000		207101	.56217000		208101	1.32061000
	209101	.83668000		210101	1.69417000		211101	1.36872000		201102	.85572000
	202102	.35321500		203102	.38894500		204102	.68609500		205102	.72571500
	206102	.11302000		207102	.33513000		208102	1.11621000		209102	.60398000
	210102	1.12894500		211102	1.16432000		201103	.94929000		202103	.57272000
*	203103	.	*	204103	.		205103	.03820500		206103	.05801500
	207103	.45983000		208103	.70745500		209103	.63812000		210103	.89282000
	211103	.71736000		201104	1.51246000		202104	1.32691500		203104	.51789000
	204104	.70184000	*	205104	.	*	206104	.		207104	.14570000
	208104	.24758000		209104	.21786500		210104	.15985000		211104	.17683000
	201105	1.44454000		202105	1.69057000		203105	.44997000		204105	1.13200000
*	205105	.		206105	.48676000		207105	.40040000		208105	.26031500
	209105	.31408500		210105	.15985000		211105	.07070500		201106	1.67523000
	202106	1.41469000		203106	.68066000		204106	.81791500		205106	.06938000
	206106	.05944750	*	207106	.	*	208106	.	*	209106	.
*	210106	.		211106	.75419500		201107	2.96288000		202107	2.79007000
	203107	1.96831000		204107	2.19329500		205107	1.45608000		206107	1.05422000
	207107	.49525000		208107	.08914500		209107	.41884000	*	210107	.
	211107	.02405500	*	301101	.	*	302101	.	*	303101	.
	304101	.34862500		305101	.61505000	*	306101	.		307101	.19500000
	308101	.30600000		309101	.39510000		310101	.52010000		311101	.63850000
	301102	.77500000		302102	.78700000		303102	.46500000		304102	.46862500
	305102	.34005000	*	306102	.		307102	.12500000		308102	.28100000
	309102	.32510000		310102	.49510000		311102	.64430000		301103	.79637500
	302103	.54337500		303103	.15637500	*	304103	.		305103	.01642500

Appendix C, Table VII (Cont'd½)

306103	.00637500	307103	.10637500	308103	.20237500	309103	.22647500
310103	.76647500	311103	.65147500	301104	1.16995000	302104	1.19595000
303104	.36495000	304104	.54857500	* 305104	.	306104	.01495000
307104	.08495000	308104	.16095000	309104	.16505000	310104	.54005000
311104	.55505000	301105	1.05570500	302105	1.91870500	303105	.37570500
304105	.88433000	305105	.00575500	306105	.21070500	307105	.17070500
308105	.26170500	309105	.27080500	310105	.82080500	311105	.37580500
301106	1.21000000	302106	1.35500000	303106	.50000000	304106	.61362500
305106	.02005000	* 306106	.	* 307106	.	* 308106	.
309106	.06010000	310106	.50510000	311106	.33510000	301107	2.52721500
302107	2.82821500	303107	1.92221500	304107	2.05584000	305107	1.43226500
306107	1.19721500	307107	1.04221500	308107	.73821500	309107	.80231500
310107	.35731500	311107	.48731500	* +201SPK	.	* +202OGD	.
* +203BIL	.	+204CHE	.23567000	+205PIE	.11815000	* +206OKC	.
+207JAC	.00253000	+208LOU	.64462000	* +209THM	.	+210ROA	.12735000
* +211HAR	.	* +301SPK	.	* +302OGD	.	* +303BIL	.
* +304CHE	.	* +305PIE	.	* +306OKC	.	* +307JAC	.
* +308LOU	.	* +309THM	.	* +310ROA	.	* +311HAR	.

Appendix C, Table IX—Shadow Prices for Optimum Shipments of Feeder Cattle from Supply to Demand Regions Model I, II, III, and IV Estimated Costs with Truck Rate of $.60 Per Mile, 1970

	201101	.72867000		202101	.44388200		203101	.93717400		204101	1.34968200
	205101	1.61583600		206101	1.19971600		207101	1.57733600		208101	2.21676400
	209101	1.98219200		210101	2.70410800		211101	2.29952800	*	212101	.
	201102	1.14032800		202102	.35896600		203102	.59381800		204102	.89002800
	205102	1.20048600		206102	.53884800		207102	.88324000		208102	1.55220400
	209102	1.28071200		210102	1.56881800		211102	1.63496800	*	212102	.
	201103	1.26744600		202103	.65037800		203103	.09145000	*	204103	.
	205103	.30861200		206103	.47213600		207103	1.05097000		208103	1.02399200
	209103	1.33029800		210103	1.26581800		211103	1.05691400		212103	.62000000
	201104	1.79332400		202104	1.42546600		203104	.55825600		204104	.70678600
	205104	.04994000		206104	.18762000		207104	.43232800		208104	.21521200
	209104	.57320600		210104	.10076000		211104	.14291200		212104	.60500000
	201105	1.70025400		202105	1.89542600		203105	.46518600		204105	1.26350800
	205105	.04547800		206105	.81818200		207105	.76014600		208105	.22736400
	209105	.68427200		210105	.09629800	*	211105	.		212105	.59500000
	201106	2.11345200		202106	1.64775600		203106	.87838400		204106	.96599600
	205106	.24823200		206106	.37299000		207106	.35002800	*	208106	.
	209106	.39676000	*	210106	.		211106	1.00391800		212106	.61500000
	201107	3.79331200		202107	3.44206800		203107	2.55824400		204107	2.76030800
	205107	2.05731200		206107	1.67072800		207107	.99612800		208107	.11629800
	209107	.94317600	*	210107	.		211107	.05138200		212107	1.57676600
*	301101	.	*	302101	.	*	303101	.		304101	.50500000
	305101	.93500000		306101	.30500000		307101	.43000000		308101	.54100000
	309101	.57000000		310101	.33000000		311101	.58840000		312101	.
	301102	.47000000		302102	.48200000		303102	.16000000		304102	.32000000
	305102	.35500000	*	306102	.		307102	.05500000		308102	.21100000
	309102	.19500000	*	310102	.		311102	.28920000		312102	.

Appendix C, Table IX (Cont'd.)

301103	.64000000	302103	.38700000	* 303103	.	* 304103	.
305103	.18000000	306103	.15500000	307103	.18500000	308103	.28100000
309103	.24500000	310103	.42000000	311103	.44500000	312103	.62000000
301104	.85000000	302104	.87600000	303105	.04500000	304104	.38500000
* 305104	.	* 306104	.	* 307104	.	308104	.07600000
309104	.02000000	310104	.03000000	311104	.18500000	312104	.60500000
301105	.73000000	302105	1.59300000	303105	.05000000	304105	.71500000
* 305105	.	306105	.19000000	307105	.08000000	308105	.17100000
309105	.12000000	310105	.30500000	* 311105	.	312105	.59500000
301106	.97500000	302106	1.12000000	303106	.26500000	304106	.53500000
305106	.10500000	306106	.07000000	* 307106	.	* 308106	.
* 309106	.	310106	.08000000	311106	.50000000	312106	.61500000
301107	2.51676600	302107	2.81776600	303107	1.91176600	304107	2.20176600
305107	1.74176600	306107	1.49176600	307107	1.26676600	308107	.96276600
309107	.96676600	310107	.15676600	311107	.42676600	312107	1.57676600
* +201SPK	.	* +202OGD	.	* +203BIL	.	+204CHE	.19170800
* +205PIE	.	* +206OKC	.	* +207JAC	.	+208LOU	.39808800
* +209THM	.	+210ROA	.13438000	* +211HAR	.	* +212DUM	.
* +301SPK	.	* +302OGD	.	* +303BIL	.	* +304CHE	.
* +305PIE	.	* +306OKC	.	* +307JAC	.	* +308LOU	.
* +309THM	.	* +310ROA	.	+311HAR	.15176000	* +312DUM	.

Appendix C, Table X—Shadow Prices for Optimum Shipments of Feeder Cattle from Supply to Demand Regions Model I, II, III, and IV Estimated Costs with Truck Rate of $.46 Per Mile, 1970

201101	.23517500	202101	.11330500	203101	.34713500	204101	.73343000
205101	1.04409000	206101	.61959000	207101	.77969000	208101	1.53813000
209101	1.05420000	210101	1.91169000	211101	1.60301500	* 212101	.
201102	.55072000	202102	.04821500	203102	.08394500	204102	.38109500
205102	.72571500	206102	.11302000	207102	.24765000	208102	1.02873000
209102	.51650000	210102	1.04146500	211102	1.09361500	* 212102	.
201103	.94929000	202103	.57272000	* 203103	.	* 204103	.
205103	.34320500	206103	.36301500	207103	.67735000	208103	.92497500
209103	.85564000	210103	1.11034000	211103	.95165500	212103	.77637500
201104	1.20746000	202104	1.02191500	203104	.21289000	204104	.39684000
* 205104	.	* 206104	.	207104	.05822000	208104	.16010000
209104	.13038500	210104	.07237000	211104	.10612500	212104	.61995000
201105	1.13954000	202105	1.38557000	203105	.14497000	204105	.82700000
* 205105	.	206105	.48376000	207105	.31292000	208105	.17283500
209105	.22660500	210105	.07237000	* 211105	.	212105	.61570500
201106	1.45771000	202106	1.19717000	203106	.46314000	204106	.60039500
205106	.15686000	206106	.14695500	* 207106	.	* 208106	.
* 209106	.	* 210106	.	211106	.77097000	212106	.63248000
201107	2.74536000	202107	2.57255000	203107	1.75079000	204107	1.97577500
205107	1.54356000	206107	1.14170000	207107	.49525000	208107	.08914500
209107	.41884000	* 210107	.	211107	.04083000	212107	1.36969500
* 301101	.	* 302101	.	* 303101	.	304101	.34862500
305101	.92005000	306101	.30500000	307101	.41505000	308101	.52352000
309101	.55252000	310101	.38030500	311101	.56769500	312101	.
301102	.47000000	302102	.48200000	303102	.16000000	304102	.16362500
305102	.34005000	* 306102	.	307102	.04005000	308102	.19352000

Appendix C, Table X (Cont'd.)

	309102	.17752000		310102	.05030500		311102	.26849500		312102	.
	301103	.79637500		302102	.54337500		303103	.15637500	*	304103	.
	305103	.32142500		306103	.31137500		307103	.32642500		308103	.41989500
	309103	.38389500		310103	.62668000		311103	.58067000		312103	.77637500
	301104	.86495000		302104	.89095000		303104	.05995000		304104	.24357500
*	305104	.		306104	.01495000	*	307104	.		308104	.07347000
	309104	.01747000		310104	.09525500		311104	.17924500		312104	.61995000
	301105	.75070500		302105	1.61370500		303105	.07070500		304105	.57933000
	305105	.00575500		306105	.21070500		307105	.08575500		308105	.17422500
	309105	.12322500		310105	.37601000	*	311105	.		312105	.61570500
	301106	.99248000		302106	1.13748000		303106	.28248000		304106	.39610500
	305106	.10753000		306106	.08748000		307106	.00253000	*	308106	.
*	309106	.		310106	.14778500		311106	.04677500		312106	.63248000
	301107	2.30969500		302107	2.61069500		303107	1.70469500		304107	1.83832000
	305107	1.51974500		306107	1.28469500		307107	1.04474500		308107	.73821500
	309107	.74221500	*	310107	.		311107	.19899000		312107	1.36969500
*	+201SPK	.	*	+202OGD	.	*	+203BIL	.		+204CHE	.23567000
	+205PIE	.11815000	*	+206OKC	.	*	+207JAC	.		+208LOU	.64462000
	+209THM	.06010000		+210ROA	.48466500		+211HAR	.30510000	*	+212DUM	.
*	+301SPK	.	*	+302OGD	.	*	+303BIL	.	*	+304CHE	.
*	+305PIE	.	*	+306OKC	.	*	+307JAC	.	*	+308LOU	.
*	+309THM	.	*	+310ROA	.	*	+311HAR	.	*	+312DUM	.

6-68/2½M