THE COMPETITIVE POSITION OF KANSAS IN MARKETING BEEF

by

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INTRODUCTION

Meat packers and beef producers are well aware of the heavy concentration of cattle throughout the central United States. This geographical location of beef production differs sufficiently from the high density areas of population to necessitate large shipments of cattle and beef products. During 1959 the area east of the Mississippi River contained two-thirds of the nation's population but provided less than three-tenths of the estimated beef and veal production available for slaughter during the year. This meant that the Eastern portion of the United States produced less than one-half of the beef and veal sufficient to serve its consumers. The remainder must be supplied from the surplus areas existing West of the Mississippi River. The ten Great Plains States, including Kansas, is one of these major surplus producing regions. In 1959 the Great Plains States produced more than three times the quantity necessary to supply its own consumers.

The geographical location of these surplus livestock regions has important implications for the producers, meat-packers and consumers in terms of costs, prices and location of processing plants. It is this diversity between the areas of production and the areas of population that influences the quantity to be shipped, the method and pattern of transportation, and the cost involved.

An increase in the general level of production in a particular region is attributable to the competitive advantage which that region enjoys over another region. This advantage is determined chiefly by the abundance of feed grains, the location of consumers, and the availability of markets. The influence of the latter two factors is reflected in the freight rate

structure.

Feed grain production has always held an important place in Kansas agriculture. Since enforcement of wheat allotment programs, the tremendous increase in the available supply of feed grains has been primarily the result of increased grain sorghum production. This increase may be attributed to the ability of grain sorghum to substitute as a cash crop for wheat and the realization of its importance as a feed grain. The introduction of hybrid varieties and better production methods, including irrigation, have greatly increased the yields. In 1959 Kansas produced 137,082,000 bushel of grain sorghum. This was 6 percent above the previous high set in 1958 and 36,720,000 bushel above the five year average (1955-58). As a result grain sorghum has become a surplus crop in Kansas. The production has been mainly in the 46 countries of the western two-thirds of Kansas. This area accounted for 58.6 percent of the state's production in 1959. This area is outlined in Fig. 1.

Throughout the history of grain sorghum production in the United States a major portion has been utilized as livestock feed. In 1959, an estimated 390 million bushels of sorghum grain was fed to livestock.[1] This represented 69 percent of the estimated U. S. production. Meanwhile, records from the Kansas Entomology Commission show that some 11,600 railroad carloads of milo were shipped out of Kansas during the 1959-60 fiscal year.[2] This amounted to approximately 20,000,000 bushels of milo. During this same period the stocks of grain sorghum increased 23,900,000.

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[1] The Feed Situation, Agriculture Marketing Service, U.S.D.A. May, 1960, p. 8.

[2] Out of state shipments not requiring the corn borer certificates or going into CCC storage are not included in these figures.

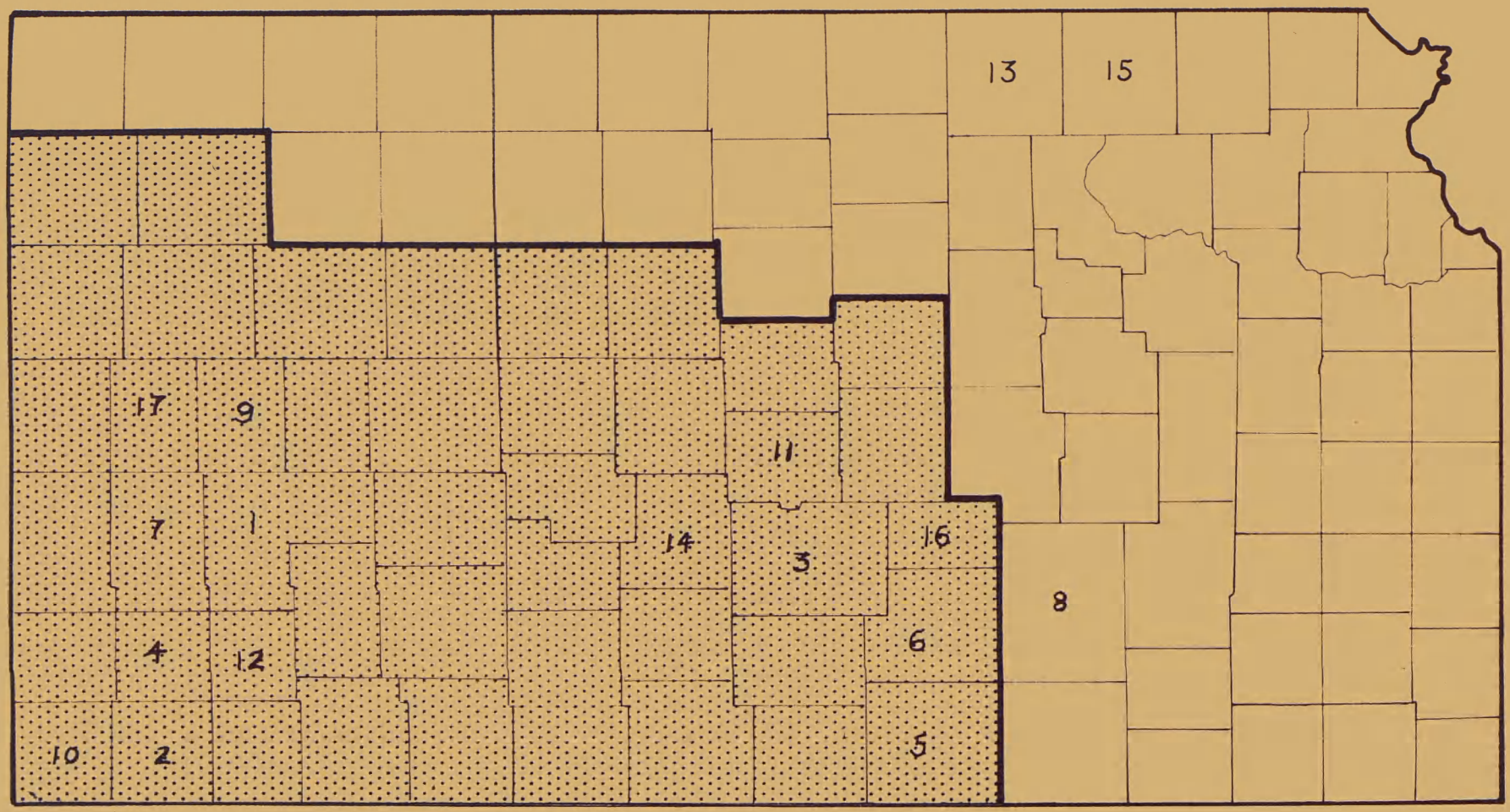

Fig. 1. Major grain sorghum producing area of Kansas. The number indicates the rank of those counties producing over 2,000,000 bushels of grain sorghum in 1959.
Source: Kansas Farm Facts, 1959-1960, Kansas State Board of Agriculture

bushels. These two items accounted for approximately one-third of the Kansas 1959 milo crop. If account was taken for seed and other non-feed uses as well as outshipments not recorded, it is apparent that Kansas fed less than the national average.

While this increase in Kansas feed grain production has been occurring, a tremendous shift in the population of the United States has been taking place. During the past decade (1950-60) the Southwest increased its population 33 percent. This was more than twice the rate of growth for the remainder of the United States. The percentage increase in population for each state is shown in Fig. 2. A continuation of this migration to the West can be expected. As Donald J. Bogue in his recent book, The Population of the United States, stated, "...In general, the forces that are currently guiding the regional distribution of population appear to be quite strong and promise to continue operating for quite a while. These factors favor a continued very rapid rate of growth of the Mountain and Pacific States..."[1]

In contrast to the shift in population the cattle industry has shown its greatest rate of growth in the Southeast. Data compiled by the United States Department of Agriculture showed that the East South Central and South Atlantic states increased farm production 70.32 percent during the period from 1947 to 1958, inclusive.[2] During this same period, the rate of expansion in the Southwest was only slightly more than the national average of 45.11 percent. In spite of the growth in the Southeast the

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[1]Donald J. Bogue, The Population of the United States, The Free Press of Glencoe, Glencoe, Illinois, 1959, p. 782.

[2]Livestock and Meat Statistics, United States Department of Agriculture, August, 1948, p. 19. Livestock and Meat Statistics, Supplement for 1958, Statistical Bulletin 230, U.S.D.A., June, 1959, p. 29.

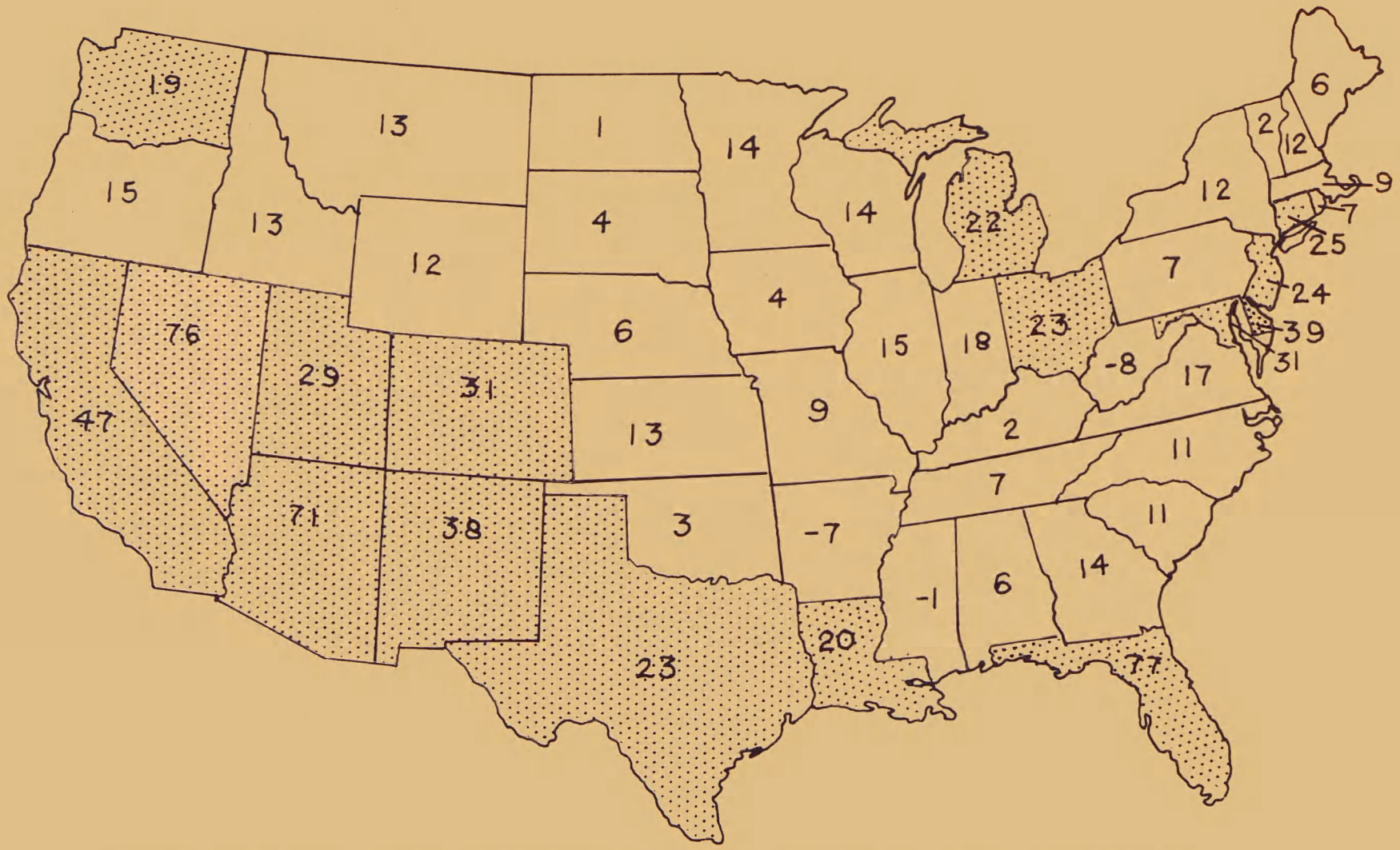

Fig. 2. Percent change in population, by states, July 1, 1950 - July 1, 1960 (est.). Shading indicates those states increasing at a faster rate than the continental United States average (18.6 percent). Arabic numerals denote percentage change in state population.
Source: Time, June 27, 1960, p. 17.

twelve North Central states continued to dominate production. These states accounted for approximately 50 percent of the beef production during this period, whereas the relative importance of the East South Central and South Atlantic states increased 1.9 percent to 12.8 percent in 1958 and the Southwest increased .5 percent to 18.6 percent in 1958.

With the human population growth exceeding cattle production in the West and Southwest, a potential demand for beef produced in the central United States is developing. For some time Kansas has been an important contributor to the nation's livestock industry. Since 1924 it has never ranked lower than fifth in the nation in farm production of cattle and calves. Kansas ranked fourth in 1959. However, in relation to national beef production Kansas has shown a decline. In 1947, Kansas contributed 5.74 percent compared to 4.78 in 1958. The decline in slaughter production has been even more significant. Kansas contributed 6.20 percent in 1947 and only 3.70 percent in 1958. Despite this relative decline in slaughter Kansas has remained a surplus producing and slaughtering state. Kansas ranked tenth nationally in commercial cattle and calves for slaughter in 1959. Seven of the nine states exceeding Kansas were located to the north and east of Kansas.

This relative decline in importance of the beef industry in Kansas is attributable to numerous factors. One of the principal factors often mentioned is the competitive disadvantage of Kansas in respect to the freight rate structure. In this paper, attention is directed to the impact of freight rates on the marketing of beef and beef products. The simplex method of linear programming was employed to investigate economic basis for expansion of beef production in western Kansas.

REVIEW OF LITERATURE

Theoretical Studies

Since the era of David Ricardo and A. A. Gournot, the construction of a general location theory involving the complicated problem of price relationships between two or more spatially separated--but not isolated markets--has been a stimulating challenge to economists. Despite the early efforts of such men as J. W. von Thuenen (1898) and V. Pareto (1909), the construction of a theoretical framework for interregional competition and the specification of corresponding operational models was slow in evolving. In 1941, F. L. Hitchcock originated the now familiar transportation problem and was successful in solving it several years later.[1] This problem required data as to the quantity of a given commodity available for shipping from each supply point and the requirements to be fulfilled at each destination point. It is a necessary condition that shipments from each supply point do not exceed its capacity and that shipments to each destination point equal its requirements. It is also necessary that transportation costs be known. In 1947, T. C. Koopman developed a similar static model of transportation, unaware of the work of Hitchcock.[2] The work of these men has become known as the Koopman-Hitchcock transportation model.

In more recent years, such economists as W. Leontief (1941), S. Enke (1951), M. Beckman (1951), P. Samuelson (1952), and W. Baumal (1952) and such mathematicians as G. Dantizg (1947) and J. von Neuman (1954) have

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[1] F. L. Hitchcock, "The Distribution of a Product from Several Sources to Numerous Localities, " Journal of Math Physics, 1941, 20:224-230.

[2] T. C. Koopman, "Optimum Utilization of the Transportation System," Econometrica, Supple. July, 1949, 17:136-146.

contributed to a new type of theory called linear programming. The new stimulus toward this problem was a direct result of increased efforts in research of the problems that arose in the organization of defense surrounding World War II. Since then, linear programming has supplemented the classical marginal formulation for defining equilibrium. Specifically, these men have suggested new approaches to the problem of price equilibrium and flows in terms of linear programming. With this new approach the space factor came to be treated explicitly.

The theoretical application of linear programming to the theory of spatial location has developed into three closely related models: 1) the transportation model; 2) the contract award model and; 3) the spatial equilibrium model.[1]

The "transportation model" was the earliest in development and has won a prominent place in linear programming literature. This model specifies that quantities of a given commodity are to be shipped from each of a number of sources and other specified quantities are to be received at each of a number of destinations. Total receipts must equal total shipments. The receipts at each market are predetermined and do not depend upon price. With transportation rate between all points known, the objective is to satisfy the set of destination requirements at the least possible total transportation cost. The Hitchcock-Koopman model previously mentioned illustrates the early use of this technique.

The "contract-award" model is similar to the transportation model except that total supplies at the various shipping points exceed the requirements at the various receiving points. The objective is to satisfy

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[1]Karl A. Fox, Econometric Analysis for Public Policy, Ames, Iowa, Iowa State College Press, 1958, p. 170-171.

the destination requirements by allocating purchases at the least possible total delivered cost. This model has been applied to some purchasing programs of the federal government and similar problems arising among private concerns.

The "spatial equilibrium" model differs from these in that it employs a price-dependent demand and/or supply function of the quantities shipped and received plus the quantities produced and retained locally. Given the demand function in each region, the transportation structure between regions and the regional supply of the commodity, the objective is to find the equilibrium price and the consumption in each region and the net quantity shipped over each interregional path. A necessary requirement for equilibrium is that no trader can profit by shipping additional units from one region to another.

Prior to the work of Dr. Stephen Enke, the problem of spatially interdependent markets in four or more regions involved undue difficulty in solving analytically except by the iterative method. Dr. Enke implicitly expressed the problem of spatial equilibrium in the following form:

> There are three regions trading a homogeneous good. Each region constitutes a single and distinct market. The regions of each possible pair of regions are separated--but not isolated--by a transportation cost per physical unit which is independent of volume. There are no legal restrictions to limit the action of profit-seeking traders in each region. For each region the functions which relate local production and local use to local price are known and consequently, the magnitude of the differences which will be exported or imported at each local price is also known. Given these trade functions and transportation costs, we wish to ascertain: 1) the net price in each region, 2) the quantity of exports or imports for each region, 3) which regions export, import or do neither, 4) the aggregate trade in the commodity, 5) the volume and direction of trade between each possible pair of regions.[1]

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[1] S. Enke, "Equilibrium Among Spatially Separated Markets: Solution by Electric Analogue," Econometrica, January, 1951, 19:41.

This problem included the Koopman-Hitchcock model previously mentioned in that both models assumed the scale of output and the deficit or surplus in each region are known.

After stating the nature of the problem, Enke suggested solving such problems by a network of electric circuits. Employing electrical theory, Enke represented various mathematical models by a system of volts, amps and ohms. By interpreting a positive current flow from high voltage to low voltage as a commodity flow from the lower price region to the higher price region, the volume of trade between each pair of regions and the total volume of trade was determined. This is related to the minimum principle--a minimization of total power loss.

Paul A. Samuelson proceeded to relate the Enke formulation to the standard problem of linear (mathematical) programming.[1] Samuelson discussed the problem in terms of maximizing net social pay-off, i.e. determining the flow were by the combined payoffs or benefits of the various regions less the transportation cost was maximized. This he suggested could be solved by trial and error or by a systematic procedure of varying shipments. By converting the spatial equilibrium system of Enke to a maximization problem it became possible to make predications as to the qualitative direction of change in variables when quantitative changes in data of the program occur.

In a prior article W. J. Baumol arrived at similar conclusions quite independently of Samuelson's solution.[2]

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[1]Paul A. Samuelson, "Spatial Price Equilibrium and Linear Programming," American Economic Review, June, 1952, 42:283-303.

[2]W. J. Baumol, "Spatial Equilibrium with Supply Points Separated from Markets and with Supplies Predetermined," United States Department of Agriculture Ditto Report, February, 1952.

Martin Beckman extended the analysis to consider the problem of minimizing transportation cost associated with continuous geographical intensity distribution of production in light of a system of efficiency.[1] The continuous model carried more theoretical appeal than the discontinous models of Enke or Samuelson. By assuming a system of continuous distribution of production densities and transportation costs within each region, more flexibility was allowed. For the Beckman problem to be defined data was required of the spatial distribution of production and consumption within each region, of exports and imports and of the transportation costs.

Beckman's model, as those preceding his, were static models and could be employed to answer questions of a comparative static nature and to indicate changes in optimum values brought about by specified changes in the data.

In contrast, Fox has considered a livestock-feed model in which both supply and demand functions are included.[2] This "dynamic" model treated livestock prices and production in each region as mutually dependent variables whereas a static model would treat these as predetermined variables. This joint model of the livestock-feed economy included 40 separate equations. With these equations, Fox was able to solve for prices, production and consumption of livestock products in each region, and prices and consumption of feed in each region, as well as the pattern of interregional shipment for each of these products.

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[1]Martin Beckman, "A Continuous Model of Transportation," Econometrica, October, 1952, pp. 643-660.

[2]Karl A. Fox, Econometric Analysis for Public Policy, Chapter 9, Ames, Iowa, Iowa State College Press, 1958.

Empirical Studies

Prior to the explicit formulation of linear programming, T. C. Koopman employed his formulation of the transportation model to derive the optimum flow of dry cargo on the ocean shipping routes of the world for the year 1925.[1] The objective was to move the empty ships from where they became available to where they were needed at the most economical cost. The optimal solution was arrived at by applying a procedure of trial and error whereby a minimum of time was involved in the movement of empty ships.

Following the appearance of the Enke-Samuelson-Beckman formulation, Karl A. Fox developed spatial price equilibrium models of the livestock-feed sectors of the economy for 1949-50.[2] Given the distribution of feed production and livestock number (in terms of grain consuming units) among the 10 regional subdivisions of the United States, he predicted the feed price differential between regions. By employing a least squares demand function for feed, he obtained a set of regional equilibrium prices equating the U. S. total feed consumption estimates with the U. S. total supply available for feeding which was also consistent with the structure of freight rates between regions. The set of interregional freight rates were estimated for this process. Given these values, Fox solved for a set of equilibrium values of feed prices and feed consumption in each region and the net quantity of feed to be shipped over each interregional path. The equilibrium solution was arrived at by first determining

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[1] Koopman, loc. cit.

[2] Karl A. Fox, "A Spatial Equilibrium Model of the Livestock-Feed Economy in the United States," Econometrica, October, 1953, 21:547-66.

probable surplus and deficit regions. By visual approximation and a check of the freight rates to determine comparative freight advantages a flow pattern was set up. Using one area as a basing point, feed prices were estimated in accordance with their differential above or below the assumed price in the base region. These assumed regional prices were used in the regional demand function for feeds mentioned earlier, to obtain regional consumption estimates. As total feed consumption at the first level of prices did not exhaust the available supply, prices were adjusted downward in accordance with the assumed rigid structure of price differentials.

A comparison of regional production and consumption estimates of each region yielded the net quantities of imports and exports. Following the flow pattern, he specified the quantity to be shipped over each interregional path.

A comparison of freight rates and price differentials showed that any alternations in the flow would be unprofitable. Thus, he had attained the "unique equilibrium trade pattern."[1] Having obtained the solution to the basic situation, he applied the same analysis assuming changes in the basic data. He found that the solutions could be obtained in a 10-region model with no more than a desk calculator and the investigator's judgment.

He was aware that his model involved numerous over simplifications and suggested further studies involving less aggregation, time lags and supply responses.

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[1] Ibid., p. 181.

Fox later employed a dynamic analysis to the above data.[1] By inserting a supply equation for livestock, Fox arrived at a new equilibrium solution under approximate 1949-50 conditions. A comparison of the results obtained from these separate models showed that the dynamic model yielded a slightly lower feed price for all regions than did the static model. The total quantity shipped was relatively the same for both analysis although one region did shift from a self-sufficient region to a surplus region in the dynamic model. However, this did not affect the pattern of flow set up in the static model.

In the livestock sector of the models, a slightly higher price prevailed in the static model. This corresponded to a slightly lower total quantity shipped under the static conditions. One livestock area was also reclassified from surplus in the static model to self sufficient in the dynamic model. Again the pattern of flow remained the same for both models.

George G. Judge later employed the static procedure as described above in developing and solving a spatial equilibrium model for the marketing of eggs in the United States.[2] He formulated his program as follows: The United States is divided into various geographical regions each possessing a given market demand curve for eggs. Transportation cost between each pair of regions is known. The predetermined variables --supply of eggs, population, and disposable income--are also known. The market is assumed to be perfectly competitive in time, form, and place;

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[1]Karl A. Fox and R. C. Taeuber, "Spatial Equilibrium Livestock-Feed Economy," American Economics Review, September, 1955, pp. 584-608.

[2]George G. Judge, "Competitive Position of the Connecticut Poultry Industry," Storrs Agricultural Experiment Station Bulletin 318, January, 1956.

and all firms are seeking to maximize profits. Given this operational framework he ascertained: 1) the equilibrium prices of eggs and the quantities consumed in each region; 2) the quantity of eggs exported or imported in each region; 3) the aggregate net trade of eggs, and 4) the volume and direction of trade at a minimum transportation cost. The determination of all unknowns was a mutually dependent process.

To ascertain the conformity of the equilibrium price structure with that of the actual price structure a correlation test was performed. This test suggested that approximately one-half of the varietions of the price structure was attributable to considerations other than those allowed for in the model. This pointed up the simplifying assumptions upon which the model rested. However, the information obtained from this model was employed to predict the direction and magnitude which the variables of the system would change when some change occurred in the data of the problem. Judge suggested that these results could be used to judge in advance the implication of various policy decisions by the firm or the government. On a regional basis this gives insight into the long-run competitive position of one region relative to another. He also suggested that data should be gathered on a quarterly basis to overcome the problem of seasonal variations and yield results more consistent with the actual flows throughout the year.

W. R. Henry and C. E. Bishop conducted a study of the broiler industry also employing spatial equilibrium analysis to identify the relative profitability of various markets.[1] Through the use of linear programming,

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[1]W. R. Henry and C. E. Bishop, "North Carolina Broilers in Interregional Competition," North Carolina State College, A. E. Information Series No. 56, February, 1957.

a flow pattern was achieved representing the best possible adjustment of the national market. This was assuming each firm seeks to maximize its profits. Analyses were also conducted measuring the relative advantage or disadvantage of various production areas as compared to North Carolina as well as the relative disadvantage of alternative markets for North Carolina.

The objective of these analyses was to identify markets offering the best long-run prospects for the North Carolina broiler industry by measuring the trends appearing in the national broiler market in regard to regional supplies and demands. The authors concluded that the trend of economic forces appear to favor the demand side, but the increasing competition of surrounding areas will tend to offset this effect.

More recently, T. C. Wallace and George G. Judge solved a spatial equilibrium model for the beef sector of the economy using 1955 data.[1] They employed the basic Enke formulation, except that the regional supply of beef, population and income are considered predetermined variables. Thus, this problem follows the procedures of the previously mentioned Judge study.

The authors solved two spatial equilibrium price patterns and optimum flows for 1955 to obtain an indication of the impact of change in the geographical location of beef production. The first analysis assumed processing plants were market orientated, i.e. beef supplies were based on actual slaughter data. The second analysis assumed processing plants were production orientated, i.e. beef supplies were based on estimated

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[1]G. G. Judge and T. C. Wallace, "Spatial Equilibrium Analysis of the Livestock Economy," Oklahoma State University, Technical Bulletin TB-78, June, 1959.

production available for slaughter. A comparison of equilibrium solutions showed marked variations in the magnitude of surplus and deficit among regions and indicated a certain amount of cross-hauling and resource misallocation.

The authors suggest that such analysis makes explicit the impact of the location of production and processing firms on the resulting comparative advantage or disadvantage of a particular region.

In a subsequent bulletin by the same authors the above techniques of analyses were applied to quarterly data of the same time period (1955).[1] This was an effort to construct spatial flow and price models that reflected the variation in seasonal production and flow patterns. Quarterly data was adjusted to annual totals in order that comparisons between the annual and quarterly data could be made.

During the first quarter, regional beef prices were estimated to be about two cents per pound higher than those obtained from the annual analysis, due to a low seasonal production. However, the optimum flow patterns remained unchanged from the annual analysis.

The second quarter showed an increase in production and a decrease in regional prices. The most significant change was a change in the flow pattern. This resulted from a change in the magnitude of surpluses and deficits and not from a reclassification of any region as to surplus or deficit.

The third quarter showed lower regional prices than any other quarter or for the annual analysis. Although the flow pattern was the same as for the annual data, the increased cost relative to the amount shipped indicated increased shipments over the longer routes during the third quarter.

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[1] Ibid., T. B. 79, December, 1959

The fourth quarter showed a large seasonal production with a somewhat lower price than for the annual analysis. A reclassification of regions as to surplus or deficit introduced new flows not present in the annual analysis.

In the aggregate, the quarterly analysis accounted for a slight increase in shipments. The authors concluded, that relative to the magnitude of total shipments and costs involved there was a consistency in the alternative estimates, which indicated that for the beef sector of the economy the aggregative annual analysis for 1955 offered a good approximation.

A separate analysis was presented involving the "contract-award" approach in which supply was unequal to demand as an example of the implications of governmental programs.

M. M. Snodgrass and C. E. French conducted a study employing the transportation model and the digital computer to analyze interregional relationships in the dairy industry.[1]

After determining the required data for the solution, analyses were run to obtain 1) optimum flows at minimum costs, 2) location of processing firms and 3) location of production. A comparison of these ideal conditions with a model portraying 1953 conditions suggested that the allocation of resources tends to conform to the ideal conditions as estimated.

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[1]M. M. Snodgrass and C. E. French, "Linear Programming Approach to Interregional Competition in Dairying", Purdue University Agricultural Experiment Station, S. B. 637, May, 1958.

PROBLEM

Given the general problem of determining equilibrium among spatially separated markets as stated by Enke, this study was concerned with developing spatial price equilibrium models for the beef sector of the economy.

The specific problem was formulated as follows: The United States was divided into various geographically contiguous regions that engage in the trading of beef. Each possible pair of regions were separated by a transportation cost which was independent of volume. Each region was assumed to possess a given demand curve. Production of beef available for slaughter, population, per capita disposable personal income, and price of pork for each region were considered predetermined variables, i.e. the optimum regional level and location of production was not considered in this problem and was assumed given for any point in time. Given these regional demand relationships and the transportation costs along with the existing values of the predetermined variables, the problem was one of ascertaining:

1) A set of equilibrium prices of beef and the quantity consumed in each region,

2) The quantity of beef exported or imported from each region under equilibrium conditions,

3) Which regions export, import or do neither,

4) The aggregate net trade,

5) The volume and direction of trade between each possible pair of areas that would permit the geographical distribution of beef at a minimum transportation cost.

Obviously, this limits a surplus area from exporting more than its capacity or a deficit area from importing more than its requirements.

After analyzing the results of these spatial price equilibrium analyses for each year individually, a comparison of results may be made to ascertain the direction and magnitude of changes in: 1) the geographical flows and prices; 2) the quantity of interregional trade, and 3) the transportation cost occurring with changes in the phase of the cattle cycle. Total transportation cost depends upon the quantity of beef shipped and the distance from the consumer. The quantity of beef shipped over a given route times the corresponding freight rate determines the transportation bill for that shipment. The total transportation bill is a summation of these shipment bills.

SCOPE

The general scope of this study covered the beef marketing sector of the livestock economy. The quantity available within the marketing system was composed of all beef and veal production available for consumption from farm and commercial slaughter.[1] Imports and exports were assumed negligible. The area included for study was the continental United States. In most instances states or groups of states were aggregated into areas. The only exception was Kansas. Western Kansas was delineated as area VIII (Wichita) for special consideration in this study. Northern Kansas was placed in area VII (Sious Falls). Eastern Kansas was placed in area XIII (Kansas City). The population included the civilian population and the Armed Forces stationed within the area. The transportation cost between all possible pairs of regions included freight rates only. Special transportation charges were not included. The data gathered were for the years 1956, 1958, 1959.

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[1]Hereafter the term beef will be used to signify both beef and veal products.

These three years represented various phases in the most recent cattle cycle. Similar analyses were conducted for each year to appraise the impact of changes in beef production available for slaughter on the basic variables involved. A further analysis was conducted for 1959 based on actual slaughter. Finally, area data was projected under various alternative assumptions. The latter are not to be interpreted as forecasts, but as "illustrative projections" of the implications of changes in the basic data. Results from these analyses were compared with those obtained from a recent study at Kansas State University involving the pork sector of the livestock economy to compare the relative position of western Kansas in producing beef and pork.[2]

HYPOTHESIS AND OBJECTIVES

Over the past 40 years there has been a marked increase in the demand for beef compared with non-beef products at the retail level. Elmer J. Working in his book, "Demand for Meat," stated that after accounting for the effect of changes in per capita disposable income and supplies of non-beef meats during the period 1922-41 the demand for beef increased by about the same amount as the decrease in per capita demand for pork.[2] Working further stated that the most important factor affecting the per capita demand for beef was per capita disposable income. Although the relative amount of disposable income spent for beef has remained fairly constant since the 1920's, signifying no appreciable shift in the demand

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[1]Kelley, Paul, John McCoy, and Milton Manuel, "The Competitive Position of western Kansas in Marketing Hogs." Unpublished, Kansas State University, Manhattan, Kansas, 1959.

[2]Elmer J. Working, Demand for Meat, University of Chicago Press, Chicago, 1954, p. 80.

function, the absolute amount spent per capita has shown a marked increase. As a result of this increase in disposable income and the growth of the population the total quantity of beef consumed has more than doubled since 1920.

Under the assumption that there would be no important shift in the demand function for beef in the foreseeable future and that the increasing population would continue to migrate to the West and Southwest, the hypothesis was set up that western Kansas was in an economically competitive position for the marketing of surplus beef relative to other sources of supply. This hypothesis, assumed that western Kansas could engage in the production of beef as efficiently as could other areas of production.[1]

Operating under this hypothesis the following objectives were set up for this study:

1) To determine the equilibrium flow patterns under conditions approximating those of 1956, 1958, and 1959,

2) To estimate the beef production potential in western Kansas,

3) To estimate changes in demand resulting from changes in the predetermined variables,

4) To estimate the effect of these changes on beef prices,

5) To determine the equilibrium flow of beef under these various conditions,

6) To compare the relative position of western Kansas in producing beef.

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[1]Appendix I.

ASSUMPTIONS

With this type of spatial equilibrium analysis certain basic assumptions are made. These assumptions are: A perfectly competitive market dictates the pattern of prices and flows of the commodity among the areas. It is therefore a necessary condition in this model that a uniform price exist which differs only by the transportation cost involved. This transportation cost connecting all areas is independent of the volume of trade. Only one price can prevail in any area at any given time. The supply source and market destination for each area is represented by a point within that area. Area demands are represented by a known linear function and area supplies are predetermined. The product is homogeneous and consumers are indifferent as to which area satisfies their demand. Marketing occurs uniformly throughout the year in each area. Imports and exports are taken as negligible. The supply curve is vertical and all beef that is produced is consumed. The objective of each firm is profit maximization; therefore, there can be no cross-hauling of products.

These restrictive and expository assumptions reduce the model to a simplified version of reality, making it manageable without destroying the basic relationships.

BASIC DATA

Converting the formal model into a reflection of the real world situation required the division of the United States into geographically contiguous areas. Given these regional demarcations, the model specified the need for the following regional data: 1) market demand relationships for beef, 2) values of the predetermined variables--beef production

available for slaughter, population, retail pork prices, and disposable income, and 3) the structure of transportation rates between all possible pairs of areas. The procedure for obtaining basic data for the past years, with examples drawn from 1958 data, is presented in this section. Basic data for alternative analyses will be given when the particular analysis is introduced.

Regional Demarcations

As states were the smallest geographical units for which adequate data were available, they became the major components of each area. The only exception being Kansas which was divided among three areas. Western Kansas was singled out as a separate area for special consideration in this study. (Figure 1). Area demarcations were drawn so as to yield a model that was both manageable and reasonably realistic within the limitations imposed by the data. The criteria employed was primarily per capita supply of beef available for slaughter. Per capita disposable income also was considered.

As per capita disposable income by states was not available for the various years, a relationship between per capita personal income and per capita disposable income was established for 1955, the latest year such data were available.[1] Under the assumption that this relationship did not change between 1955 and the years considered in this study, the per capita disposable income for each state was derived from the per capita personal income of that state.

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[1] National Income Number, July, 1959, United States Department of Commerce, July, 1959. United States Income and Output, United States Department of Commerce, November, 1958.

e. g. Maine	1955		1958
personal income/per capita	$1580		$1704
		1704 X .9171	
disposable income/per capita	1449		1563 est.
		1449 ÷ 1580 =	.9171

Available data on beef production and slaughter in terms of live weight were obtained from various issues of the "Livestock and Meat Statistics."[1] Production available for slaughter was derived from annual farm production data. Farm production is defined as the live weight produced on farms and ranches in that state during the calendar year. It is compiled by the U.S.D.A. for each state by deducting the weight of livestock shipped into the state from total marketings and farm slaughter and adjusting for inventory changes during the year.[2] Animals that die during the year are deducted from the current year's farm production. Disposition of total annual U. S. farm production for a given year was found to be comprised fo three categories: 1) commercial slaughter, 2) farm slaughter, and 3) changes in inventory. To estimate the production available for slaughter it was necessary to account for changes in inventory during the year. As the necessary data were not available on a state or area basis, estimates were made of the three categories. The same procedure was followed in estimating both beef and veal production available for slaughter. The combined total of these estimates was referred to as beef production available for slaughter.

The first step in estimating beef production available for slaughter was to estimate the weight attributable to farm slaughter. The number

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[1]Agricultural Marketing Service, United States Department of Agriculture, 1956, 1958, 1959.

[2]Meat Animals, United States Department of Agriculture, Statistical Bulletin 184, June, 1956, p. 2.

of cattle and calves slaughtered on the farm was available from the Department of Agriculture for the individual states as well as for the United States. Also available was the U. S. average live weight of farm slaughter for each class. From these data the weight attributable to U. S. farm slaughter was derived. U. S. farm production less the estimated U. S. farm slaughter gave the weight attributable to production for commercial slaughter and changes in inventory.

The next step in the procedure was to estimate the weight attributable to changes in inventory. As actual U. S. commercial slaughter was available along with the estimated U. S. farm slaughter, the difference between the total of these weights and U. S. farm production was attributed to changes in inventory. Given the number change in inventory during the year, it was possible to compute an average weight per animal change in the inventory for the United States. This estimated average weight times the number change in inventory for each state gave the total weight attributable to changes in inventory for each state. A decrease in inventory was shown by a negative figure which meant that production of prior years was being accounted for in the present year's slaughter figure. An increase in inventory was shown by a positive figure which meant that some of the present year's production was going for building up inventory. For each state showing a decrease in inventory, the weight associated with the decrease in inventory was added to the state's farm production. Similarly, for each state showing an increase in inventory, the weight associated with the increase in inventory was subtracted from the state's farm production. The resulting figures represented the estimated beef production available for slaughter in each statestate. The sum of the beef production available for slaughter in

the individual states necessarily equaled the combined U. S. farm and commercial slaughter.

Analysis required that beef production available for slaughter be stated in terms of dressed weight. This necessitated the conversion of beef production available for slaughter computed from the procedure described above to dressed weight equivalents. The appropriate ratio for each year was obtained by dividing the dressed weight of U. S. total slaughter by the live weight of the U. S. total slaughter. A numerical example of the above procedure for estimating production available for slaughter is presented in Table 1.

Estimates of state population were obtained from the United States Bureau of the Census. These estimates included the civilian population and the Armed Forces stationed within the area as of July 1 of the corresponding year. Population in the three areas of Kansas was obtained from County Assessors reports as of March 1 and adjusted to equal estimates of the U. S. Bureau of Census. Dividing state beef production available for slaughter by state population gave the per capita beef production available for slaughter in each state. Comparing state per capita figures with the U. S. average per capita figure indicated those states which were surplus or deficit in production in relation to consumption requirements. This assumes uniform consumer preferences throughout the U. S. No data are available to determine the validity of this assumption.

On the basis of these factors (per capita disposable income and per capita beef production available for slaughter) the continental United States was divided into 20 geographical areas. Area demarcations are illustrated in Figure 3 and the component states are listed in Table 2.

Table 1. Beef production available for slaughter, United States and Maine, 1958, Illustration of Method of Calculation.

United States			
Total farm production, liveweight, (1,000 lbs.)			27,697,506
Farm slaughter:			
Cattle (1,000 head)	841		
Av. liveweight	837	703,917	
Calves (1,000 head)	437		
Av. liveweight	346	151,202	
Total farm slaughter, liveweight (1,000 lbs.)		855,119	
Change in inventory:			
U.S. farm production (1,000 lbs.)		27,697,506	
Less: U.S. farm slaughter	855,119		
U.S. Commercial slaughter	25,219,441	26,074,560	
Weight attributed to increase in inventory (1,000 lbs.)			1,622,946
Total inventory weight ÷ number change in inventory = av. weight per animal.			
1,622,946,000 ÷ 3,501,000 = 463.566+ lbs.			
Production available for slaughter, liveweight (1,000 lbs.)			26,074,560
Conversion factor 1)			.5573
Production available for slaughter, dressed wt. (1,000 lbs.)			14,531,000
Maine			
Total farm production, liveweight (1,000 lbs.)			37,325
Change in inventory:			
Decrease in inventory (1,000 head)		8	
Av. liveweight, U.S.		463.566	
Weight attributed to decrease in inventory (1,000 lbs.)			3,709
Production available for slaughter, liveweight (1,000 lbs.)			41,034
Conversion factor 1)			.5573
Production available for slaughter, dressed weight (1,000 lbs.)			22,868

1) This is the ratio of total U. S. liveweight slaughter to total U. S. dressed weight slaughter for the given year.

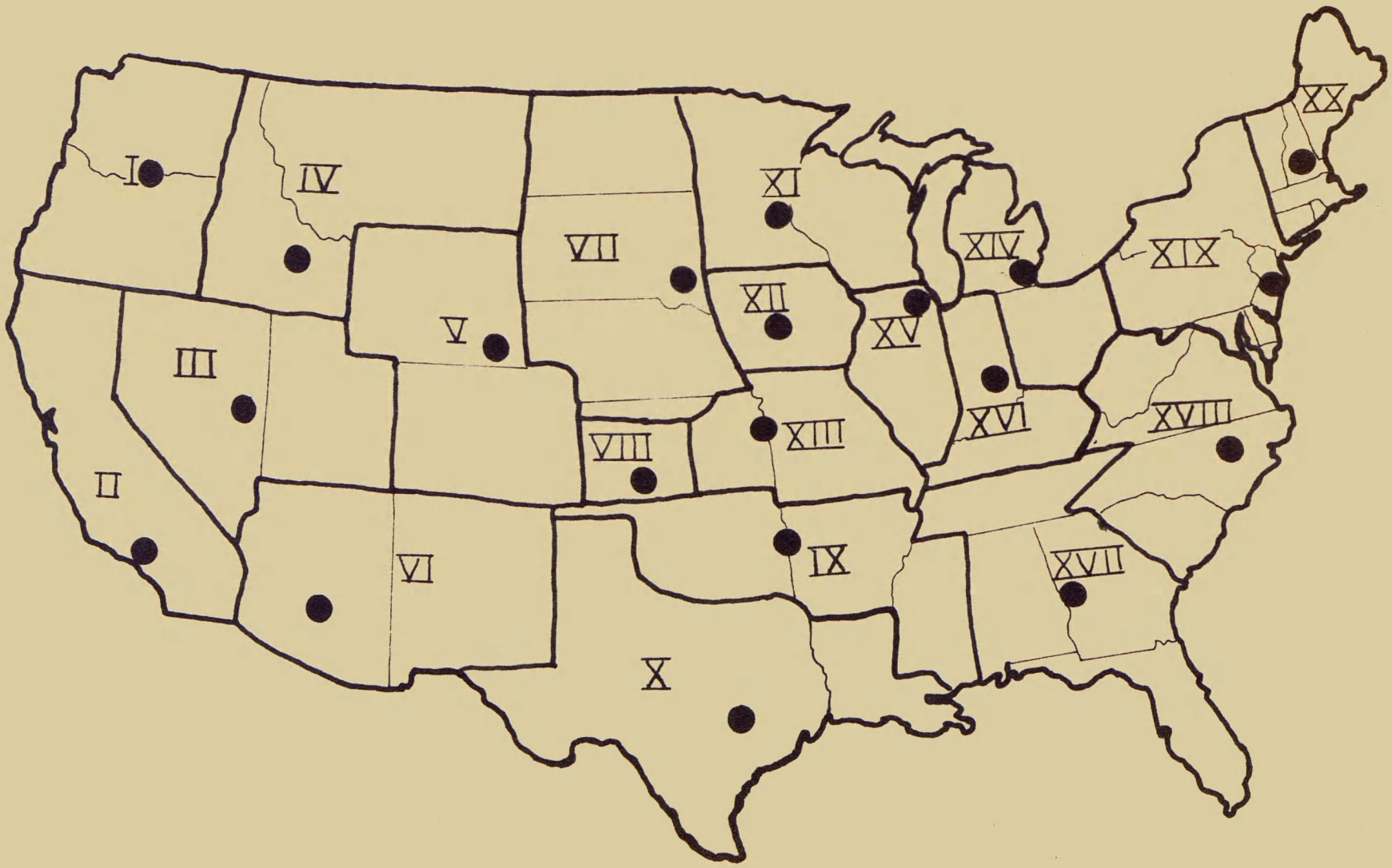

Fig. 3. Demarcation of beef production areas. Roman numerals denote area. Location of shipping or receiving points are shown by solid dots.

Table 2. States comprising various areas with shipping/ receiving points.

Area	States	Shipping/receiving points
I	Washington and Oregon	Portland
II	California	Los Angeles
III	Nevada and Utah	Ely
IV	Idaho and Montana	Boise
V	Wyoming and Colorado	Laramie
VI	New Mexico and Arizona	Phoenix
VII	North Dakota, South Dakota, Nebraska, and Northern Kansas	Sioux Falls
VIII	Western Kansas	Wichita
IX	Oklahoma, Arkansas, Mississippi	Fort Smith
X	Texas and Louisiana	Austin
XI	Minnesota and Wisconsin	St. Paul
XII	Iowa	Des Moines
XIII	Eastern Kansas and Missouri	Kansas City
XIV	Michigan, Ohio	Detroit
XV	Illinois	Chicago
XVI	Kentucky, Indiana	Indianapolis
XVII	Georgia, Florida, Alabama, Tennessee	Columbus, Georgia
XVIII	West Virginia, Virginia, South Carolina, and North Carolina	Raleigh
XIX	New York, New Jersey, Pennsylvania, Maryland, Delaware, D. C.	Trenton
XX	Vermont, New Hampshire, Mass., Conn., Rhode Island, Maine	Concord

Estimating Equation

As actual beef consumption was not available on a state or area basis, it was necessary to derive an estimating equation to estimate the regional demand relationships for beef.[1] The model of Henry Schultz accounting for the interrelated demands of beef and pork was adopted.[2] This model was linear in natural units. It was derived by the method of least squares which treats the demand equation in isolation of the supply equation.

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[1] Appendix II.

[2] Theory and Measurement of Demand, University of Chicago Press, Chicago, 3rd ed. 1958, pp. 636-641.

The model was as follows:

$Y = A + b_1X_1 + b_2X_2 + b_3X_3$ where

Y = per capita consumption of beef in pounds
X_1= retail price of beef in cents per pound
X_2= retail price of pork in cents per pound
X_3= per capita disposable income.

Beef consumption and disposable income were placed on a per capita basis to avoid the influence of changes in the population.

The data for deriving the estimating equation was gathered from the ten most recent years for which such information was available, 1949-58 (Table 3). These data were programmed through the IBM 650 computer available at Kansas State University to obtain certain parameter values. The resulting estimating equation and the standard error of the respective coefficients was obtained:

$$Y = 63.194 - \underset{(.036684)}{.886582X_1} + \underset{(.037880)}{.181767X_2} + \underset{(.037808)}{.042402X_3}$$

The regression coefficients of beef price (X_1) and disposable income (X_3) were found to be significant at the five percent level. Although the coefficient for pork price (X_2) was found to be nonsignificant it was retained in the equation as it reduced the variation 7.47 percent between the fitted curve and the actual observations. Beef price accounted for 54.74 percent of the variation and disposable income accounted for 37.04 percent of the variation. This yielded a coefficient of correlation of .992 which indicated that the fitted curve was in close agreement with the observations. This is, the estimating equation accounted for 99.2 percent of the variation in beef consumption.

A further analysis of this function as well as a review of similar functions is presented in Appendix II.

Table 3. Basic data used in deriving the estimating equation.

Year	Per capita consumption[1] Y	Retail beef price[2] X_1	Retail pork price[3] X_2	Disposable personal income[4] X_3
	Pounds	Cents per pound		
1949	72.8	62.0[a]	55.8[b]	$1,272
1950	71.4	69.3	55.1	1,369
1951	62.7	81.8	59.2	1,474
1952	69.4	76.5	57.5	1,520
1953	87.1	60.5	63.5	1,582
1954	90.1	58.5	64.8	1,582
1955	91.4	58.9	54.8	1,660
1956	94.9	57.8	52.1	1,742
1957	93.9	63.5	60.2	1,799
1958	87.2	75.1	64.8	1,818
Av.	82.09	66.39	58.78	1,581.8

a)Includes an average for all grades of beef as computed by the United States Department of Agriculture.

b)Includes an estimated average composite price of pork sold as retail cuts (ham, bacon, loin, picnics, butts, spareribs, bacon, squares).

Sources: 1) Livestock and Meat Situation, May, 1959, p. 28, Table 14.
2) American Meat Institute, Department of Marketing, February, 1960, Table 818-R3.
3) Ibid.
4) Economic Report of the President, Transmitted to Congress, January 20, 1960, p. 141, Table D-14 as derived from the Department of Commerce and Council of Economic Advisors.

Regional Values of the Predetermined Variables

The estimating function used in this study applied to the United States as a whole. As data were not available to derive estimating functions for each of the twenty areas, this basic function was applied to each of these areas. This procedure implicitly assumed there were no differences in consumer preference among areas. Solving the spatial equilibrium model specified the need for regional data related to beef production available for slaughter, disposable income, pork prices and population. As these data were not available, estimates were made of each of these predetermined variables.

Area beef production available for slaughter was obtained from estimates of state beef production available for slaughter derived earlier. The total of the estimated state values for these states within the area gave the area beef production available for slaughter (Table 4).

Per capita disposable income by states was estimated earlier for the demarcation of areas. The per capita figure in each state was multiplied by the population of the respective state (Table 5) to arrive at the total disposable income for each state. The combined disposable income of each state in the area was then divided by the combined population of those states giving a weighted per capita disposable income for each area (Table 6).

Next retail pork prices by state were derived by assigning percentage values to five cuts of pork as obtained from "Prices of Hogs and Hog Products"[1] and discussions with various members of the Kansas State University faculty.

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[1]United States Department of Agriculture, March, 1958.

Table 4. Dressed weight beef production available for slaughter, United States by areas, 1956, 1958, 1959.

Area	Origin or Destination	Total			Per Capita		
		1956	1958	1959	1956	1958	1959
		(million pounds)			(pounds)		
I	Portland	454.91	387.20	391.76	103.20	85.25	85.37
II	Los Angeles	667.52	487.84	607.88	49.70	34.03	41.52
III	Ely	192.40	199.38	193.51	178.30	176.13	166.82
IV	Boise	776.22	661.03	617.50	607.85	489.65	457.07
V	Laramie	587.68	570.71	602.68	302.62	281.00	301.19
VI	Phoenix	392.75	348.25	303.11	217.95	175.71	143.52
VII	Sioux Falls	2,219.58	1,870.38	1,966.95	768.02	638.14	675.70
VIII	Wichita	401.74	215.23	284.49	505.33	264.74	347.79
IX	Fort Smith	1,117.67	1,040.30	974.95	182.81	166.79	157.12
X	Austin	1,882.46	1,398.69	1,349.24	157.81	112.12	106.42
XI	St. Paul	1,152.26	1,206.01	1,209.80	163.42	164.91	163.29
XII	Des Moines	1,196.31	1,271.43	1,344.71	434.71	450.54	478.71
XIII	Kansas City	1,237.58	934.34	1,089.50	229.69	171.47	201.97
XIV	Detroit	620.54	583.34	570.51	37.29	33.89	32.31
XV	Chicago	705.13	775.75	779.21	74.35	78.45	76.35
XVI	Indianapolis	653.24	663.85	614.56	88.00	86.65	79.17
XVII	Columbus	762.72	866.70	763.21	53.83	58.01	49.91
XVIII	Raleigh	417.28	413.05	381.04	33.68	32.13	29.53
XIX	Trenton	531.12	526.59	477.63	14.52	14.11	12.55
XX	Concord	124.89	110.93	101.76	12.86	11.14	10.02
U.S.		16,094.00	14531.00	14,624.00	96.22	83.87	83.00

Table 5. Population of the United States, by areas, 1956, 1958, 1959.

Area	Origin or destination	1956	1958	1959
			Thousands	
I	Portland	4,408	4,542	4,589
II	Los Angeles	13,431	14,337	14,639
III	Ely	1,079	1,132	1,160
IV	Boise	1,277	1,350	1,351
V	Laramie	1,942	2,031	2,001
VI	Phoenix	1,802	1,982	2,112
VII	Sioux Falls	2,890	2,931	2,911
VIII	Wichita	795	813	818
IX	Fort Smith	6,114	6,237	6,205
X	Austin	11,929	12,487	12,679
XI	St. Paul	7,051	7,313	7,409
XII	Des Moines	2,752	2,822	2,809
XIII	Kansas City	5,388	5,449	5,439
XIV	Detroit	16,641	17,211	17,660
XV	Chicago	9,484	9,889	10,205
XVI	Indianapolis	7,423	7,661	7,763
XVII	Columbus	14,169	14,940	15,293
XVIII	Raleigh	12,388	12,857	12,904
XIX	Trenton	36,585	37,314	38,073
XX	Concord	9,713	9,961	10,154
U.S.		167,261	173,259	176,174

Table 6. Estimated per capita disposable income for the United States, by area, 1956, 1958, 1959.

Area	Origin or destination	1956	1958	1959
I	Portland	$1,785	$1,856	$1,931
II	Los Angeles	2,152	2,223	2,312
III	Ely	1,604	1,718	1,787
IV	Boise	1,586	1,630	1,695
V	Laramie	1,668	1,810	1,883
VI	Phoenix	1,464	1,606	1,670
VII	Sioux Falls	1,376	1,635	1,701
VIII	Wichita	1,564	1,799	1,871
IX	Fort Smith	1,144	1,234	1,284
X	Austin	1,490	1,572	1,635
XI	St. Paul	1,611	1,696	1,764
XII	Des Moines	1,494	1,676	1,743
XIII	Kansas City	1,680	1,817	1,890
XIV	Detroit	1,927	1,885	1,961
XV	Chicago	2,124	2,146	2,232
XVI	Indianapolis	1,556	1,571	1,634
XVII	Columbus	1,338	1,422	1,479
XVIII	Raleigh	1,291	1,329	1,382
XIX	Trenton	2,014	2,115	2,200
XX	Concord	1,961	2,054	2,136
U.S.		1,747	1,818	1,891

The weights given to these five cuts were:

Ham	34.0%
Lard	22.0%
Bacon	15.9%
Sausage	14.4%
Pork Chops	13.7%

The retail prices for these various cuts by states were obtained from "Agricultural Prices."[1] From these data, a weighted retail pork price was computed for each state, e. g. deriving retail pork prices in Maine:

Pork cut	Retail price 1958 ¢ per lb.	Weight of cut %	
Ham	70.4	34.0	23.93
Lard	21.8	22.0	4.79
Bacon	68.8	15.9	10.94
Sausage	67.2	14.4	9.68
Pork chops	88.3	13.7	12.10
TOTAL		100.0	61.44

Thus 61.44 was the estimated retail price of pork per pound in Maine in 1958.

Area pork prices were obtained by a simple average of the pork price for the states within each area. As the simple average of the area retail pork price differed from the reported U. S. retail pork price, a linear adjustment was made of the area prices. These adjusted prices were used as the retail pork price (Table 7).

Transportation Rates

As this model assumed that perfect competition existed in the market there must exist a structure of uniform prices which differ only by the

[1]United States Department of Agriculture, 1957, 1959, 1960.

Table 7. Estimated retail pork price for the United States, by areas, 1956, 1958, 1959.

Area	Origin or destination	1956	1958	1959
		Cents per pound		
I	Portland	54.99	68.37	62.16
II	Los Angeles	56.38	68.79	63.20
III	Ely	56.80	69.21	61.80
IV	Boise	51.11	63.76	56.54
V	Laramie	51.64	63.65	56.33
VI	Phoenix	52.65	65.30	56.98
VII	Sioux Falls	49.41	62.99	55.19
VIII	Wichita	49.10	62.08	53.68
IX	Fort Smith	49.73	62.23	54.11
X	Austin	52.30	64.78	57.64
XI	St. Paul	49.54	62.86	54.60
XII	Des Moines	51.28	65.69	57.43
XIII	Kansas City	49.95	62.61	53.85
XIV	Detroit	51.93	64.80	56.65
XV	Chicago	52.21	63.65	56.86
XVI	Indianapolis	49.61	61.03	53.65
XVII	Columbus	51.82	63.26	55.33
XVIII	Raleigh	51.37	64.10	56.43
XIX	Trenton	53.85	67.21	59.16
XX	Concord	56.31	69.60	62.38
U.S.		52.10	64.80	57.20

transportation cost involved.[1] Thus it was necessary to obtain the freight rates which existed between each possible pair of areas. In order to obtain the freight rates between all areas one city in each area was chosen as the shipping or receiving point. This choice was made primarily on the basis of its centrally located position within the area as well as its importance as a market for livestock. These cities are located on Figure 3 and listed in Table 2. The corresponding dressed weight freight rate between each city is shown in Table 8. These railroad rates were obtained from the Union Pacific Railroad Company, Kansas City office.

Once the freight rates were available it was possible to develop equilibrium price differentials between the various points. The first step was to classify each area as either surplus or deficit. This was done by comparing U. S. average consumption with per capita production available for slaughter in each area. Given this classification for each region an approximate set of price differentials were generated by employing the following rules: 1) if one area ships to another area, the price must differ by the unit transportation cost and 2) if two surplus areas ship to the same deficit area, the difference between prices in the surplus areas will be equal to the difference between their unit transportation costs to the deficit area.[2] For expository purposes, let us assume a problem in which two surplus and one deficit area are involved. In This case the price differential between the surplus and deficit areas would be equivalent to the transportation cost. However, the price

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[1] Appendix III.

[2] Judge and Wallace, Technical Bulletin TB-79, op. cit., p. 14.

Table 8. Freight rates for fresh meats between given cities, Dec., 1958.

Area	Origin / Destination	I Portland	II Los Angeles	III Ely	IV Boise	V Laramie	VI Phoenix	VII Sioux Falls	VIII Wichita	IX Fort Smith	X Austin	XI Saint Paul	XII Des Moines	XIII Kansas City	XIV Detroit	XV Chicago	XVI Indianapolis	XVII Columbus	XVIII Raleigh	XIX Trenton	XX Concord
I	Portland Oregon		192[c]	290	121	299	299	333	333	342	352	333	345	333	416[e]	360	373	475	511	546[b]	546[b]
II	Los Angeles California	192[c]		295	312[a]	299	177	336	333	333	327	336	345	333	416[e]	360	373	475	511	546[b]	546[b]
III	Ely Nevada	290	295		194	236	329	344	341	575	355	374	347	341	435	n.a.	413	460	502	502	502
IV	Boise Idaho	121	192[a]	195		252	361	307	333	354	352	319	345	333	439	n.a.	373	460	502	502	502
V	Laramie Wyoming	299	300	236	240		329	198	193	236	263	228	201	259	287	n.a.	228	308	363	363	385
VI	Phoenix Arizona	365	177	329	361	329		336	307	332	304	336	345	332	411	n.a.	373	411	468	482	505
VII	Sioux Falls S. Dakota	319	336	336	319	198	300		141	183	232	63	70	79	141[e]	85	145	180	220	272[d]	272[d]
VIII	Wichita Kansas	333	307	333	333	193	274	155		141	179	146	130	67	201	n.a.	159	170	229	288[b]	288[b]
IX	Fort Smith Arkansas	344	308	333	344	236	278	196	125		158	213	168	130	203	147	188	199	258	297	324
X	Austin Texas	352	293	327	352	263	257	248	179	170		265	226	166	341		248	248	294	342	377
XI	St. Paul Minnesota	319	336	336	319	228	300	77	146	213	236		87	94	154[e]	98	206	180	205	286[d]	286[d]
XII	Des Moines Iowa	345	345	345	345	201	307	67	109	174	227	87		51	119[e]	63	156	160	197	251[d]	251[d]
XIII	Kansas City Kansas	333	308	333	333	259	278	79	67	132	186	94	60		139[e]	83	140	157	215	271[d]	271[d]
XIV	Detroit Michigan	381	381	381	381	287	346	183	278	286	341	186	184	179		n.a.	123	219	206	150[f]	150[g]
XV	Chicago Illinois	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
XVI	Indianapolis Indiana	373	373	373	373	228	333	210	298	289	248	220	187	201	123	n.a.		192	199	176[i]	176[h]
XVII	Columbus Georgia	521	518	460	460	318	412	268	346	199	226	281	268	250	219	n.a.	192		164	231	278
XVIII	Raleigh N. Carolina	522	517	502	502	363	468	267	345	258	294	279	267	249	206	n.a.	199	164		151	209
XIX	Trenton New Jersey	569	569	502	502	363	482	333	437	297	342	346	358	332	204	n.a.	231	231	151		151
XX	Concord New Hampshire	569	569	502	502	385	505	334	458	324	377	356	379	343	219	n.a.	250	278	209	151	

Notes for table 8

a)	Between Boise, Ida. and Portland, Ore.	M23000 - 120	
	Between Portland, Ore. and Los Angeles	M21000 - 191	plus 1¢
	Other than on hooks	M30000 - 159	
		M40000 - 119	
b)	Portland and Los Angeles to E. St. Louis	M21000 - 341	
	Wichita to E. St. Louis	M21000 - 83	
	East St. Louis to Trenton, N. J.		
	Other than on hooks	M21000 - 205	
		M30000 - 142	
		M25000 - 184	
	East St. Louis to Concord, N. H.	M21000 - 205	
	Other than on hooks	M30000 - 147	
		M25000 - 192	
c)	Between Portland, Ore. and Los Angeles	M21000 - 192	
	Other than on hooks	M30000 - 160	
		M40000 - 119	

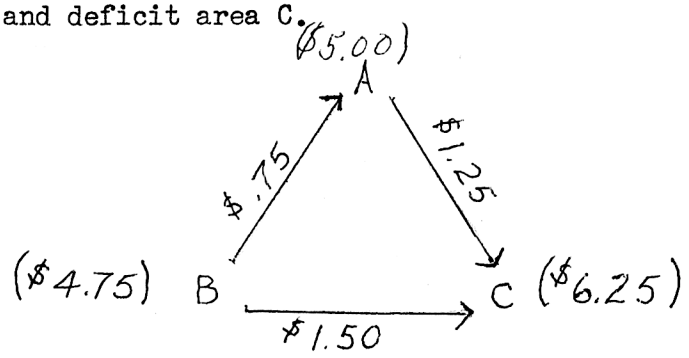
d)	Sioux Falls, S.D. to Chicago	M21000 - 85	
	Kansas City, Mo. to Chicago	M21000 83	
	St. Paul, Minn. to Chicago	M21000 98	
	Des Moines, Ia. to Chicago	M21000 63	
	Chicago to Trenton, N. J.	21000 - 187	
		25000 167	plus 1¢
	Other than on hooks	30000 124	
	Chicago to Concord, N. H.	21000 - 187	
		25000 173	plus 1¢
	Other than on hooks	30000 130	
e)	Ft. Smith, Ark. to Chicago	M21000 - 147	
	Sioux Falls, SD to Chicago	M21000 85	
	St. Paul, Minn. to Chicago	M21000 98	
	Des Moines, Ia. to Chicago	M21000 63	
	Portland, Ore. to Chicago	M21000 360	
	Los Angeles,Cal.to Chicago	M21000 360	
	Kansas City, Mo.to Chicago	M21000 83	
	Chicago to Detroit, Mich.	30000 - 55	plus 1¢
f)	Detroit, Mich. to Trenton, N. J.	M21000 - 150	
	Other than on hooks	M30000 120	
g)	Detroit, Mich. to Concord, N. H.	M21000 - 150	
	Other than on hooks	M30000 133	

Notes for table 8 (Cont.)

h)	Indianapolis, Ind. to Concord, N. H.	M21000 -	176
		25000	162
	Other than on hooks	30000	126
i)	Indianapolis, Ind. to Trenton, N. J.	M21000 -	176
		25000	156
	Other than on hooks	30000	113

"n. a." - not available.

differential between the two surplus areas would not be equal to the transportation cost between the two surplus areas. Instead the price differential between the two surplus areas would be equal to the differences in their transportation cost to the deficit area, e. g. surplus areas A and B and deficit area C.



If area A is arbitrarily chosen as the base, the price in area C would be the price in area A ($5.00) plus the transportation cost between areas A and C ($1.25) or a price in area C of $6.25. The price in area B would be the price in area C ($6.25) less the transportation cost between areas B and C ($1.50) or a price in area B of $4.75. Thus the difference in price between area A and B was $0.25 ($5.00 - $4.75). The difference was not $0.75 which was the transportation cost between the two areas. If the price differential between regions was less than the freight rate, there would be no movement of beef between the areas.

Due to the number of regions set up in this study, it was necessary to use visual judgment in approximating the initial set of price differentials. The logic used in this procedure was that the surplus area would first ship to the deficit area in which it enjoyed a comparative advantage to another surplus area, generally the nearest deficit area. It was important that direction of flow and not the volume of flow be determined. The corresponding differentials for each analysis were obtained by choosing area XII (Iowa) as the base. The choice of a base

area was arbitrary, but as Iowa was a large surplus area and centrally located, it was chosen.

The above area data, including beef production available for slaughter, per capita disposable income, population, retail pork price and price differential, as well as the total United States beef slaughter and the regression coefficients of the estimating equation were programmed through the IBM 650 computer. With this information the computer was wired so as to yield the following information by area: 1) equilibrium beef price, 2) per capita consumption, 3) total consumption, and 4) amount of surplus or deficit. The equilibrium beef price for each area is equal to the base price plus or minus the price differential.

The determination of this data was a mutually dependent process. Through the computer, and equilibrium beef price was derived that equated United States beef production available for slaughter with United States beef consumption. This necessarily gave the per capita consumption by areas (by means of the estimating equation) which in turn was multiplied by the area population. The area consumption was then subtracted from the area supply to give the quantity of surplus or deficit in each region.

EMPIRICAL RESULTS

Having presented the formal model and the necessary data, the task became one of deriving interregional trade patterns of the real world to the extent that the simplifying assumptions were valid. This involved two separate operations. The initial step was to derive a set of uniform regional prices that varied spatially by the cost of transportation in order that the quantity of surplus or deficit in each area could be obtained. The second step involved the determination of the geographical flow pattern such that the total transportation bill was minimized. Each step was programmed through the IBM 650 computer. This method of analysis will be discussed in detail for the year 1956. Similar procedures were followed for each analysis.

Dressed Beef - 1956

The first year chosen as representative of a phase in the recent cattle cycle was 1956. This year was characterized by a cyclical peak in both cattle and hog numbers at the beginning of the year. During the year cattle inventories began to decline and slaughter production reached an all time high both in total production and on a per capita basis. The big increase in slaughtered animals was in steers which were fed to heavy weights due to the unseasonally low prices in the summer and fall. Although during 1956 cattle inventories declined in most states and the United States as a whole, the South and Southeast continued to increase cattle numbers, especially Mississippi, Louisianna and Florida. The Great Plains, including Kansas, showed sharp declines in cattle numbers due to adverse climatic conditions. As the cattle taken from inventories entered marketing channels, increasing slaughter supplies, the average retail beef price fell to 57.8 cents per pound, the lowest since 1947. Accompanying this was the highest per capita

beef consumption on record, 94.9 pounds.

The data used in solving this situation has been presented in the basic data section of this paper. It was assumed that all beef was slaughtered in the producing area and that all shipments were of dressed beef at fresh meat freight rates. The initial phase in the analysis was to determine a structure of geographical prices bound together by the freight rates that would be consistent with the final equilibrium flow pattern. Since area XII (Des Moines) appeared as a definite surplus area it was chosen as the basing point and the remaining areas were estimated to be either surplus or deficit. It was estimated that areas II, XIV, XV, XVII, XVIII, XIX and XX would be deficit; and that the remaining areas would be surplus. With each area so defined the procedure explained in the basic data section was used to approximate a set of price differentials. As area XII was the basing point its price differential was zero. Assuming that area XII would ship to area XIX (Trenton) and the freight rate for fresh meat between areas XII and XIX was $2.51 per hundred, the price in area XIX must be $2.51 per hundred higher than in area XII. Area VII (Sioux Falls) which was surplus, was assumed to ship to area XIX also. The freight rate between these two areas was $2.73 per hundred. As the price in area XIX must be $2.51 higher than in area XII, the price in area VII must be the price in area XIX less the freight rate ($2.73). Assuming that areas VII and XII both shipped to area XIX, the difference between equilibrium prices in the surplus regions must be equal to the difference in their freight rate to the deficit area. Area VI(Phoenix) was assumed to ship to area XIX also, at a freight rate of $4.82 per hundred. Thus the price in area VI was assumed to be the price in area XIX less $4.82. Area VI became the link connecting the structure of prices in the East with those in the West (Figure 4). Using the fresh meat freight rates in Table 8

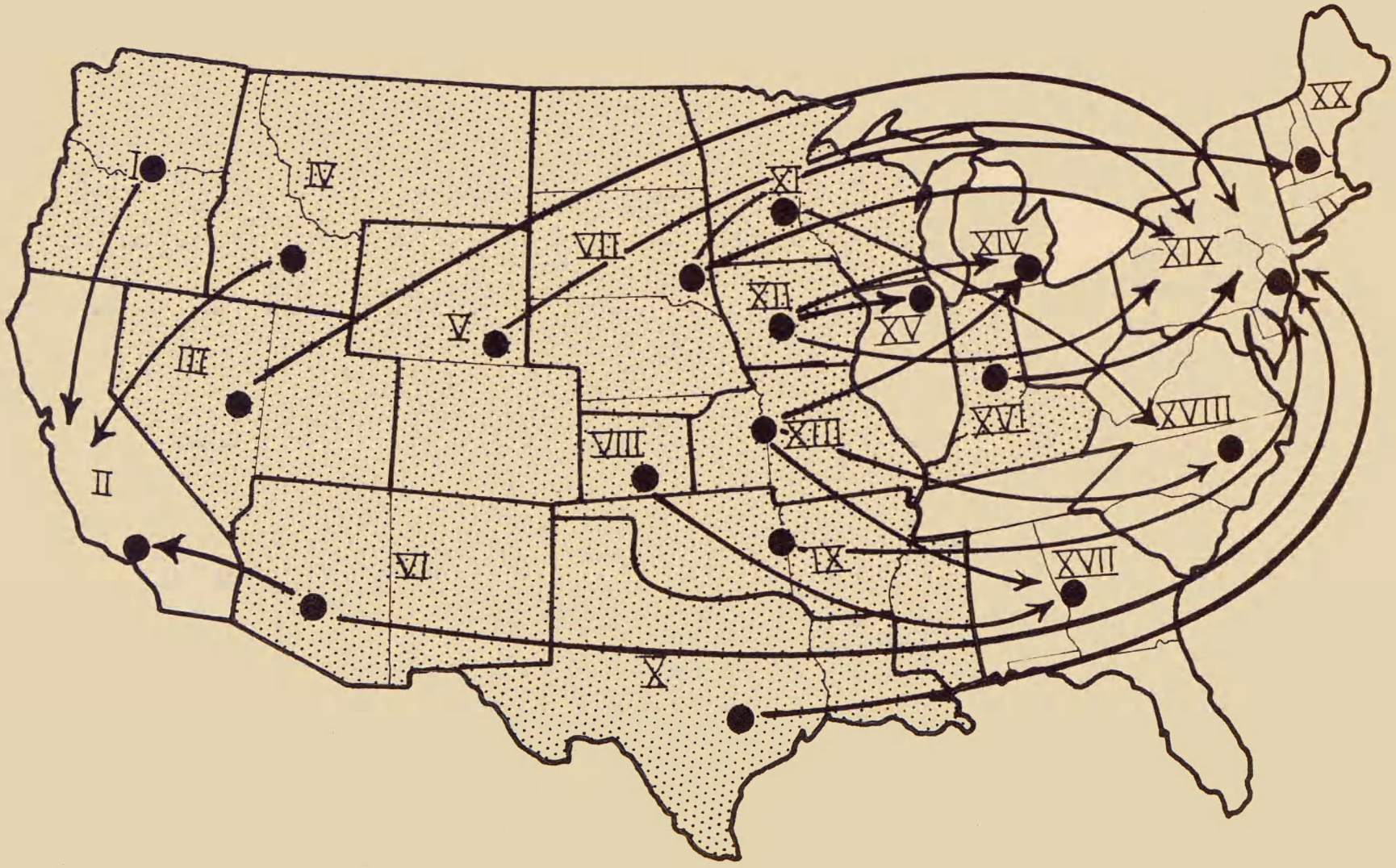


Fig. 4. Equilibrium flow, dressed beef, 1956.

Table 9. Per capita consumption, equilibrium beef price and price differential by area, dressed beef, 1956.

Area	Origin or destination	Per capita consumption	Equilibrium beef price	Price differential
		Pounds	Cents per pound	Cents per pound
I	Portland	101.17	53.82	-2.46
II	Los Angeles	115.28	55.74	- .54
III	Ely	93.86	53.76	-2.51
IV	Boise	92.02	53.82	-2.46
V	Laramie	94.41	55.16	-1.12
VI	Phoenix	87.00	53.96	-2.31
VII	Sioux Falls	80.82	56.06	- .22
VIII	Wichita	88.84	55.95	- .33
IX	Fort Smith	71.26	55.82	-. 46
X	Austin	86.79	55.36	- .91
XI	St. Paul	90.71	56.18	- .10
XII	Des Moines	85.97	56.28	-----
XIII	Kansas City	93.79	56.08	- .20
XIV	Detroit	103.39	57.46	1.19
XV	Chicago	112.30	56.90	.63
XVI	Indianapolis	87.63	57.02	.75
XVII	Columbus	78.24	57.64	1.37
XVIII	Raleigh	75.65	58.22	1.95
XIX	Trenton	106.26	58.78	2.51
XX	Concord	104.46	58.78	2.51

it was possible to establish the price differential in each area relative to area XII (Table 9). For example, the price in area VIII (Wichita) is .33 cents per pound lower than the price in area XII, but .13 cents per pound higher than the price in area IX (Fort Smith).

These assumed price differentials along with the estimating equation, the regional values of the independent variables, the total U. S. beef production available for slaughter and area population were programmed through the IBM 650 computer. From this equilibrium beef prices as well as area per capita consumption were determined (Table 9). With the data programmed through the computer total consumption and the amount of surplus or deficit in each area was also obtained (Table 10).

Given the excess supply or demand in each area, the second phase was to determine the geographical flow pattern so as to minimize the total cost of transportation. With the above data and the freight rates for fresh meat, the simplex linear programming model was used to obtain an optimum trade pattern. The flow pattern is presented in Figure 4 and the amount moved over each route is presented in Table 11. For example, the optimum flow solution indicates that area VI (Phoenix) supplies 213,100,000 pounds of beef (to area II (Los Angeles) and the remainder of its surplus, 22,880,000 pounds, is shipped) to area XIX (Trenton). The transportation cost for each route as well as the total transportation bill is presented in Table 12.

In some instances the initial set of price differentials were not the optimum set. In the initial phase of the analysis it is not definitely known which surplus areas ship to which deficit areas or, in some cases, whether an area will be surplus or deficit under equilibrium conditions. If the initial set or price differentials used to estimate the quantities of surplus or

Table 10. Production, equilibrium consumption of dressed beef by area, 1956.

Area	Origin or destination	Production	Consumption	Surplus	Deficit
		(million pounds)			
I	Portland	454.91	445.94	8.97	
II	Los Angeles	667.52	1,548.30		880.78
III	Ely	192.40	101.28	91.12	
IV	Boise	776.22	117.51	658.71	
V	Laramie	587.68	183.34	404.34	
VI	Phoenix	392.75	156.77	235.98	
VII	Sioux Falls	2,219.58	233.58	1,986.00	
VIII	Wichita	401.74	70.63	331.11	
IX	Fort Smith	1,117.67	435.66	682.01	
X	Austin	1,882.46	1,035.37	847.09	
XI	St. Paul	1,152.26	639.56	512.70	
XII	Des Moines	1,196.31	236.60	959.71	
XIII	Kansas City	1,237.58	505.36	732.22	
XIV	Detroit	620.54	1,720.59		1,100.05
XV	Chicago	705.13	1,065.01		359.88
XVI	Indianapolis	653.24	650.49	2.75	
XVII	Columbus	762.72	1,108.59		345.87
XVIII	Raleigh	417.28	937.17		519.89
XIX	Trenton	531.12	3,887.61		3,356.49
XX	Concord	124.89	1,014.64		889.75
U.S.		16,094.00	16,094.00	7,452.71	7,452.71

Table 11. Equilibrium trade pattern of dressed beef by area, 1956.

Area	Origin → / Destination ↓	Area I Portland	Area III Ely	Area IV Boise	Area V Laramie	Area VI Phoenix	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area X Austin	Area XI St. Paul	Area XII Des Moines	Area XIII Kansas City	Area XVI Indian-apolis	Total
		(million pounds)													
II	Los Angeles	8.97		658.71		213.10									880.78
XIV	Detroit											389.78	710.27		1,100.05
XV	Chicago											359.88			359.88
XVII	Columbus							331.11					14.76		345.87
XVIII	Raleigh										512.70		7.19		519.89
XIX	Trenton		91.12		404.34	22.88	1,096.25		682.01	847.09		210.05		2.75	3,356.49
XX	Concord						889.75								889.75
Total		8.97	91.12	658.71	404.34	235.98	1,986.00	331.11	682.01	847.09	512.70	959.71	732.22	2.75	7,452.71

Table 12. Transportation cost of shipping dressed beef from surplus to deficit areas, 1956.

Area	Origin / Destination	Area I Portland	Area III Ely	Area IV Boise	Area V Laramie	Area VI Phoenix	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area X Austin	Area XI St. Paul	Area XII Des Moines	Area XIII Kansas City	Area XVI Indianapolis	Total
		(thousand dollars)													
II	Los Angeles	172.2		12,647.2		3,771.9									16,591.3
XIV	Detroit											4,638.4	9,872.8		14,511.2
XV	Chicago											2,267.2			2,267.2
XVII	Columbus							5,628.9					231.7		5,860.6
XVIII	Raleigh										10,510.4		154.6		10,665.0
XIX	Trenton		4,574.2		14,677.5	1,102.8	29,927.6		20,255.7	28,970.5		5,272.3		48.4	104,829.0
XX	Concord						24,290.2								24,290.2
Total		172.2	4,574.2	12,647.2	14,677.5	4,874.7	54,217.8	5,628.9	20,255.7	28,970.5	10,510.4	12,177.9	10,259.1	48.4	179,014.5

deficit in each area are not consistent with the flow pattern obtained from the second phase, the first phase must be repeated. However, the flow resulting from the second phase provides an approximation upon which a new set of price differentials can be derived. For several situations this process was repeated numerous times until the correct price differentials were established.

When the set or price differentials is consistent with the flow pattern, the equilibrium trade pattern is obtained. This solution can be checked to see if it meets the equilibrium condition that no trader can profit by shipping additional beef from one region to another. For example, a comparison of freight rates show that a change in shipments from area IV (Boise) to area XIX (Trenton) with area III (Ely) forced to ship to area II (Los Angeles) would result in an increased transportation bill. Similar analysis can be conducted for the entire trading pattern. In some cases, changes in the flow pattern may be made without increasing costs, but would not reduce costs.

An analysis of the solution under equilibrium conditions for 1956 shows that per capita consumption of beef varied from a high of 115 pounds in area II (Los Angeles) to a low of 71 pounds in area IX (Fort Smith) (Table 9). The national average was 96.2 pounds. The relatively low consumption in the Southeast was due primarily to the disposable income variable in the estimating equation. The equilibrium beef price, equal to the price in area XII plus or minus the price differential relative to area XII, tended to increase progressively from the western surplus producing areas to the eastern deficit areas. The prices per pound varied from 58.78 cents in areas XIX and XX (Trenton and Concord) to 53.76 cents in area III (Ely) (Table 9). This price represents a composite price for all cuts of beef and veal.

Under these equilibrium conditons 7,452.71 million pounds of beef were shipped interregionally. This represented 46.31 percent of the total beef consumed. The optimum flow pattern illustrated in Figure 4 reveals two marketing structures. However, the movement of dressed beef was predominately to the eastern coastal areas. Area XIX was shown to receive shipments from eight of the thirteen surplus areas, including such far West areas as areas III, V and VI. Area II, the only deficit area west of the Mississippi River received beef from areas I, IV and VI. Area VIII (Wichita) moved its surplus beef to the Southeast, area XVII (Columbus). This pattern of shipment points out the heavy concentration of production west of the Mississippi River, especially in the central United States, while the major consuming areas are located in the far eastern and western portions of the nation. This is further illustrated by the additional data presented in Table 11. Of the 7,452.71 million pounds shipped, 45.04 percent was shipped to area XIX and 68.59 percent was shipped to the four Atlantic coastal areas. The cost of transporting the total shipments was $179,014,500 or 2.402 cents per pound (Table 12). In terms of average per capita cost this was $1.07. This does not include intraregional shipments.

Dressed Beef - 1958

In order to obtain some indication of the impact of changes in the geographical location of production, a second situation, based on 1958 data, was considered. The year of 1958 represented the first phase in the recovery part of the cattle cycle. The beginning inventory was at its lowest number since 1952. During the year all cattle on farms increased 3,501,000 head. This increase was almost entirely in the western United States. For Kansas and the Great Plains it was partly a rebuilding program following the drought.

The rapid expansion in the South which had been occuring in the earlier fifties showed signs of slowing down. Associated with this build-up was a decline in slaughter animals as well as average slaughter weight. The relatively higher prices accompanying a decline in slaughter encouraged a record amount of beef imports.

Reflecting the decline in production available for consumption areas I and II (Portland and Los Angeles) showed an increase in deficit amounts (Tables 10 and 13). Area I shifted from surplus to deficit and area II increased its deficit about 80 million pounds. This indicates that despite the decline in per capita consumption in these areas, the increase in population had maintained total consumption at a level near the 1956 amount while production declined. This is in contrast to the increase in surplus amounts in areas III and XVI (Ely and Indianapolis). The increase in area XVI was due primarily to a decline in total consumption while an increase in production was about equally important in area III as was the decline in consumption. The general level of per capita consumption was down approximately 13 pounds from the 1956 record high. The equilibrium per capita consumption varied from 100.96 pounds in area II to 59.90 in area IX (Table 14).

Due to the lower slaughter production during the year and the rise in the general level of disposable income the set of spatial equilibrium prices were considerably higher than in 1956. More important than the general price level in this study was the competitive position of prices among the separate areas. In contrast to the previous situation, prices rose more in the West so that the price surface was not so clearly defined as being lower in the West. The equilibrium beef prices varied from 78.46 cents per pound in areas XIX and XX (Trenton and Concord) to 74.83 cents per pound in area V (Laramie) (Table 14). This was a variation of only 3.63 cents per pound compared to a

Table 13. Production and equilibrium consumption of dressed beef by areas, 1958.

Area	Origin or Destination	Production	Consumption	Surplus	Deficit
		(million pounds)			
I	Portland	387.20	390.37		3.17
II	Los Angeles	487.84	1,447.40		959.56
III	Ely	199.38	93.09	106.29	
IV	Boise	661.03	103.41	557.62	
V	Laramie	570.71	172.98	397.73	
VI	Phoenix	348.25	150.10	198.15	
VII	Sioux Falls	1,870.38	225.19	1,645.19	
VIII	Wichita	215.23	68.09	147.14	
IX	Fort Smith	1,040.30	373.61	666.69	
X	Austin	1,398.69	937.73	460.96	
XI	St. Paul	1,206.01	581.45	624.56	
XII	Des Moines	1,271.43	222.56	1,048.87	
XIII	Kansas City	934.34	460.23	474.11	
XIV	Detroit	583.34	1,488.93		905.59
XV	Chicago	775.75	967.78		192.03
XVI	Indianapolis	663.85	558.49	105.36	
XVII	Columbus	866.70	993.12		126.42
XVIII	Raleigh	413.05	801.70		388.65
XIX	Trenton	526.59	3,564.63		3,038.04
XX	Concord	110.93	930.14		819.21
U.S.		14,531.00	14,531.00	6,432.67	6,432.67

Table 14. Per capita consumption, equilibrium beef prices and price differentials by area, 1958.

Area	Origin or Destination	Per capita consumption	Equilibrium beef prices	Price differential
		Pounds	Cents per pound	Cents per pound
I	Portland	85.95	77.12	1.17
II	Los Angeles	100.96	77.83	1.88
III	Ely	82.23	74.88	-1.07
IV	Boise	76.60	75.91	- .04
V	Laramie	85.17	74.83	-1.12
VI	Phoenix	75.73	76.06	.11
VII	Sioux Falls	76.83	75.73	-0.22
VIII	Wichita	83.75	75.58	-0.37
IX	Fort Smith	59.90	75.49	-0.46
X	Austin	75.10	75.04	-0.91
XI	St. Paul	79.51	75.60	-0.35
XII	Des Moines	78.87	75.95	-----
XIII	Kansas City	84.46	75.75	-0.20
XIV	Detroit	86.51	77.14	1.19
XV	Chicago	97.86	76.58	.63
XVI	Indianapolis	72.90	76.70	.75
XVII	Columbus	66.47	77.28	1.33
XVIII	Raleigh	62.36	77.65	1.70
XIX	Trenton	95.53	78.46	2.51
XX	Concord	93.38	78.46	2.51

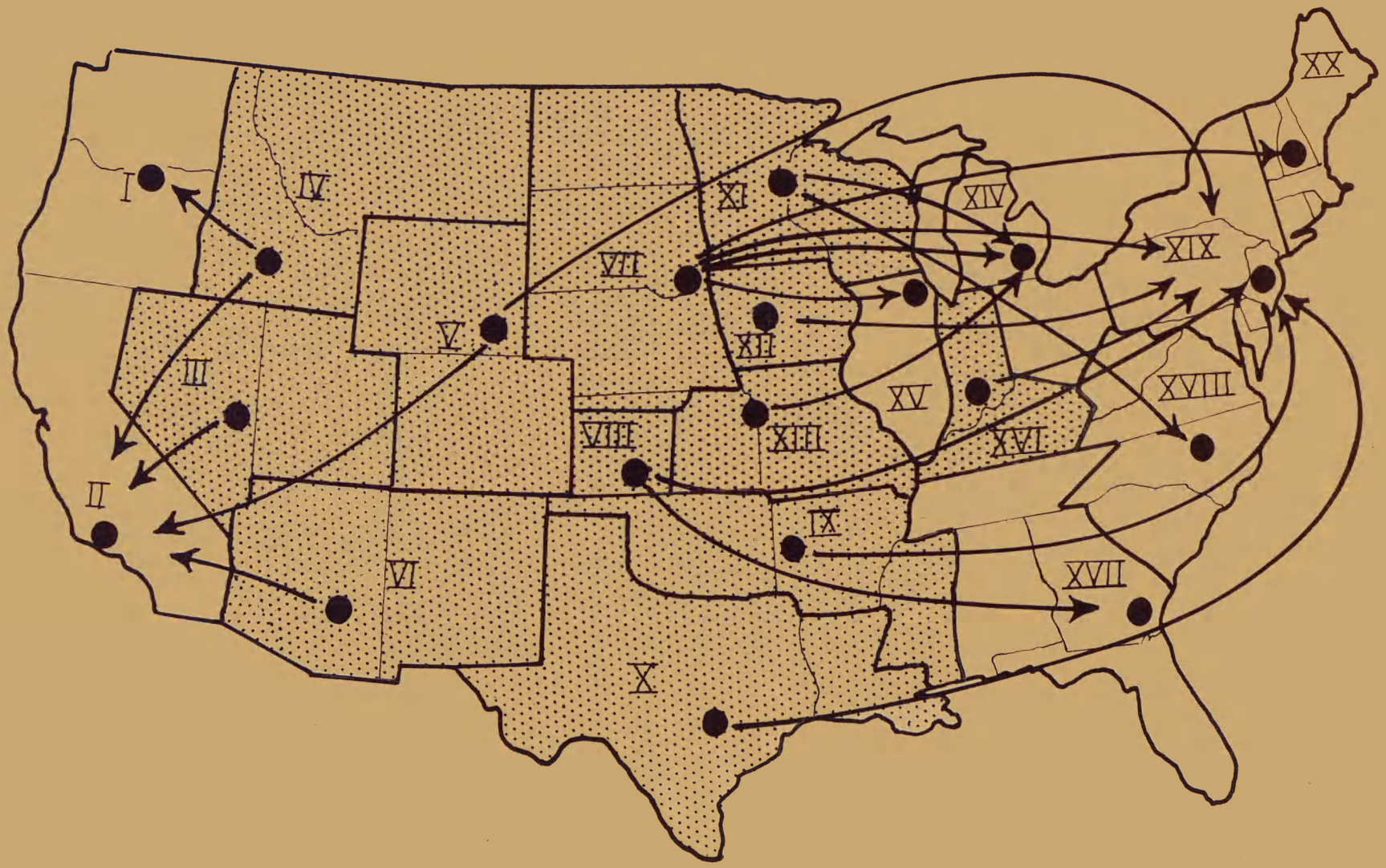


Fig. 5. Equilibrium flow, dressed beef, 1958.

variation of 5.02 cents in 1956. This can be attributed to the increased deficits in areas I and II creating changes in the movement of beef in the western areas. In most cases the flow pattern in 1958 was less complex than in the 1956 situation (Figures 4 and 5). Area V became the link between the two general flow patterns. All areas west of area V shipped to the west coast while the remaining surplus areas including area V supplied the deficit areas in the East. As area VIII (Wichita) was able to supply the entire deficit to area XVII (Columbus) shipping its remaineder to area XIX (Trenton), area XIII (Kansas City) shipped its entire surplus to area XIV (Detroit). Also area XII (Des Moines) shipped only to Trenton in 1958. As in 1956, a large portion of the shipments went to the four Atlantic coastal areas. Of the 6,432.67 million pounds shipped interregionally, representing 44.27 of the total consumption, 67.97 went to these areas (Table 15). This was a slight decline from the 1956 level. The cost of transporting the total shipments was $154,534,700 or 2.4023 cents per pound (Table 16). This cost per pound was slightly more than in 1956, but in terms of per capita costs it was lower due to the lower consumption and increased population.

Dressed Beef - 1959

By 1959 the cyclical expansion of cattle numbers was in full swing. Accompanying this upswing in cattle numbers was an increase in productivity per animal. This was the result of favorable range conditions and feed prices which encouraged the feeding of cattle to heavier weights and the withholding of calves from the market. Thus during the year there was a slight reduction in the number of cattle slaughtered as compared with 1958 but due to the large portion of fed cattle slaughter, slaughter production increased slightly. In terms of average per capita production available for

Table 15. Equilibrium trade pattern of dressed beef by area, 1958, U. S.

Area	Origin / Destination	Area III Ely	Area IV Boise	Area V Laramie	Area VI Phoenix	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area X Austin	Area XI St. Paul	Area XII Des Moines	Area XIII Kansas City	Area XVI Indianapolis	Total
		(million pounds)												
I	Portland		3.17											3.17
II	Los Angeles	106.29	554.45	100.67	198.15									959.56
XIV	Detroit					195.57				235.91		474.11		905.59
XV	Chicago					192.03								192.03
XVII	Columbus						126.42							126.42
XVIII	Raleigh									388.65				388.65
XIX	Trenton			297.06		438.38	20.72	666.69	460.96		1,048.87		105.36	3,038.04
XX	Concord					819.21								819.21
Total		106.29	557.62	397.73	198.15	1,645.19	147.14	666.69	460.96	624.56	1,048.87	474.11	105.36	6,432.67

Table 16. Transportation cost of shipping dressed beef from surplus to deficit areas, 1958.

Area	Origin / Destination	Area III Ely	Area IV Boise	Area V Laramie	Area VI Phoenix	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area X Austin	Area XI St. Paul	Area XII Des Moines	Area XIII Kansas City	Area XVI Indianapolis	Total
		(thousand dollars)												
I	Portland		38.4											38.4
II	Los Angeles	3,135.6	10,645.4	3,020.1	3,507.3									20,308.4
XIV	Detroit					2,757.5				3,633.0		6,590.1		12,980.6
XV	Chicago					1,632.3								1,632.3
XVII	Columbus						2,149.1							2,149.1
XVIII	Raleigh									7,967.3				7,967.3
XIX	Trenton			10,783.3		11,967.8	596.7	19,800.7	15,764.8		26,326.6		1,854.3	87,094.2
XX	Concord					22,364.4								22,364.4
Total		3,135.6	10,683.8	13,803.4	3,507.3	38,722.0	2,745.8	19,800.7	15,764.8	11,600.3	26,326.6	6,590.1	1,854.3	154,534.7

Table 17. Per capita consumption, equilibrium beef price and price differential by area, dressed beef, 1959.

Area	Origin or destination	Per capita consumption	Equilibrium beef price	Price differential
		Pounds	Cents per pound	Cents per pound
I	Portland	86.21	81.19	1.17
II	Los Angeles	100.40	81.90	1.88
III	Ely	81.73	78.95	-1.07
IV	Boise	73.84	79.98	- .04
V	Laramie	82.94	78.90	-1.12
VI	Phoenix	71.07	80.13	.11
VII	Sioux Falls	70.49	79.80	- .22
VIII	Wichita	78.33	79.69	- .33
IX	Fort Smith	58.00	79.56	- .46
X	Austin	72.86	79.11	- .91
XI	St. Paul	78.81	79.67	- .35
XII	Des Moines	77.19	80.02	-----
XIII	Kansas City	82.40	79.82	- .20
XIV	Detroit	86.97	81.21	1.19
XV	Chicago	99.55	80.65	.63
XVI	Indianapolis	72.44	80.77	.75
XVII	Columbus	64.65	81.39	1.37
XVIII	Raleigh	62.02	81.72	1.70
XIX	Trenton	95.12	82.53	2.51
XX	Concord	90.75	82.53	2.51

slaughter there was a small decline due to the increase in population. Areas I and XV (Portland and Chicago) did show an increase in per capita consumption in 1959 due primarily to an increase in their disposable income at a faster rate than that of the U. S. as a whole. The per capita equilibrium consumption ranged from 100.40 pounds in area II (Los Angeles) to 62.02 in area XVII (Raleigh) (Table 17). As a result of the general increase in per capita disposable income and the decline in pork prices the equilibrium beef price was approximately four cents per pound higher. The equilibrium prices ranged from 82.53 cents per pound in areas XIX and XX (Trenton and Concord) to 78.90 in area V (Laramie) (Table 17). Other than this general price increase, the price surface for 1959 was strikingly similar to that of 1958. The only difference in the flow patterns of the two years was that in 1959 area VIII (Wichita) was unable to fill the entire deficit needs of area XVII (Columbus) as it had in 1958. This remaining deficit was then supplied from area XIII (Kansas City). The flow pattern for 1959 is illustrated in Figure 6. Although there was no shift among the classification of areas from 1958 to 1959, some changes were noted in the quantities of surplus or deficit within each area (Tables 13 and 18). All the deficit areas with the exception of area II, showed increases in their demand for beef shipments in 1959. Most notable of these areas was area XVI (Columbus). Although there was a small decline in total consumption, the area production was down more than 100 million pounds. Among the surplus areas the trend was not so clear. Six of the surplus areas showed increases in the quantity available for shipment, while the remaining six showed decreases. Those areas increasing their surplus -- areas V, VII, VIII, XI, XII, XIII -- are predominately those areas in which the bulk of the production is in highly finished fed cattle. This tended to concentrate the

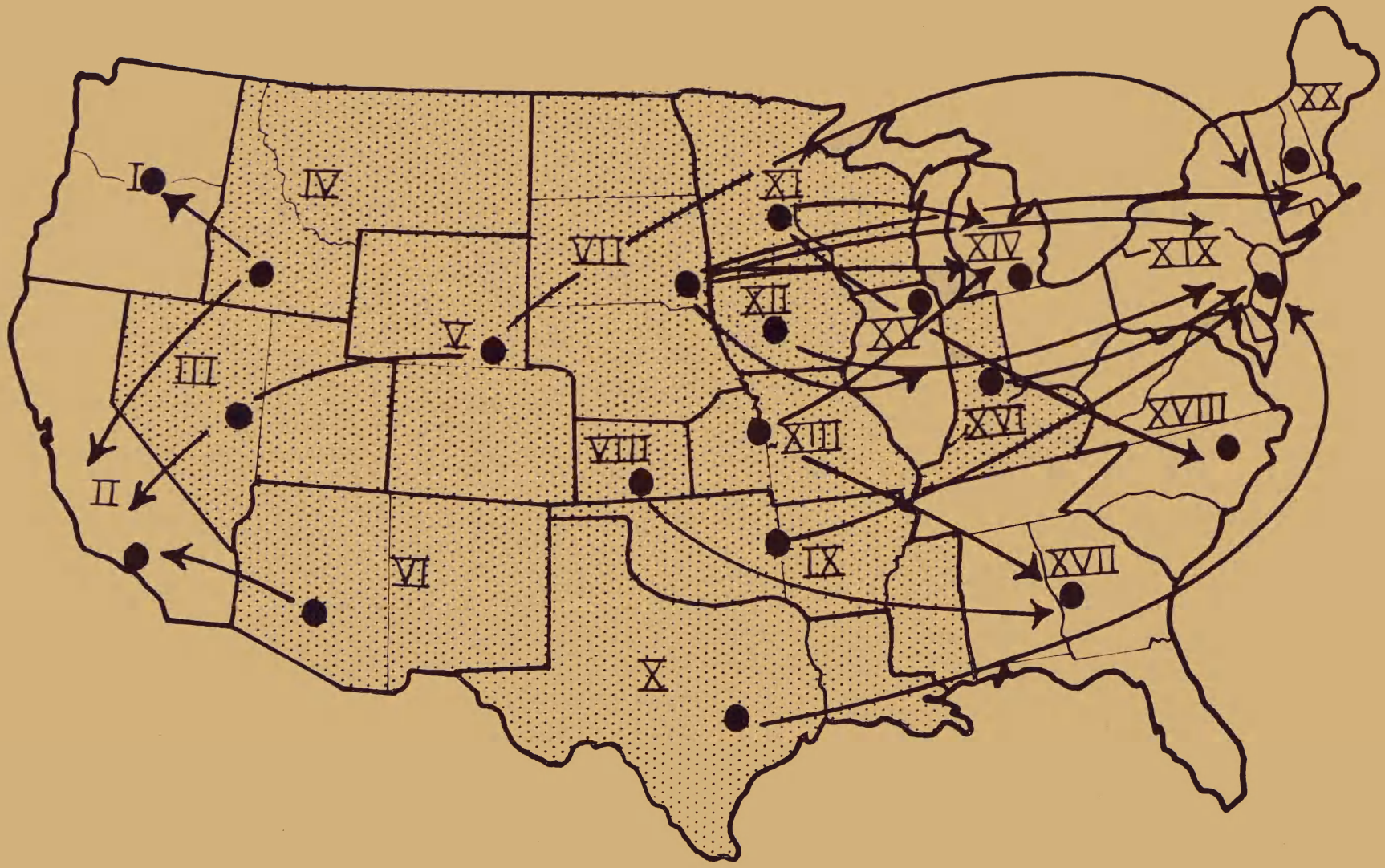


Fig. 6. Equilibrium flow, dressed beef, 1959.

Table 18. Production and equilibrium consumption of dressed beef by area, 1959.

Area	Origin or destination	Production	Consumption	Surplus	Deficit
		(million pounds)			
I	Portland	391.76	395.63		3.87
II	Los Angeles	607.88	1,469.76		861.88
III	Ely	193.51	94.80	98.71	
IV	Boise	617.50	99.76	517.74	
V	Laramie	602.68	165.97	436.71	
VI	Phoenix	303.11	150.10	153.01	
VII	Sioux Falls	1,966.95	205.19	1,761.76	
VIII	Wichita	284.49	64.07	220.42	
IX	Fort Smith	974.95	359.87	615.08	
X	Austin	1,349.24	923.80	425.44	
XI	St. Paul	1,209.80	583.89	625.91	
XII	Des Moines	1,344.71	216.82	1,127.89	
XIII	Kansas City	1,089.50	448.16	641.34	
XIV	Detroit	570.51	1,535.96		965.45
XV	Chicago	779.21	1,015.92		236.71
XVI	Indianapolis	614.56	562.38	52.18	
XVII	Columbus	763.21	988.73		225.52
XVIII	Raleigh	381.04	800.25		419.21
XIX	Trenton	477.63	3,621.51		3,143.88
XX	Concord	101.76	921.43		819.67
U.S.		14,624.00	14,624.00	6,676.19	6,676.19

increased quantities available for shipment in the areas west and north of area VIII (Wichita).

Of the 6,676.19 million pounds shipped, interregionally, representing 45.65 percent of the total consumption, 69.03 percent was shipped to the four Atlantic coastal areas (Table 19). This represents a moderate increase over the previous years. More significant is the fact that although total production increased only 97 million pounds in 1959 over 1958, the interregional shipments are shown to increase almost 250 million pounds. This is due primarily to the more concentrated production in those areas already surplus producing.

The total transportation cost was $159,302,200 (Table 20). This was somewhat higher than in 1958. However, the cost per pound was only 2.386 cents per pound. This was .016 cents per pound below the 1958 average cost indicating that the increased shipments were over the lower cost routes. As a result there was no change in per capita cost.

Actual Slaughter - 1959

To obtain some indication of the impact of changes in the geographical supply of beef on the equilibrium solution and the tendency of slaughter plants to be "market orientated"[1] a spatial analysis was conducted for 1959 based on actual slaughter data rather than production data. Actual slaughter figures included both commercial and farm slaughter. Commercial slaughter data was obtained from the Supplement for 1959 to "Livestock and Meat Statistics", United States Department of Agriculture, June 1960. Farm

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[1]This term relates to the tendency of slaughter to occur in or nearer the area of demand. Beef supplies are defined as actual slaughter in the area. This is in contrast to "production orientated," where beef supplies are defined as area farm production available for slaughter.

Table 19. Equilibrium trade pattern of dressed beef, by area, 1959.

Area	Origin / Destination	Area III Ely	Area IV Boise	Area V Laramie	Area VI Phoenix	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area X Austin	Area XI St. Paul	Area XII Des Moines	Area XIII Kansas City	Area XVI Indianapolis	Total
		(million pounds)												
I	Portland		3.87											3.87
II	Los Angeles	98.71	513.87	96.29	153.01									861.88
XIV	Detroit					122.51				206.70		636.24		965.45
XV	Chicago					236.71								236.71
XVII	Columbus						220.42					5.10		225.52
XVIII	Raleigh									419.21				419.21
XIX	Trenton			340.42		582.87		615.08	425.44		1,127.89		52.18	3,143.88
XX	Concord					819.67								819.67
Total		98.71	517.74	436.71	153.01	1,761.76	220.42	615.08	425.44	625.91	1,127.89	641.34	52.18	6,676.19

Table 20. Transportation cost of shipping dressed beef from surplus to deficit areas, 1959.

Area	Origin / Destination	Area III Ely	Area IV Boise	Area V Laramie	Area VI Phoenix	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area X Austin	Area XI St. Paul	Area XII Des Moines	Area XIII Kansas City	Area XVI Indianapolis	Total
		(thousand dollars)												
I	Portland		46.8											46.8
II	Los Angeles	2,911.9	9,866.3	2,888.7	2,708.3									18,375.2
XIV	Detroit					1,727.4				3,183.2		8,843.7		13,754.3
XV	Chicago					2,012.0								2,012.0
XVII	Columbus						3,747.1					80.1		3,827.2
XVIII	Raleigh									8,593.8				8,593.8
XIX	Trenton			12,357.2		15,912.4		18,267.9	14,550.0		28,310.0		918.4	90,315.9
XX	Concord					22,377.0								22,377.0
Total		2,911.9	9,913.1	15,245.9	2,708.3	42,028.8	3,747.1	18,267.9	14,550.0	11,777.0	28,310.0	8,923.8	918.4	159,302.2

slaughter data was estimated from data reported by the United States Department of Agriculture. This data was based on the number of cattle and calves slaughtered in each state and the U. S. average live weight of farm slaughter for cattle and calves.

To determine actual slaughter in area VIII (Wichita) it was necessary to distribute total Kansas slaughter among the three areas of Kansas. This required estimates of the location of non-federally inspected slaughter, federally inspected slaughter and farm slaughter.

Estimates of non-federally inspected slaughter in each of the three area divisions of Kansas was based on data obtained from the Crop Reporting Board, Topeka, Kansas. The first step in this procedure was to obtain the number of wholesale and local plants in each of these areas. The annual reported base (in number of head, cattle and calves) of those plants in each area was summed to obtain an estimate of the number slaughtered. The estimated total number slaughtered, by type of plant and class of animal, was then divided into the respective liveweight slaughter for 1959 to obtain an average liveweight per animal slaughtered. These average weights were multiplied by their corresponding number in each area to obtain area slaughter. As there was no reported base available for the butcher plants in Kansas, the proportion of plants in each area was determined and this ratio was used to distribute total slaughter from butcher plants among the areas.

The difference between total commercial slaughter and the estimated nonfederally inspected slaughter was attributed to federally inspected slaughter. As it was possible to obtain federally inspected slaughter in terms of liveweight and the number of animals, an average weight was obtained for both cattle and calves. Based on a survey conducted at Kansas State University of federally inspected plants in Kansas, estimates of the number

slaughter in each area in 1959 were made. These estimates multiplied by their respective average weights yielded the federally inspected slaughter in each area.

Farm slaughter was distributed among the three areas on the bases of liveweight production. The total of these above estimates was used as the actual slaughter occuring in each of these areas.

The U. S. actual slaughter necessarily equaled the U. S. production available for slaughter, however, this was not true for individual states.

This analysis was then conducted on the basis of actual slaughter data as compiled above and the 1959 values for the remaining variables.

A comparison of results between this situation where slaughter tends to be market oriented and the previous situation where slaughter was assumed to occur in the area of production reveals that some inefficiencies may be occuring in the transportation of beef. Areas VI and XVI (Phoenix and Indianapolis) which were surplus in the production of beef were found to be deficit in the actual slaughter of beef in relation to their consumption needs (Tables 18 and 21). Thus the outshipment of live cattle was so large that inshipments of dressed beef were needed to fulfill consumption needs. Conversely, area I (Portland) changed from a deficit area to a surplus area.

Of the remaining ten surplus areas only areas XI and XII (St. Paul and Des Moines) showed increases in actual slaughter as compared with production available for slaughter in 1959. Among the seven remaining areas which were deficit in both analysis only area XVIII (Raleigh) slaughtered less than the estimated production available for slaughter within the area. The densely populated areas of California and the Northeast which were highly deficit in terms of production available for slaughter were considerably less deficit in terms of actual slaughter.

Table 21. Production and equilibrium consumption of dressed beef by areas, actual slaughter, 1959.

Area	Origin or destination	Production	Consumption	Surplus	Deficit
		(million pounds)			
I	Portland	396.55	396.55	-----	-----
II	Los Angeles	1,370.59	1,470.17		99.58
III	Ely	123.61	94.84	28.77	
IV	Boise	162.95	99.79	63.16	
V	Laramie	564.81	166.02	398.79	
VI	Phoenix	114.20	147.26		33.06
VII	Sioux Falls	1,473.06	205.27	1,267.79	
VIII	Wichita	172.01	64.09	107.92	
IX	Fort Smith	368.77	360.04	8.73	
X	Austin	963.91	924.16	39.75	
XI	St. Paul	1,501.62	584.09	917.53	
XII	Des Moines	1,463.99	216.90	1,247.09	
XIII	Kansas City	1,049.73	448.31	601.42	
XIV	Detroit	1,098.85	1,536.46		437.61
XV	Chicago	957.34	1,016.20		58.86
XVI	Indianapolis	476.28	559.78		83.50
XVII	Columbus	597.70	989.16		391.46
XVIII	Raleigh	275.46	800.61		525.15
XIX	Trenton	1,341.53	3,622.58		2,281.05
XX	Concord	151.04	921.72		770.68
U.S.		14,624.00	14,624.00	4,680.95	4,680.95

A comparison of the quantity of beef shipped interregionally indicates further that slaughter plants tend to be market orientated. The total quantity of beef shipped in the actual slaughter situation was 4,680.95 million pounds. (Table 22). This was approximately 29.3 percent less than in the previous situation. This was due to the fact that interregional live shipments are not included in the actual slaughter situation. Thus the difference in total beef flows of the previous analysis and this analysis, 6,676.19 million pounds compared with 4,680.95 million pounds, indicates that an estimated live interregional shipment of 1,995.76 million pounds of beef occurred. This is in terms of carcass weights and assuming the indicated area demarcation.

The decline in transportation cost to $112,617,600 was in nearly the same proportion as the decline in quantity shipped interregionally (Table 23). As a result there was only a moderate increase in transportation cost per pound shipped from 2.39 to 2.41 cents. This increase in attributable to the fact that 85 percent of the shipments went to the eastern coastal areas compared to only 69 percent in the previous situation.

Although this alternative analysis had very little effect on the equilibrium base price in area XII it did point out the impact of the location of production and slaughter on the comparative advantage or disadvantage of a particular area (Tables 17 and 24). For example, area VI which had been surplus in the previous analysis had a price differential of .11 cents per pound, but in this situation, where it was deficit, its price differential became 1.66 cents per pound. As a result of the higher beef price the per capita consumption declined. A similar circumstance occurred in relation to area XVI. It was interesting to note that area IX and X (Fort Smith and Austin) which are normally highly surplus producing

Table 22. Equilibrium trade pattern of dressed beef, actual slaughter, 1959.

Area	Destination	Area III Ely	Area IV Boise	Area V Laramie	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area X Austin	Area XI St. Paul	Area XII Des Moines	Area XIII Kansas City	Total
						(million pounds)						
I	Portland											-----
II	Los Angeles	28.77	63.16	7.65								99.58
VI	Phoenix							33.06				33.06
XIV	Detroit								119.73		317.88	437.61
XV	Chicago								58.86			58.86
XVI	Indianapolis			83.50								83.50
XVII	Columbus					107.92					283.54	391.46
XVIII	Raleigh								525.15			525.15
XIX	Trenton			307.64	497.11		8.73	6.69	213.79	1,247.09		2,281.05
XX	Concord				770.68							770.68
Total		28.77	13.16	398.79	1,267.77	107.92	8.73	39.75	917.53	1,247.09	601.42	4,680.95

Table 23. Transportation cost of shipping dressed beef from surplus to deficit areas, actual slaughter, 1959.

Area	Origin / Destination	Area III Ely	Area IV Boise	Area V Laramie	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area X Austin	Area XI St. Paul	Area XII Des Moines	Area XIII Kansas City	Total
		(thousand dollars)										
I	Portland											-----
II	Los Angeles	848.7	1,212.7	229.5								2,290.9
VI	Phoenix							849.6				849.6
XIV	Detroit								1,843.8		4,418.5	6,262.3
XV	Chicago								576.8			576.8
XVI	Indianapolis			1,903.8								1,903.8
XVII	Columbus					1,834.6					4,451.6	6,286.2
XVIII	Raleigh								10,765.6			10,765.6
XIX	Trenton			11,167.3	13,571.1		259.2	228.8	6,144.4	31,302.0		62,542.8
XX	Concord				21,039.6							21,039.6
Total		848.7	1,212.7	13,300.6	34,610.7	1,834.6	259.2	1,078.4	19,300.6	31,302.0	8,870.1	112,617.6

Table 24. Per capita consumption, equilibrium beef prices and price differentials by areas, actual slaughter, 1959.

Area	Origin or destination	Per capita consumption	Equilibrium beef price	Price differential
		Pounds	Cents per pound	Cents per pound
I	Portland	86.40	80.98	.99
II	Los Angeles	100.43	81.87	1.88
III	Ely	81.76	78.92	-1.07
IV	Boise	73.87	79.95	- .04
V	Laramie	82.97	78.87	-1.12
VI	Phoenix	69.73	81.65	1.66
VII	Sioux Falls	70.52	79.77	- .22
VIII	Wichita	78.35	79.66	- .33
IX	Fort Smith	58.03	79.53	-..46
X	Austin	72.89	79.08	- .91
XI	St. Paul	78.84	79.64	- .35
XII	Des Moines	77.22	79.99	-----
XIII	Kansas City	82.43	79.79	- .20
XIV	Detroit	87.00	81.18	1.19
XV	Chicago	99.58	80.62	.63
XVI	Indianapolis	72.11	81.15	1.16
XVII	Columbus	64.68	81.36	1.37
XVIII	Raleigh	62.04	81.69	1.70
XIX	Trenton	95.15	82.50	2.51
XX	Concord	90.77	82.50	2.51

areas, were found to be less surplus in terms of actual slaughter. In 1959 these areas produced a surplus of over 1,000 million pounds of beef. However, during the same year they slaughtered a surplus of less than 50 million pounds. In determining the base price it was first estimated that area I (Portland) was surplus. However, on this basis the area was found to be deficit. When the analysis was rerun with area I estimated to be deficit it appeared as a surplus area. This was due to the change in its equilibrium price reflecting a change in consumption. As a result, area I was declared a selfsufficient area and a price differential of .99 was established to equate production and consumption. Thus, the flow pattern shows no shipment to or from the area (Figure 7). In both analyses western Kansas found its greatest comparative advantage in shipping to the Southwest. However, this does not indicate that area VIII does not also enjoy a comparative advantage over other surplus areas to ship to other deficit areas.

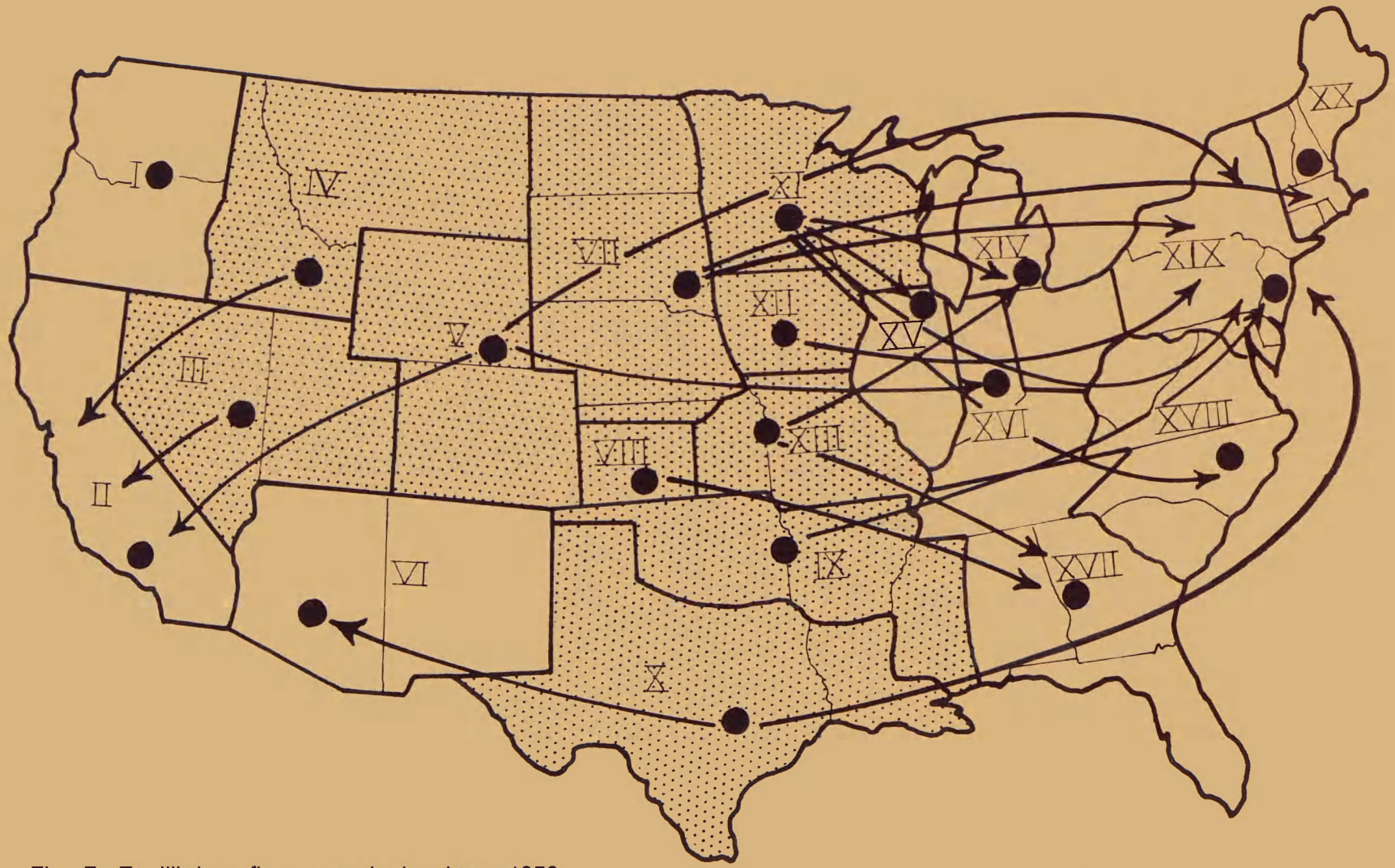

Fig. 7. Equilibrium flow, actual slaughter, 1959.

ILLUSTRATIVE PROJECTIONS

Spatial equilibrium analysis provides a useful methodology for estimating the equilibrium conditions that may exist in future time periods. The accuracy of extrapalating, however, is conditioned by the accuracy of the projected values. The "illustrative projections" are not presented as predictions of future conditions, but indicate rather the nature of the effect of changes in the level and distribution of the predetermined variables.

Actual Slaughter - 1961, 1st projection

In order to measure the impact of increased beef production and slaughter in western Kansas a situation was projected to 1961 on the basis of available data. Recent census data of population by states for 1960 was obtained.[1] It was assumed population would increase 1.6 percent by 1961.[2] This increase was distributed among states on the basis of estimated growth in the next decade.[3] From this, area, area population was obtained for 1961 (Table 25).

Per capita personal disposable income was assumed constant at the 1959 level (Table 25). This was done in part because of the lack of data to make accurate projections by area and in part to account for the possibility of a mild recession in 1961.

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[1] "The Latest on U. S. Growth in the Ten Years Ahead," U. S. News and World Report, October 17, 1960, p. 138.

[2] Population increase 1.6 percent from 1959-1960.

[3] Ibid., U. S. News and World Report.

Table 25. Estimated population, per capita disposable income, pork prices and beef slaughter by areas, actual slaughter, 1961 projection.

Area	Origin or destination	Population	Per capita dis. income	Pork Price	Slaughter
		(1,000)	(dollars)	(cents/pound)	(1,000)
I	Portland	4,712	$1,974	66.52	465,772
II	Los Angeles	16,218	2,319	67.62	1,585,104
III	Ely	1,210	1,823	66.13	159,024
IV	Boise	1,364	1,681	60.50	216,651
V	Laramie	2,125	1,874	60.27	722,944
VI	Phoenix	2,332	1,617	60.97	147,246
VII	Sioux Falls	2,858	1,604	59.05	1,876,161
VIII	Wichita	838	1,793	57.44	383,975
IX	Fort Smith	6,295	1,309	57.90	428,733
X	Austin	13,077	1,635	61.67	1,056,917
XI	St. Paul	7,482	1,800	58.42	1,799.828
XII	Des Moines	2,777	1,757	61.45	1,894,391
XIII	Kansas City	5,563	1,891	57.62	1,200,642
XIV	Detroit	17,820	2,016	60.62	1,242,439
XV	Chicago	10,248	2,300	60.84	935,355
XVI	Indianapolis	7,792	1,677	57.41	563,344
XVII	Columbus	16,082	1,499	59.20	695,601
XVIII	Raleigh	12,868	1,439	60.38	336,794
XIX	Trenton	38,841	2,225	63.30	1,520,604
XX	Concord	10,607	2,108	67.75	148,475
U.S.		181,109	1,891	61.20	17,380,000

Pork prices were adjusted upward by 7 percent from the 1959 level. This figure was chosen because of the somewhat smaller supply of hogs expected in the early part of 1961. This increase in price was equal to slightly more than one-half the difference between the record high pork price in 1958 and the price in 1959. (Table 25).

The estimated beef production for 1960 was 15,800 million pounds.[1] This was 8 percent above 1959. Slaughter for 1961 was estimated to be ten percent above the 1960 level.[2] This represented a slaughter production of 17,380 million pounds in 1961. Under these conditions it was assumed that Kansas would increase its beef production by feeding one-half of its excess grain sorghum production. As mentioned earlier it appears that presently no more than 65 percent of the sorghum production was fed in 1959. Assuming this was constant throughout the state, western Kansas would have bed approximately 46,214,500 bushels of its 1959 production. Furthermore, it was assumed that western Kansas produced the same portion of the 1960 crop as it did of the 1959 crop (58.6 percent). As the estimated crop production for 1960 was 141,015,000 bushels, it was assumed 82,634,790 bushels were produced in western Kansas. This was 36,420,290 bushels in excess of what was assumed fed in 1959. Assuming one-half of this excess (18,210,145) was fed by western Kansas farmers the problem became one of determining the effect on beef production in western Kansas. This projection was made on the following basis.

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[1] Livestock and Meat Situation, Agricultural Marketing Service, United States Department of Agriculture, May, 1960, p. 14.

[2] Kramer, Robert C. and John Ferris, "Cattle Cycle Climbs in Roller Coaster," National Livestock Producer, August, 1960, p. 9.

The excess milo would be fed to steers or heifers placed under a full-feeding program at 650 pounds and sold at 1,000 pounds, after a gain of 350 pounds. The daily ration would include 17 pounds of milo and the average daily gain would be 2.25 pounds. This meant that 13.5 bushels of milo would be needed to produce 100 pounds of live cattle. Using this ratio the 18,210,145 bushels of grain sorghum would produce 134,889,963 pounds of live weight cattle. If this increase in production was distributed among animals at the rate of 350 pounds of gain per animal this would increase the number of cattle fed by 385,400 head. Assuming furthermore, that these animals were sold at 1,000 pounds this would increase slaughter potential in Kansas by 385,400,000 pounds. In terms of dressed weight equivalents this was approximately 211.97 million pounds. Added to the 1959 slaughter of 172.01 million pounds this meant a potential slaughter of 383.98 million pounds in western Kansas in 1961.

The U. S. slaughter production in 1961 was estimated to increase 2,756 million pounds or 18.85 percent over the 1959 level. Assuming western Kansas increased its slaughter production 211.97 million pounds, the remaining 2,544.03 million pounds were distributed among the other nineteen areas. Two methods were employed. First, the remaining increase was distributed among the nineteen areas on the basis of their relative importance in 1959. Second, the remaining increase was distributed among the nineteen areas on the basis of their increase in slaughter between 1952-59. That is, each region except western Kansas was assumed to increase slaughter in 1961 by the same proportion as it had contributed to the increase in slaughter from 1952-1959. The year 1952 corresponded to a similar phase in the cattle cycle as did 1959.

The latter procedure was used in distributing the remaining increase in production. On this basis areas XV and XX (Chicago and Concord) showed declines in actual slaughter from 1959 (Tables 21 and 26).

Table 26. Production and equilibrium consumption of dressed beef by area, actual slaughter, 1961, 1st projection.

Area	Origin or destination	Production	Consumption	Surplus	Deficit
		(million pounds)			
I	Portland	465.77	468.17		2.40
II	Los Angeles	1,585.11	1,841.67		256.56
III	Ely	159.02	114.79	44.23	
IV	Boise	216.65	118.55	98.10	
V	Laramie	722.94	204.02	518.92	
VI	Phoenix	147.25	191.98		44.73
VII	Sioux Falls	1,876.16	238.77	1,637.39	
VIII	Wichita	383.98	76.50	307.48	
IX	Fort Smith	428.73	438.15		9.42
X	Austin	1,056.92	1,095.86		38.94
XI	St. Paul	1,799.83	687.26	1,112.57	
XII	Des Moines	1,894.39	250.69	1,643.70	
XIII	Kansas City	1,200.64	530.91	669.73	
XIV	Detroit	1,242.44	1,782.86		540.42
XV	Chicago	935.36	1,154.20		218.84
XVI	Indianapolis	563.34	663.23		99.89
XVII	Columbus	695.60	1,248.58		552.98
XVIII	Raleigh	336.79	966.22		629.43
XIX	Trenton	1,520.60	4,203.66		2,683.06
XX	Concord	148.48	1,103.93		955.45
U.S.		17,380.00	17,380.00	6,032.12	6,032.12

On the basis of these projections the estimated average per capita consumption in 1961 was 95.91 pounds. This was 12.91 pounds above the 1959 per capita consumption. However, this did not equal the record high consumption in 1956. Per capita consumption among areas varied from 113.56 pounds in area II (Los Angeles) to 69.60 pounds in area IX (Fort Smith) (Table 27). In relation to the 1959 actual slaughter analysis numerous changes occurred in the model. Area I (Portland) changed from a self-sufficient area to a deficit area (Table 26). Similarly, areas IX and X (Fort Smith and Austin) changed from surplus areas to deficit areas. The nine areas which were deficit in the previous analysis all increased their deficit amounts. This indicates that the expected population growth will outstrip the actual slaughter in these areas as based on past data. The remaining eight surplus areas all increased their surplus quantities of slaughtered beef. This was especially true of those areas to the north and east of western Kansas. On the basis of the projection for western Kansas, this area increased its surplus by 200 million pounds.

The total quantity of interregional shipments was 6,032.12 million pounds. This represented 34.71 percent of the total slaughter or about 2 percent more than in 1959. Due to the increase in the number of deficit areas a smaller relative percent went to the four Atlantic coastal areas than in the comparable 1959 situation.

Under the assumed conditions of per capita disposable income held constant at the 1959 level and the corresponding increase in per capita consumption equilibrium beef prices ranged from 68.60 cents per pound in areas XIX and XX (Trenton and Concord) to 64.97 cents per pound in area V (Laramie) (Table 27). This was approximately 14 cents per pound lower than in 1959, but nearly 10 cents above the estimated price in 1956 when

Table 27. Per capita consumption, equilibrium beef price and price differential by area, actual slaughter, 1961 1st projection.

Area	Origin or destination	Per capita consumption	Equilibrium beef price	Price differential
		Pounds	Cents per pound	Cents per pound
I	Portland	99.36	67.26	1.17
II	Los Angeles	113.56	67.97	1.88
III	Ely	94.87	65.02	-1.07
IV	Boise	86.91	66.05	- .04
V	Laramie	96.01	64.97	-1.12
VI	Phoenix	82.32	68.26	2.17
VII	Sioux Falls	83.54	65.87	- .22
VIII	Wichita	91.29	65.84	- .25
IX	Fort Smith	69.60	67.25	1.16
X	Austin	83.80	67.60	1.51
XI	St. Paul	91.86	65.74	- .35
XII	Des Moines	90.27	66.09	-----
XIII	Kansas City	95.44	65.89	- .20
XIV	Detroit	100.05	67.28	1.19
XV	Chicago	112.63	66.72	.63
XVI	Indianapolis	85.12	67.25	1.16
XVII	Columbus	77.64	67.54	1.45
XVIII	Raleigh	75.09	67.79	1.70
XIX	Trenton	108.23	68.60	2.51
XX	Concord	104.08	68.60	2.51

consumption was only slightly higher. This is due primarily to the positive demand coefficient for income.

With the change in the classification of three areas as well as the amount of surplus or deficit in the remaining areas numerous changes occurred in the flow pattern (Table 28 and Figure 8). Area V supplied the entire deficit quantity in three areas (Areas VI, X and XVI) and then shipped its remaining surplus to areas I and XIX. Area VIII (Wichita) supplied the demand in area IX (Fort Smith) and then shipped its remaining surplus to area XVII (Columbus). As area VIII was unable to fill the increased demand in area XVII, area XI (St. Paul) supplied the remainder. This was in contrast to the previous situation in which area XIII (Kansas City) shipped to the Southeast. The remaining newly introduced deficit area (Area I) was supplied by area IV (Boise). The result of this change in flow pattern was a decrease in the price differential for western Kansas. The price differential dropped from -.33 to -.25 cents per pound. This indicates a more favorful competitive position for western Kansas in regard to transportation.

The total transportation bill was $141,441,600 (Table 29). This represented an average cost of 2.34 cents per pound.

Actual Slaughter - 1961, 2nd projection

Using the same basis data for the predetermined variables as in the previous situation (Table 25) a second analysis was conducted. In this analysis variable elasticity coefficients were used in the estimating equation. A set of elasticities for each of the four census regions of the U. S. Census Bureau was used. These were derived by Omar Wahby and Wilbur Maiki and based on data obtained from the 1955 Household Food Consumption Survey.[1] (Table 30).

1 Adjustment in Livestock Marketing in the North Central States to Changing Patterns of Production and Research: Detailed Research Plan.

Table 28. Equilibrium trade patterns of dressed beef by areas, actual slaughter, 1961 1st projection.

Area	Origin → / Destination ↓	Area III Ely	Area IV Boise	Area V Laramie	Area VII Sioux Falls	Area VIII Wichita	Area XI Saint Paul	Area XII Des Moines	Area XIII Kansas City	Total
					(million pounds)					
I	Portland		2.40							2.40
II	Los Angeles	44.23	95.70	116.63						256.56
VI	Phoenix			44.73						44.73
IX	Fort Smith					9.42				9.42
X	Austin			38.94						38.94
XIV	Detroit							540.42		540.42
XV	Chicago							218.84		218.84
XVI	Indianapolis			99.89						99.89
XVII	Columbus					298.06	254.92			552.98
XVIII	Raleigh						629.43			629.43
XIX	Trenton			218.73	1,566.38		228.22		669.73	2,683.06
XX	Concord				71.01			884.44		955.45
Total		44.23	98.10	518.92	1,637.39	307.48	1,112.57	1,643.70	669.73	6,032.12

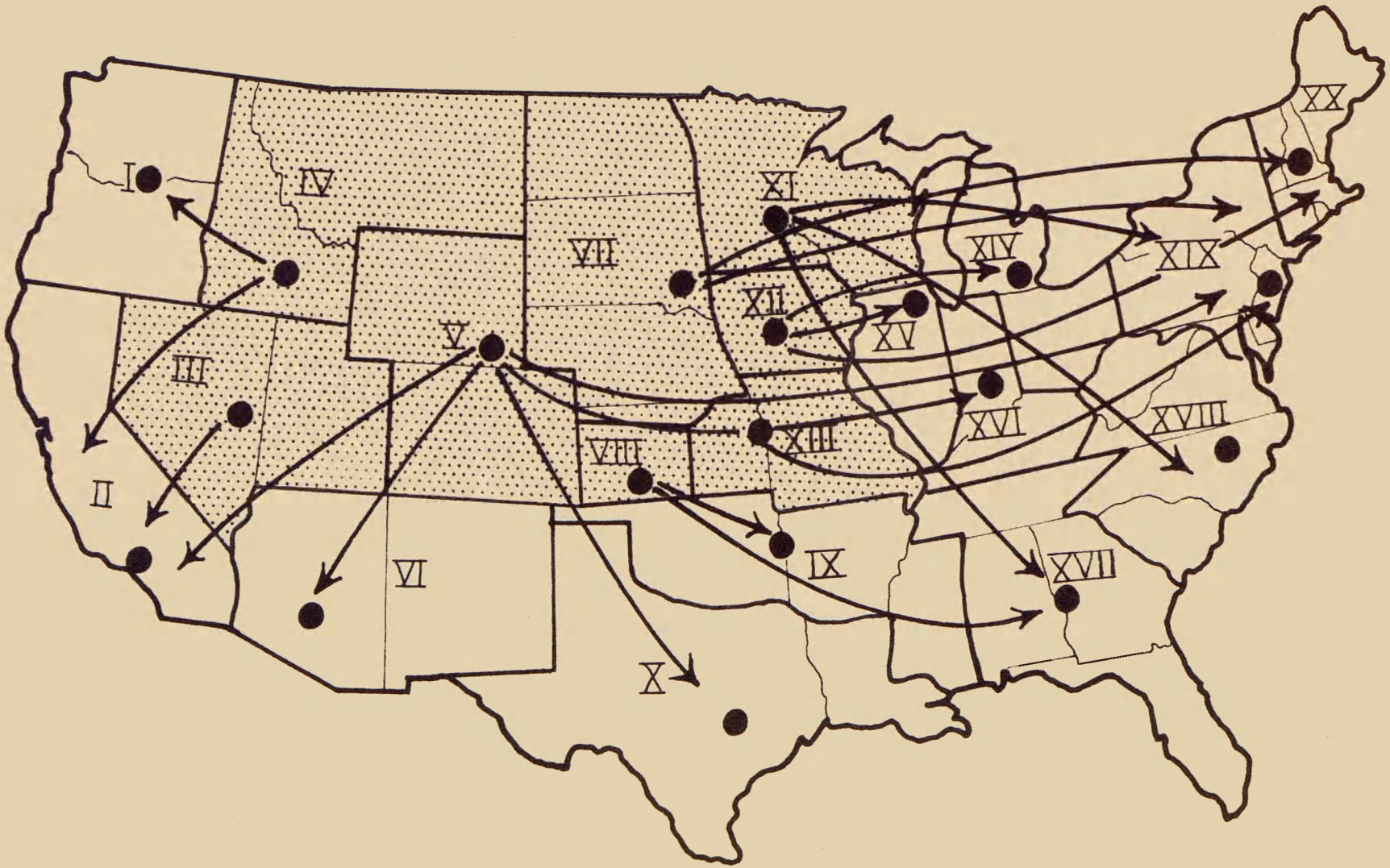

Fig. 8. Equilibrium flow, actual slaughter, 1961 1st projection.

Table 29. Transportation cost of shipping dressed beef from surplus to deficit areas, actual slaughter, 1961 1st projection.

Area	Origin / Destination	Area III	Area IV	Area V Laramie	Area VII Sioux Falls	Area VIII Wichita	Area XI Saint Paul	Area XII Des Moines	Area XIII Kansas City	Total
					(thousand dollars)					
I	Portland		29.0							29.0
II	Los Angeles	1,304.8	1,837.4	3,498.9						6,641.1
VI	Phoenix			1,471.6						1,471.6
IX	Fort Smith									132.8
X	Austin			1,024.1						1,024.1
XIV	Detroit							6,431.0		6,431.0
XV	Chicago							1,378.7		1,378.7
XVI	Indianapolis			2,277.5						2,277.5
XVII	Columbus						4,588.6			9,655.6
XVIII	Raleigh						12,903.3			12,903.3
XIX	Trenton			7,939.9	42,762.2		6,507.1		18,149.7	75,358.9
XX	Concord				1,938.6			22,199.4		24,138.0
Total		1,304.8	1,866.4	16,212.0	44,700.8		23,999.0	30,009.1	18,149.7	141,441.6

Table 30. Coefficients of elasticity for demand variables, by census regions.

	Beef Price	Pork Price	Disposable Income
Northeast[a]	-.80	.20	.290
North Central[b]	-.85	.22	.271
South[c]	-.95	.10	.428
West[d]	-.80	.18	.305

[a]includes area XIX and XX.

[b]includes areas VII, VIII and XI through XVI.

[c]includes areas IX, X, XVII and XVIII.

[d]includes areas I through VI.

The initial step was to establish the per capita consumption of one area in each of the four census bureau regions for a given period. The per capita consumption in each of the four base areas was based on various journal articles read by the author and data taken from the 1955 Household Food Consumption Survey. As an initial step the 1956 estimated per capita consumption in each of the base areas was: Area XX (Northeast) 104 pounds; area VII (North Central), 90 pounds; area IX (South), 63 pounds; and area VI (West), 100 pounds.

Once the base area was determined it then became necessary to find the relative difference in disposable income, pork price and beef price of each area in the census bureau region in relation to the base area.[1] These relative differences times their respective elasticities gave the percentage change in each area relative to the base; i.e., assume:

1) per capita consumption in area VI is 100 pounds,

2) disposable income area I is 21.93% greater than in area VI,

3) pork price in area I is 4.44% higher than in area VI, and

4) beef price in area I is .26% lower than in area VI.

Using the elasticities derived for the West the per capita consumption in area I becomes:

$$\begin{aligned} 100 \times (21.93 \times .305) + 1 &= 106.69 \\ 106.69 \times (.0444 \times .18) + 1 &= 107.54 \\ 107.54 \times (-.0026 \times -.80) + 1 &= \underline{107.74} \end{aligned}$$

This procedure was followed for each of the areas. The estimated area per capita consumption of each area in 1956 was used as a basis from which to

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[1]The disposable income and pork prices estimated for the 1956 analysis were used. The beef prices were those prices obtained in the equilibrium solution for 1956.

derive 1961 per capita consumption.

Using the 1956 area data the same procedure was followed in determining the 1961 per capita consumption. The relative change in disposable income, pork prices and beef prices form 1956-61 was determined for each area. When these percentage changes were multiplied by their respective elasticities it was possible to measure the influence of these variables on the 1961 per capita consumption levels.

When the resulting area per capita consumption data was multiplied by the respective area population the total consumption did not equal the estimated slaughter for 1961. As a result a linear adjustment was made in the total consumption data. The final area consumption figures (Table 31) were divided by the area population (Table 26) to obtain the adjusted area per capita consumption (Table 32).

Under this analysis fourteen areas increased consumption when compared to the previous analysis. In contrast areas IX and X (Fort Smith and Austin) became surplus areas. The greatest change occurred in area X which had been deficit by 39 million pounds in the previous situation and which became surplus by 143.5 million pounds in this analysis. Similarly, area XVII (Columbus) decreased its deficit by 163 million pounds.

In terms of per capita consumption the range was from a high of 113.56 pounds in area II (Los Angeles) to a low of 62.78 in area IX (Fort Smith) (Table 32). This was a wider range among areas than observed in the previous situation. It was also noticeable that the greatest increase in per capita consumption occurred in the West and Northwest while the South and Southeast experienced a general decline. (Tables 26 and 32).

The price differentials derived from the resulting flow pattern were identical with the 1959 actual slaughter situation with the exception that

Table 31. Production, equilibrium consumption of dressed beef by areas, 1961 2nd projection.

Area	Origin or destination	Production	Consumption	Surplus	Deficit
		(million pounds)			
I	Portland	465.77	500.02		34.25
II	Los Angeles	1,585.11	1,844.82		259.71
III	Ely	159.02	130.02	29.00	
IV	Boise	216.65	139.18	77.47	
V	Laramie	722.94	230.41	492.53	
VI	Phoenix	147.25	228.03		80.78
VII	Sioux Falls	1,876.16	281.12	1,595.04	
VIII	Wichita	383.98	83.47	300.51	
IX	Fort Smith	428.73	395.22	33.51	
X	Austin	1,056.92	913.46	143.46	
XI	St. Paul	1,799.83	741.83	1,058.00	
XII	Des Moines	1,894.39	276.01	1,618.38	
XIII	Kansas City	1,200.64	560.58	640.06	
XIV	Detroit	1,242.44	1,812.62		570.18
XV	Chicago	935.36	1,097.19		161.83
XVI	Indianapolis	563.34	736.51		173.17
XVII	Columbus	695.60	1,085.66		390.06
XVIII	Raleigh	336.79	842.28		505.49
XIX	Trenton	1,520.60	4,301.15		2,780.55
XX	Concord	148.48	1,180.42		1,031.94
U.S.		17,380.00	17,380.00	5,987.96	5,987.96

Table 32. Per capita consumption and price differential by area, actual slaughter, 1961 2nd projection.

Area	Origin or destination	Per capita consumption	Price Differential
		Pounds	Cents per pound
I	Portland	106.12	1.17
II	Los Angeles	113.75	1.88
III	Ely	107.45	-1.07
IV	Boise	102.04	- .04
V	Laramie	108.43	-1.12
VI	Phoenix	97.78	1.66
VII	Sioux Falls	98.36	- .22
VIII	Wichita	99.61	- .33
IX	Fort Smith	62.78	- .46
X	Austin	69.85	- .91
XI	St. Paul	99.15	- .35
XII	Des Moines	99.39	-----
XIII	Kansas City	100.77	- .20
XIV	Detroit	101.72	1.19
XV	Chicago	107.06	.63
XVI	Indianapolis	94.52	1.16
XVII	Columbus	67.51	1.37
XVIII	Raleigh	65.46	1.70
XIX	Trenton	110.74	2.51
XX	Concord	111.29	2.51

area I (Portland) was deficit (Table 32).[1] Similarily there were no changes in the flow pattern, although the amount shipped over each route did change (Figure 9 and Table 33). The total quantity shipped, 5,987.96 million pounds, was slightly less than found in the previous analysis (Table 33). However, it was still relatively larger than in 1959. It is important to note that area V (Laramie), which is the connecting link between the East and West, had been shipping large quantities to area XIX (Trenton). However, in this analysis area V was found to ship only a moderate amount to area XIX. This may indicate a declining surplus in the far West States.

Although the total quantity shipped was less in this analysis than under the previous assumption, the total transportation cost was higher. The total cost of $142,869.300 amounted to 2.39 cents per pound shipped (Table 34). This increase can be attributed to the increased amount of shipment occuring in the West where the rates are generally higher as well as the higher cost of shipments to area XX (Concord).

Actual Slaughter - 1975, Projection

It is extremely difficult to make projections into the distant future because of the number of variables or factors which enter into production, distribution and consumption of beef.

This illustrative projection was solved to determine what the competitive position of western Kansas would be should the present trends in the location of slaughter, the growth and shift of population and the increase in per capita income continue into the 1970's.

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[1]No attempt was made to determine equilibrium beef prices as they would tend to equal those in the previous situation.

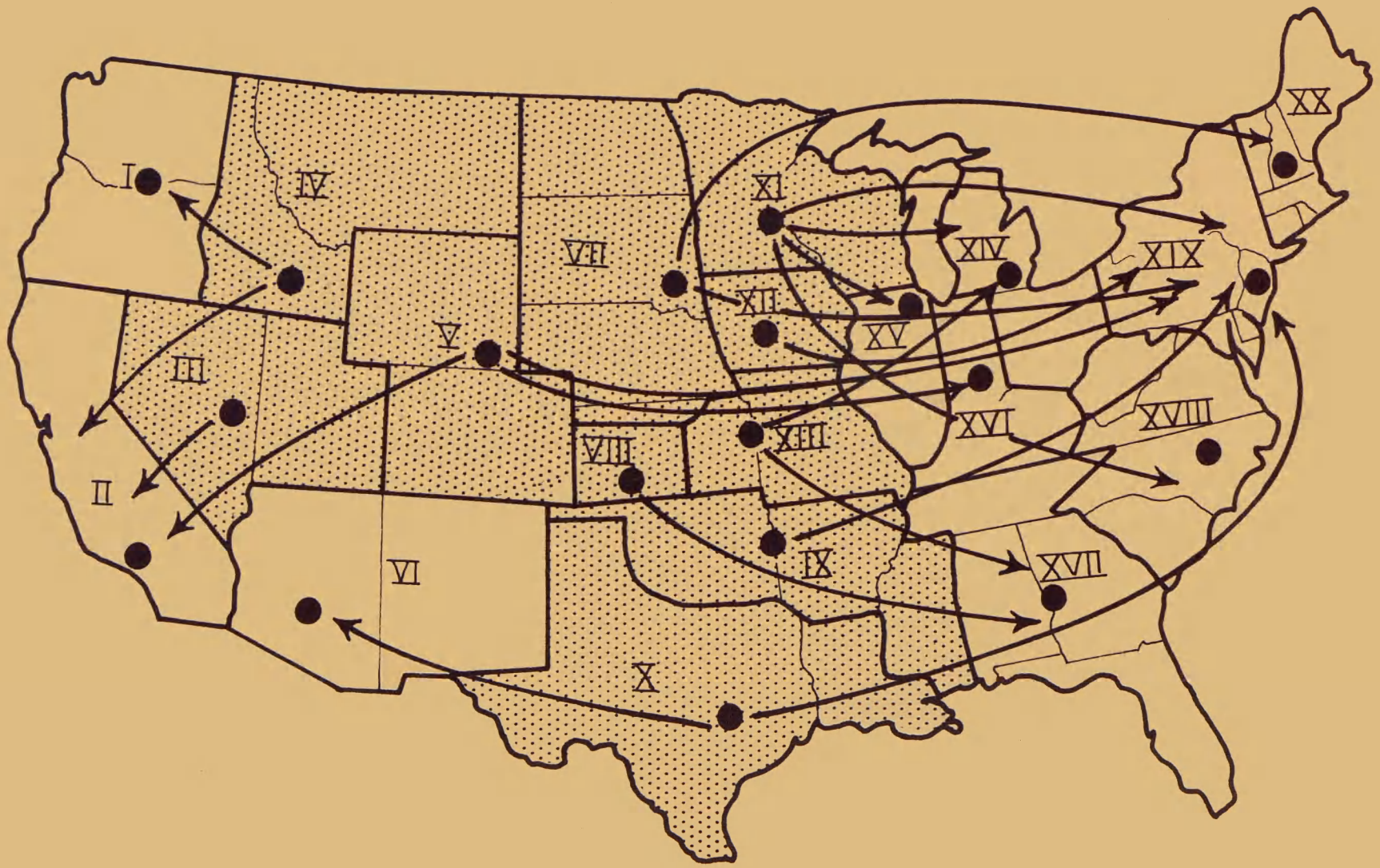

Fig. 9. Equilibrium flow, actual slaughter, 1961 2nd projection.

Table 33. Equilibrium trade patterns of dressed beef by area, 1961
2nd projection.

Area	Origin ~~or~~ → / destination ↓	Area III Ely	Area IV Boise	Area V Laramie	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area X Austin	Area XI Saint Paul	Area XII Des Moines	Area XIII Kansas City	Total
						(million pounds)						
I	Portland		34.25									34.25
II	Los Angeles	29.00	43.22	187.49								259.71
VI	Phoenix							80.78				80.78
XIV	Detroit								19.67		550.51	570.18
XV	Chicago								161.83			161.83
XVI	Indianapolis			173.17								173.17
XVII	Columbus					300.51					89.55	390.06
XVIII	Raleigh								505.49			505.49
XIX	Trenton			131.87	563.10			62.68	371.01	1,618.38		2,780.55
XX	Concord				1,031.94							1,031.94
Total		29.00	77.47	492.43	1,595.04	300.51		143.46	1,058.00	1,618.38	640.06	5,987.96

Table 34. Transportation cost of shipping dressed beef from surplus to deficit areas, actual slaughter, 1961 2nd projection.

Area	Origin / Destination	Area III Ely	Area IV Boise	Area V Laramie	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area X Austin	Area XI Saint Paul	Area XII Des Moines	Area VIII Kansas City	Total
						(thousand dollars)						
I	Portland		414.4									414.4
II	Los Angeles	855.5	829.8	5,624.7								7,310.0
VI	Phoenix							2,076.0				2,076.0
XIV	Detroit								302.9		7,652.1	7,955.0
XV	Chicago								1,585.9			1,585.9
XVI	Indianapolis			3,948.3								3,948.3
XVII	Columbus					5,108.7					1,405.9	6,514.6
XVIII	Raleigh								10,362.5			10,362.5
XIX	Trenton			4,786.9	15,372.6		995.2	2,143.7	10,610.9	40,621.3		74,530.6
XX	Concord				28,172.0							28,172.0
Total		855.5	1,244.2	14,359.9	43,544.6	5,108.7	995.2	4,219.7	22,862.2	40,621.3	9,058.0	142,869.3

Table 35. Input data - spatial equilibrium, actual slaughter, 1975 projection.

Area	Origin or destination	Pork price	Disposable income	Population	Price differential	Production
		Cents/Pound	Dollars	Thousand	Cents/pound	Million pounds
I	Portland	62.17	2,882	6,277	.90	780.24
II	Los Angeles	63.20	3,386	30,636	2.84	2,559.60
III	Ely	61.80	2,662	2,582	- .13	319.90
IV	Boise	56.54	2,454	1,735	.90	460.63
V	Laramie	56.33	2,736	3,558	- .18	1,441.34
VI	Phoenix	56.98	2,361	4,922	2.49	297.37
VII	Sioux Falls	55.19	2,342	3,280	- .22	3,707.39
VIII	Wichita	53.68	2,618	958	- .25	986.83
IX	Fort Smith	54.11	1,911	5,344	- .04	701.14
X	Austin	57.64	2,387	18,759	1.54	1,479.45
XI	St. Paul	54.60	2,628	9,372	- .35	3,154.56
XII	Des Moines	57.43	2,565	3,095	-----	3,849.63
XIII	Kansas City	53.85	2,761	6,148	- .20	1,886.21
XIV	Detroit	56.65	2,943	25,007	1.19	1,894.72
XV	Chicago	56.85	3,358	12,464	.63	835.51
XVI	Indianapolis	53.65	2,449	9,400	1.23	958.82
XVII	Columbus	55.33	2,189	26,282	1.45	1,140.31
XVIII	Raleigh	56.43	2,101	15,920	1.70	615.44
XIX	Trenton	59.15	3,249	50,334	2.51	2,334.11
XX	Concord	62.38	3,078	10,802	2.51	136.80
U.S.		-----	-----	246,875	----	29,540.00

Population by states was assumed to increase at the same rate of increase shown between 1950 and 1956. The state projections were summed for regional projections. As this procedure yield a total population well above census projections for 1975 a linear adjustment of .884552 was used to reduce the 1975 U. S. estimated population to 246,875,000 (Table 35).[1]

In order to project disposable income a simple linear regression equation based on the U. S. average disposable income from 1948-59 was used. The resulting equation yielded a projected average U. S. per capita income of $2,761.[2] This was an increase of 46 percent over the 1959 figure of $1,891. Assuming that each region would increase at this rate disposable income in each area was increased by 46 percent (Table 35).

The retail price of beef approximated that price derived in the 1959 actual slaughter situation discussed above. Pork prices were assumed to remain at their 1959 level (Table 35).

The 1975 estimated average U. S. per capita disposable income along with the 1959 beef and pork prices were used in the estimating equation to estimate the per capita consumption of beef in 1975.

$$Y = 63.1944 - .886582\ (79.98) + .181767\ (57.10) + .042402\ (\$2,761)$$

The resulting equation yielded a per capita consumption of 119.656 pounds. This was an increase of 36.65 pounds or 44.16 percent over the 1959 level of consumption. As both beef and pork prices were held constant at the 1959 level this increase was attributed solely to the increase in per capita disposable income.

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[1] Kelley, loc. cit.

[2] Ibid.

Using the estimated per capita consumption of 119.656 pounds and the estimated U. S. population of 246,875,000, total consumption was estimated at 29,540,000,000 pounds. This was an increase of 102.01 percent over the 1959 production, but only 83.55 percent larger than the record production in 1956.

Using 1959 as the benchmark from which this increase was distributed among the areas it was assumed that the increase in actual slaughter would continue among the areas in proportion to that share of the increase which they contributed during 1952-1959, inclusively, except western Kansas (Area VIII). This area was assumed to increase slaughter production at a rate depending on the amount of milo grown and fed in that area.

For this projection it was assumed that western Kansas would produce 180,000,000 bushels of milo. This was based on an estimated acreage of 3.6 million acres and an average yield of 50 bushels per acre.[1] This represents an increase of approximately 97.4 million bushels above the 1960 estimated production.

Of this 180,000,000 bushels, one-half was assumed to be fed to beef. In a previous study at Kansas State University it was assumed that 90 million bushels were fed to hogs.[1] From the records of past marketings of fed cattle (the largest consumers of milo) it was estimated that no more than 20 million bushels of milo were currently being fed to cattle. Thus, the remaining 70 million bushels were assumed available to be fed in western Kansas. At the rate of 13.5 bushels per hundred pounds of grain this would result in the production of 518,519,000 pounds. Furthermore, it was assumed that this weight was put on 650 pound stockers and

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[1] Ibid.

feeders at the average amount of 350 pounds per animal. This would increase the number of cattle fed by 1,481,483 head. If these animals were sold at an average weight of 1,000 pounds and slaughtered in western Kansas, slaughter production would increase 1,481,483,000 pounds live weight. Converted to dressed weight this would be an increase of 814.82 million pounds. Added to the 1959 actual slaughter of 172.01 million pounds this would mean a potential slaughter in western Kansas of 986.83 million pounds by 1975.

Assuming a potential demand in 1975 of 29,540 million pounds, representing an increase of 14,916 million pounds above 1959, the potential increase of slaughter in western Kansas was subtracted from this increase and the remainder was distributed among the 19 areas in relation to their proportion of the 1952-59 increase. After deducting the western Kansas potential increase in slaughter (814.82 million pounds) from the 14,916 million pounds, this left 14,101.18 million pounds to be distributed. The estimated area slaughter for 1975 is shown in Table 35.

The values for the predetermined variables listed in Table 35 along with the estimating equation were used in the IBM 650 computer to obtain the equilibrium base price. The most significant changes occurring in the 1975 equilibrium beef price as compared with the 1959 situation was the relatively higher prices occurring in the West. The highest retail prices shifted from the Northeast in 1959 to the South and Southwest. Similarly, the lowest price areas shifted from the West to the Great Plains areas (Table 24 and 36). This was due to the larger portion of the shipments moving to the West. The connecting link between the two general flow patterns moved from area V (Laramie) to area VIII (Wichita). Area V shipped all of its surplus to area II (Los Angeles) while area VIII which

had been shipping to the Southeast shipped first to the South and West (areas II, VI and X). After filling these areas the remainder of its surplus was shipped to area XVII (Columbus) (Table 37 and Figure 10).

As a result the price in area VIII was the lowest of any area except area XI (St. Paul). The retail prices in the surplus Corn Belt areas west of area VIII ranged from .25 cents per pound above the retail price in area VIII, to .10 cents below (Table 36). The per capita consumption ranged from a high of 143.68 pounds in area II to 82.03 pounds in area IX (Fort Smith) (Table 36). Although this represented a wider variation in per capita consumption than in 1959, due to greater influence of the linear adjustment for disposable income among the more prosperous area, there were no marked variations among the individual areas compared to 1959. Of more significance was the change in the magnitude of the surplus and deficits due to varying increases in area consumption and slaughter production. The only changes in the classification of areas from 1959 to 1975 was the shift of area I from a self-sufficient area to a minor surplus area and the shift of area X (Austin) to a surplus area. The case of area II showing an increase in its deficit from approximately 100 million pounds in 1959 to over 1,840 million pounds in 1975 presents a striking example of population outstripping the supply of beef (Tables 21 and 38). Recent reports from the California Agricultural Experiment Station indicate that the expansion of beef production up to 1975 in California is very limited.[1] Only a slight increase is expected in number of cattle and proportion fed in feedlots. Similarly the Northeast is shown to almost double its demand for in-shipments of beef. Meanwhile, if the present trends in slaughter production continues the major increases in

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[1]Dean, Gerald W. and Chester O. McCarkle, Jr., "Projections Relating to California Agriculture in 1975, "California Agricultural Experiment Station Mimeographed Report 234, July, 1960.

Table 36. Per capita consumption, equilibrium beef price and price differential by area, actual slaughter, 1975 projection.

Area	Origin : Destination	Per capita consumption	Equilibrium beef prices	Price differential
		Pounds	Cents per pound	Cents per pound
I	Portland	123.84	82.18	.90
II	Los Angeles	143.68	84.12	2.84
III	Ely	115.36	81.15	-.13
IV	Boise	104.67	82.18	.90
V	Laramie	117.54	81.10	-.18
VI	Phoenix	98.72	84.53	3.25
VII	Sioux Falls	100.67	81.06	-.22
VIII	Wichita	112.12	81.03	-.25
IX	Fort Smith	82.03	81.24	-.04
X	Austin	101.46	82.82	1.54
XI	St. Paul	112.80	80.93	-.35
XII	Des Moines	110.33	81.28	----
XIII	Kansas City	118.17	81.08	-.20
XIV	Detroit	125.16	82.47	1.19
XV	Chicago	143.30	81.91	.63
XVI	Indianapolis	103.64	82.51	1.23
XVII	Columbus	92.72	82.73	1.40
XVIII	Raleigh	88.97	82.98	1.70
XIX	Trenton	137.42	83.79	2.51
XX	Concord	130.76	83.79	2.51

Table 37. Equilibrium trade pattern of dressed beef by area, actual slaughter, 1975 projection.

Area	Origin / Destination	Area I Portland	Area III Ely	Area IV Boise	Area V Laramie	Area VII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area XI Saint Paul	Area XII Des Moines	Area XIII Kansas City	Total
						(million pounds)						
II	Los Angeles	2.91	22.05	279.03	1,023.12		514.94					1,842.05
VI	Phoenix						188.53					188.53
X	Austin						161.06	262.75				423.81
XIV	Detroit									1,235.26		1,235.26
XV	Chicago									950.53		950.53
XVI	Indianapolis					15.37						15.37
XVII	Columbus						14.89		1,281.73			1,296.62
XVIII	Raleigh								800.95			800.95
XIX	Trenton					2,086.17			14.72	1,322.36	1,159.70	4,582.95
XX	Concord					1,275.67						1,275.67
Total		2.91	22.05	279.03	1,023.12	3,377.21	879.42	262.75	2,097.40	3,508.15	1,159.70	12,611.74

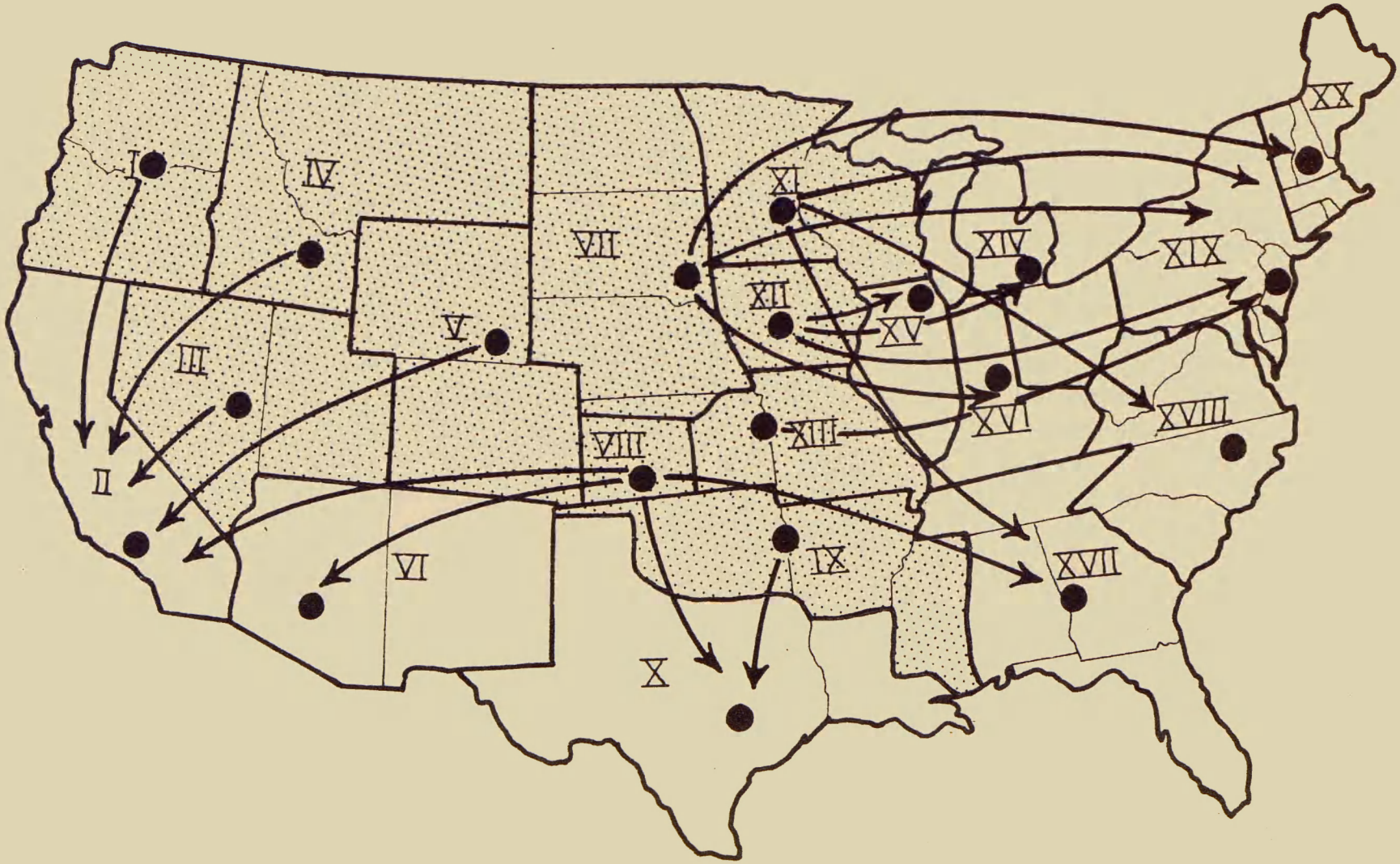

Fig. 10. Equilibrium flow, actual slaughter, 1975 projection.

Table 38. Production and equilibrium consumption of dressed beef by area, actual slaughter, 1975 projection.

Area	Origin or destination	Production	Consumption	Surplus	Deficit
		(million pounds)			
I	Portland	780.24	777.33	2.91	
II	Los Angeles	2,559.60	4,401.65		1,842.05
III	Ely	319.90	297.85	22.05	
IV	Boise	460.63	181.60	279.03	
V	Laramie	1,441.34	418.22	1,023.12	
VI	Phoenix	297.37	485.90		188.53
VII	Sioux Falls	3,707.39	330.18	3,377.21	
VIII	Wichita	986.83	107.41	879.42	
IX	Fort Smith	701.14	438.39	262.75	
X	Austin	1,479.45	1,903.26		423.81
XI	St. Paul	3,154.56	1,057.16	2,097.40	
XII	Des Moines	3,849.63	341.48	3,508.15	
XIII	Kansas City	1,886.21	726.51	1,159.70	
XIV	Detroit	1,894.72	3,129.98		1,235.26
XV	Chicago	835.51	1,786.04		950.53
XVI	Indianapolis	958.82	974.19		15.37
XVII	Columbus	1,140.31	2,436.93		1,296.62
XVIII	Raleigh	615.44	1,416.39		800.95
XIX	Trenton	2,334.11	6,917.06		4,582.95
XX	Concord	136.80	1,412.47		1,275.67
U.S.		29,540.00	29,540.00	12,611.74	12,611.74

slaughter production will occur in the Corn Belt to the north and west of area VIII.

The total U. S. shipments amounted to 12,611.74 million pounds. This amounted to 42.69 percent of the total production. This was more than 10.5 percent greater than the 32.03 percent moved in the 1959 situation. However, the relative portion going to the four coastal areas declined from 85 percent in 1959 to 63 percent in 1975. The total transportation cost of the 1975 shipments was $288,596,000 (Table 39). In terms of cost per pound this amounted to 2.37 cents per pound or slightly more than .1 cents per pound less than in 1959. Thus, relative to 1959 a larger portion was shipped in 1975 but at a lower cost per pound.

Table 39. Transportation cost of shipping dressed beef from surplus to deficit areas, actual slaughter, 1975 projection.

Area	Origin / Destination	Area I Portland	Area III Ely	Area IV Boise	Area V Laramie	Area VIII Sioux Falls	Area VIII Wichita	Area IX Fort Smith	Area XI Saint Paul	Area XII Des Moines	Area XIII Kansas City	Total
						(thousand dollars)						
II	Los Angeles	558.7	6,504.8	5,357.4	30,693.6		15,808.7					58,923.2
VI	Phoenix						5,165.7					5,165.7
X	Austin						2,883.0	4,151.4				7,034.4
XIV	Detroit									14,699.6		14,699.6
XV	Chicago									5,988.3		5,988.3
XVI	Indianapolis					222.9						222.9
XVII	Columbus						253.1		23,071.1			23,324.2
XVIII	Raleigh								16,419.5			16,419.5
XIX	Trenton					56,952.4			421.0	33,191.2	31,427.9	121,992.5
XX	Concord					34,825.8						34,825.8
Total		558.7	6,504.8	5,357.4	30,693.6	92,001.1	24,110.5	4,151.4	39,911.6	53,879.1	31,427.9	288,596.1

SUMMARY AND CONCLUSIONS

The present surplus of feed grains and the potential increase in feed grain production, especially grain sorghum, in Kansas has raised considerable interest concerning the potential development of livestock production in this area. This study was undertaken to determine the competitive position of Kansas in marketing beef and also to compare the results of this study with a previous study related to the marketing of hogs.

A linear programming analysis applicable to developing a spatial price equilibrium model was employed in this study. In this procedure the supply was predetermined and the surplus or deficit in a given area was the difference between the predetermined supply and the demand as determined by the estimating equation. The derived estimating equation was $Y = 63.194 - .886582X_1 + .181767X_2 + .042402X_3$ where:

Y = per capita consumption of beef in pounds

X_1 = retail price of beef in cents per pound

X_2 = retail price of pork in cents per pound

X_3 = per capita disposable income.

Having determined the surplus or deficit amounts in each area the second phase of the analysis became one of transporting the surplus quantities of beef to the deficit areas such that the total transportation bill was minimized. This was done through the use of linear programming applied to the transportation model.

In order to determine the movement of beef during various phases of the cattle cycle a series of analyses were run for 1956, 1958, 1959 where beef supplies were defined as area farm production available for slaughter.

The optimum flow pattern of beef shipments during the cycle revealed two separate market structures with only minor changes from year to year occurring within these two broad structures. The western mountain states formed the geographical break between the two structures. The vast majority of shipments were predominately from the Great Plains and Corn Belt states into the Atlantic coastal areas. This pattern of shipment points out the heavy concentration of production in the central United States while the major deficit areas have been in the far eastern portion of the nation. However, in the more recent years it was noted that the western marketing structure tended to include a greater volume of the shipments, especially to California. This points out the present tendency of population growth to outstrip the increase in beef production in the West.

Kansas was located on the Western fringe of the Eastern marketing structure and found its greatest competitive advantage in shipping to the East and Southeast.

Of prime importance to the producer and packer is the price that prevails in Kansas relative to other surplus areas. In terms of a composite retail price for all cuts of beef the spatial price surface tended to increase progressively from the western surplus areas to the eastern deficit areas in 1956. As the amount of shipments increased in the West this price surface did not remain so clearly defined. This change in the price surface did not materially affect the retail price, and therefore the farm price (assuming a perfectly competitive model) in western Kansas as this area continued to ship to the deficit East and Southeast areas. The retail price of beef in western Kansas

tended to be no more than .33 cents per pound below that in other surplus Corn Belt Areas. As farm prices are more elastic than retail prices the relative drop in farm prices may be greater but the absolute difference in farm prices among these areas will tend to be less than the difference in retail prices.

For 1959 an analysis was made using actual slaughter data by area rather than farm production available for slaughter by area. Although notable differences did occur between the location of production available for slaughter and location of actual slaughter in 1959, the general nature of the flow pattern remained unchanged as did the price surface. California and the Northeast were found to slaughter more than was available for slaughter from farm production in their respective areas. This indicates that inshipments of live cattle occurred tending to make slaughter production more market orientated. The fact that Arizona and New Mexico changed from a surplus producing area to a deficit slaughtering area may indicate some inefficiencies in the marketing of beef due to the resulting demand for inshipments of dressed beef.

Of considerable interest to the Kansas farmer and meat packer is the potential development of markets for Kansas beef. In view of this, several illustrative projections were made.

For the immediate future (1961) it was assumed that western Kansas would feed one half of its excess supply of grain sorghum to cattle. Under the assumed conditions this resulted in a doubling of the slaughter in western Kansas. The remainder of the expected increase in slaughter production from 1959 to 1961 was distributed among the other areas in proportion to their rate of increase from 1952-59. Population, likewise,

was projected on past trends. Under these assumed conditions the flow pattern showed no marked change. Western Kansas still found its strongest market in the Southeast.

A second projection with 1961 data was made employing variable elasticities in the estimating equation. This was done to account, in part, for the variation in consumers preference among areas. The results of this analysis indicated a greater per capita demand in the West and Northwest and a lower demand in the South than in the prior analysis. Again this alternative analysis did not materially affect the shipping pattern. However, it would seem advisable to give more consideration to the nature of consumer's preference and habits not only in terms of elasticity, but also in terms of preference for various cuts of beef.

Based on the assumption of the continuation of present trends in the growth and migration of population location of slaughter, and increase in disposable income a projection was made into 1975. Under these assumptions the demand more than doubled from 1959 to 1975.

Increased production in western Kansas was based on the feeding of one-half of an expected grain sorghum crop of 180 million bushels to feeder cattle by 1975. Production increases in the other areas were based on their rate of increase from 1952-59 and area population was estimated from data based on the 1950-56 trend. Under these assumption western Kansas became the connecting link between the two marketing structures. As a result it filled the residual demands in the West and Southwest and shipped only a small amount to the Southeast. Being situated on the fringe areas of both marketing structures, western Kansas enjoyed no strong competitive advantage in terms of freight rate advantages.

The resulting shift in the location of slaughter relative to population growth from 1959 to 1975 pointed out several factors pertinent to the western Kansas producers and packers. First, the portion of slaughter production shipped interregionally increased from 32 percent in 1959 to over 42.6 percent in 1975. This indicates an inherent tendency for the market in terms of population shifts, to be moving away from the present areas of large slaughter production. Thus, if the economies associated with market orientated slaughter continue this would seem to indicate the possibility of a shift in the location of slaughter production. The most favorable shift in the location of slaughter plants would be toward the West. Second, the relative portion of the shipments moving to the Atlantic coastal areas decreased from 85 percent in 1959 to only 63 percent in 1975. This indicates that at present rates of growth slaughter production in other areas is not keeping pace with their population growth. This was found to be especially true of the western United States. As this market demand develops in the West there will be increasing pressure for expanding beef production in the Mountain and Western States. However, a recent report from the University of California indicates that any expansion of beef production in California is extremely limited. To the extent that surrounding areas are unable to meet this growing demand and to the extent that Kansas farmers can continue to maintain their low-cost production position it appears that the market for Kansas beef in the West is favorable more so than for the more distant Corn Belt areas. Third, it was found that in 1975 the retail price in western Kansas was the lowest of any other area except the area including Minnesota and Wisconsin. Although the price in western Kansas did not fall more relative to other Corn Belt feeding areas, the increased demand in the West raised the price in these surplus areas above

the price in western Kansas. However, the highest retail price in the surplus Corn Belt areas, Iowa, was only .25 cents per pound above the price in western Kansas. In terms of farm prices it would appear that Iowa farmers would enjoy a slight advantage over Kansas farmers.

Under the purely competitive assumptions of this spatial equilibrium analysis it must be concluded that western Kansas farmers do not enjoy a competitive advantage in marketing beef in terms of its geographical location relative to the location of the market. The advantages of Western Kansas farmers in expanding beef production are to be found in low-cost production made available by an available supply of feed grain and a localized stocker-feeder market.

The results of this study are in contrast to an early study concerning the competitive position of western Kansas in marketing hogs. Conclusions from that study indicate that from a competitive standpoint western Kansas hog producers could expect prices as high or higher than producers in other surplus producing areas except the eastern Corn Belt. The advantage emphasized in that case was the strategic geographical location of western Kansas hog producers in fulfilling at least in part the growing demand in the West and Southwest.

The findings from this study suggests areas in which further research may be extended. In regards to estimating demand for beef it was felt that more consideration should be given to developing area consumption estimates. Consumer's preferences tend to vary from area to area not only in terms of elasticity of the demand variables, but also in terms of preference for various cuts of beef. Also the influence of time on consumers' tastes may warrant further study. The supply side of the market involves another area

of study. Additional analysis and research regarding the potiential expansion of beef production and slaughter in each of the areas, including western Kansas, would be extremely worthwhile. Consideration should be given to future availability of feed grains, stocker-feeder animals, management, and market location. The use of truck transportation would warrant further spatial analysis based on truck rates both for live animals and dressed beef.

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APPENDICES

APPENDIX I

Production Costs

There are numerous alternative methods applied to accomplish the one purpose of producing beef. Recognizing the various cattle programs which are adaptable to Kansas it becomes important to compare the cost position of Kansas producers with that of producers in other major beef producing areas and the value of a beef enterprise in furnishing a market for grain and roughage. The return from any given livestock enterprise is accounted for by two primary factors: (1) the price spread between the purchase price and the sale price of the animal, and (2) the feed cost per pound of grain.

Kansas is located in an intermediate position between the stocker feeder areas concentrated to the South and West and the feeding area concentrated in the Corn Belt. As a result Kansas is located favorably for either purchasing stockers to be fed in Kansas or producing stockers that might be shipped to other areas. The potential for increased production of grain sorghum and forage products as well as native and wheat pasture is advantageious to lower feed costs.

The complex nature of the cattle feeding business makes accurate comparison extremely difficult. However, feeder cattle guides available from various states provide a measure for comparison. These guides are similar in that they are based on farm management records of feeding programs that appear to be fairly uniform from state to state. These guides are not directly comparable, however, as different measures of costs are included in compiling the records. Some of the more important

differences will be noted as the data are presented. Table 40 provides a summary of data collected in Kansas, Illinois and Minnesota for a deferred or full feeding program. Data are presented for the 1957-58 feeding year and an average for the five year period, 1954-58, except Minnesota which includes a four year average, 1955-1958.

Although these guides must be interpreted with caution as a measure of comparison of costs of production they tend to substantiate the statement that Kansas is in a competitive position to produce beef on the basis of price margins and returns above feed costs. By far, the most important of these two factors have been return from feeding (feeding margin). With feeding costs representing approximately 80 percent of the total costs of production it is important that cheap efficient grains be made during the feeding program. Recent cattle feeding investigations conducted at the various Kansas Agricultural Experiment Stations show that rolled or finely pelleted grain sorghum is an economical substitute for other grains when silage or roughage is available to supplement the ration.[1] Historical data for various other cattle programs was not available so as to lend itself to adequate comparison. However, cost guide estimates compiled in various states for estimating costs and returns from cow herd, stocker, and yearling programs reveal the importance of an abundance of low cost feed. Besides those above mentioned costs, other factors tend to affect the position of Kansas producers. These include such factors as climate, willingness of the farmer to be "tied down" to the daily attention required of a livestock

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[1]Forty-seventh Annual Livestock Feeders' Day, Manhattan, Kansas, Kansas Ag. Exp. Station Circular 378, May 7, 1960.
Forty-sixth Round Up Report, Hays, Kansas, Fort Hays Branch, Kansas Ag. Exp. Station Circular 363, April 24, 1959.

Table 40. Comparison of costs and returns for a full feeding program in Kansas, Illinois and Minnesota.[1]

	Steers				Steers Heifers				Heifers	
	Kansas[2]		Illinois[3]		Minnesota		Kansas[2]		Illinois[3]	
	1958	1954-1958	1958	1954-1958	1958	1955-1958	1958	1958	1958	1954-1958
Purchase weight	541	505	429	425	398	404	405	396	417	403
Gain per animal	543	545	626	599	568	547	431	386	448	447
Feed costs per cwt. grain[5]	$14.85	$17.39	$16.94	$17.51	$13.93	$16.00	$16.30	$19.22	$17.83	$18.44
Purchase cost/cwt.[6]	23.91	20.18	26.34	22.71	24.51	20.34	[8]	[8]	23.65	19.54
Sale price/cwt.[6]	24.96	22.53	25.81	23.86	24.97	22.29	23.00	24.10	24.99	22.10
Average return/head[7]	64.26	44.84	51.88	41.90	65.49	42.99	38.34	33.13	35.54	26.06
Price spread/cwt.	1.05	2.35	- .53	1.15	.46	2.05	[8]	[8]	1.34	2.56
Feeding margin/cwt.	10.11	5.14	8.87	6.35	11.04	6.29	6.70	4.88	7.16	3.66

1. All figures are based on reports compiled from farm management records.
2. Thomas, Wilton B., Profit Factors in Marketing Management of Kansas Deferred Fed Steers and Heifers, Unpublished Master's Thesis, Manhattan, Kansas, Kansas State University, 1960.
3. Muello, A. G., "Feeder Cattle Guide for 1959-60," Department of Agricultural Economics, University of Illinois, Urbana, Illinois, A. E. 3463, August, 1959.
4. Erickson, D. E., et. al., "Feeder Cattle Costs and Returns, 1957-58," Department of Agricultural Economics, University of Minnesota, August, 1959.
5. For Kansas and Minnesota home grown hay and silage was valued at Market Prices, the value placed on home grown feed for Illinois was not stated.
6. For Illinois purchase and sale prices are net on the farm, i. e., delivery charges are included in purchase cost and transportation and commission are deducted from sales.
7. Average return per head in Kansas is the return above all costs and is essentially labor income. For Illinois and Minnesota average return includes returns above feed costs only.
8. Not available.

enterprise, management ability and marketing costs. A livestock program properly fitted to the crop program will utilize land, labor and capital more fully. An off-crop season livestock program can draw upon labor and other resources during the slack period. Fixed costs may be spread over more units of production. These factors must be viewed as favoring a livestock enterprise as an alternative market for feed grains.

APPENDIX II

Estimating Equation

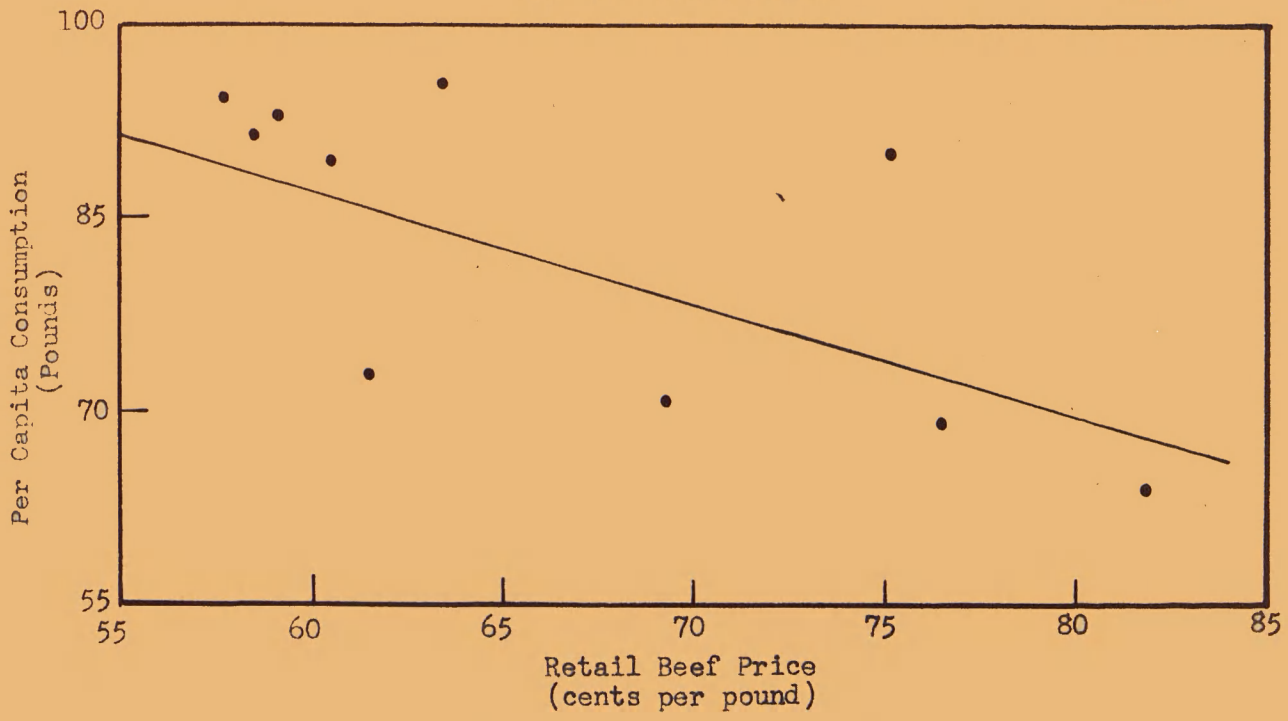
Since the early 1920's statisticians have measured the quantitative effect of price and income upon consumption of food. The general nature of these results can be shown either by diagram or numerical equation. A line estimating the consumption of a product with changes in its retail price where all other variables have been held constant at the average of the period is called a demand curve. Such a line relating beef consumption to retail prices for 1949-58 is shown in Figure 11a.

A curve relating disposable income to variations in beef consumption not already accounted for by the demand curve is shown in Figure 11b. This curve is often called an Engel's curve. Based on Engel's Law, this curve measures the relationship between disposable income and the consumption of beef.

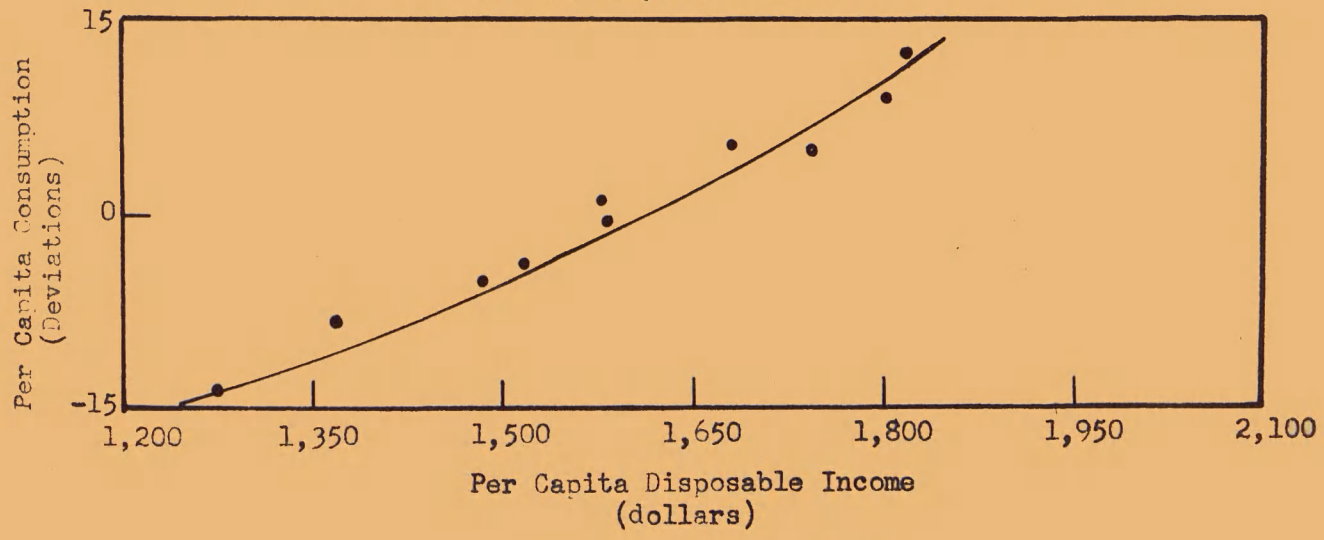
For the purposes of this study an estimating equation was computed. This equation neglects the curvature in the Engel's function which Figure 11b shows to be negative and assumes linear relations throughout. Beef consumption becomes related to beef prices, pork prices and disposable income. As will be noted later, pork prices had little effect on consumption. A comparison of the actual per capita consumption of beef from 1949 through 1959 with the estimates derived from this equation is shown in Figure 11c.

Although the time period from which this equation was derived was shorter than the periods used by numerous other authors, it was felt that the ten most recent years were highly indicative of the influence which these factors had on the demand for beef at the retail level and would yield adequate data for "illustrative projection" purposes. Time frequently is

a. To Retail Price



b. To disposable income



c. To actual consumption

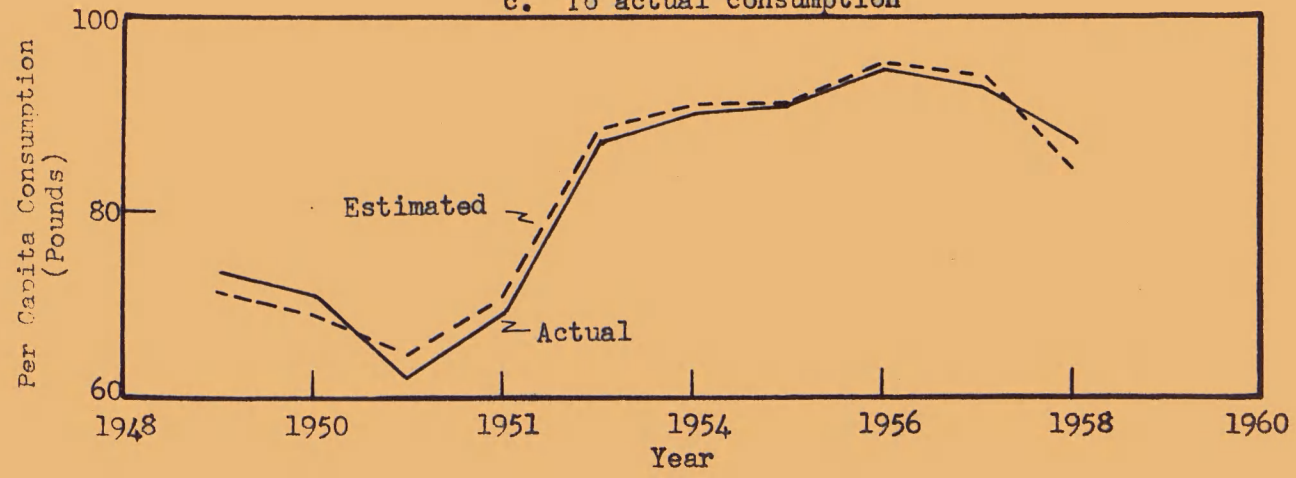


Fig. 11. Estimated beef consumption related to retail price, disposable income, and actual consumption.

introduced as a variable into the analysis as a measure of variation for which no data are available. However, time was omitted as a variable in this study due to the fact that prior studies have found the partial regression coefficient not to differ significantly from zero. When the unexplained residual from this analysis was plotted against time there appeared a random pattern of variation. On the basis of this analysis ommission was justified because any projection of this variable is an extrapolation beyond the range of experience reflected in the estimating equation. In part the impact of time, as reflected in consumer tastes and dietary habits and institutional changes, is reflected in the coefficients in the estimating equation. Thus the impact of change in disposable income will be biased to the extent that it reflects the unobserved change in demand.

The investigations made and conclusions drawn by Henry Schultz in his book, "The Theory and Measurement of Demand," provided the basis upon which much of the analysis in this section was based. In investigating the interrelated demand of beef (including veal) and pork, Schultz selected per capita consumption as the dependent variable because consumption data was generally less accurately known than price or income data. The independent variables included were beef price, pork price and disposable income. These were the same variables used by this author, although Schultz used deflated values. During the period considered (1922-33) he found time to be of no significance and did not include it among the independent variables.

The first check that was made of the regression equation was to determine whether the signs and magnitudes of the coefficients were consistent with expectations. It is a <u>priori</u> knowledge that the price-quantity coefficient should be negative. Previous information suggests that income

and competing goods coefficients should be positive. The signs obtained for these coefficients were consistant with those found by H. Schultz, J. A. Nordin, K. A. Fox and Elmer J. Working for similar analyses of earlier time periods.[1]

This was followed by an analysis of the various elasticities using the formula $bi \cdot \frac{xi}{y} = Ei$ where bi is the eoefficient value, Xi is the value of independent variable, y is the dependent variable, and Ei is the elasticity. The price elasticity for beef in 1949 was -.852. In 1958 it was -.799, while the average elasticity between 1949-58 was -.717. This was interpreted to mean that in 1958 a 1 percent increase in the price of beef would have decreased consumption .779 percent or .67 pounds per capita.

As the negative price elasticity was larger in 1949, this may indicate a somewhat declining influence of changes in beef price on beef consumption.

Similarly, the estimating equation indicated an income elasticity for beef of .741 in 1949. In 1958 the income elasticity was .902, while the average income elasticity was .817. This is interpreted to mean that in 1958 a 1 percent increase in disposable income would have increased beef consumption .902 percent or .77 pounds per capita. This indicates a favorable relationship between disposable income and beef consumption. This would indicate to cattle producers in the United States that beef is

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[1]Henry Schultz, The Theory and Measurement of Demand, University of Chicago Press, Chicago, 1958, pp. 636-643.

J. A. Nordin, G. G. Judge and O. Wahby, Application of Econometric Procedure to the Demand for Agriculture Products, Iowa Agriculture Station Research Bulletin 410, July, 1954, pp. 979-1034.

Karl A. Fox, Analysis of Demand for Farm Products, U.S.D.A. Technical Bulletin 1081, September, 1953.

Elmer J. Working, Demand for Wheat, University of Chicago Press, Chicago, 1954, pp. 80-87.

continuing to be viewed as a surperior good by the consumer and that increasing disposable income will create more of a demand for beef.

Pork prices showed relatively less importance than either income or beef prices. During this period the elasticity fluctuated between .130 and .150. The average elasticities from this study are listed in Table 41.

From the analysis of the various elasticities it appeared that the demand for beef was more influenced by changes in income than any other variable introduced. In a study of the demand for agriculture products by Nordin, Judge and Wahby, it was found that beef consumption was more influenced by its own price than by income.[1] Their study covered the period from 1921 through 1941. These authors employed the least-squares method, as did this author, as well as the simultaneous equation procedure. In both cases they included more variables than this author. They found that the most reasonable results appeared to be those obtained by the simultaneous equation procedure. However, for the purposes of projection the least-squares method yielded data closer to the realized figures. A summary of the resulting average elasticities are presented in Table 41.

Karl A. Fox, using a least-squares equation linear in the first differences of logarithms, based on the period 1922-41, found elasticities similar to those of the above study.[2] Using first differences of logrithms has the effect of accounting for trends. Fox also estimated that the predetermined variables explaining the level of production accounted for 85 percent of the variation in beef consumption. Pork production and disposable income were among these predetermined variables. Although this applied to the beef market structure only, a review of the veal structure revealed similar values.

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[1] J. A. Nordin, Op. Cit.

[2] Karl A. Fox, Op. Cit.

Table 41. Summary of the elasticity of demand for beef with respect to:

	A 1 percent increase in		
	Beef price	Pork price	Income
This study (least squares)	- .72	.13	.82
Nordin (simultaneous equation)	- .77	.53	.65
(least-squares)	- .96	.16	.33[1]
Fox (least-squares)	- .79	2)	.73
Working (least-squares)	- .90	.13	.67
Judge & Wallace (least-squares)	- .76	.32	.58

[1]Although the deflated disposable income of the present year was not significant, the weighted average of the five preceding years was found to be significant.

[2]Not available.

For the same period, Elmer J. Working found evidence that the short-run elasticity of demand for beef was somewhat inelastic, whereas the long-run elasticity was more elastic.[1] Similar to evidence presented by this author, Working also found per capita income to be the most important factor influencing demand. The resulting estimated elasticities with deflated beef price as the dependent variable are listed in Table 41.

In a more recent study of the beef sector of the economy, G. G. Judge and T. D. Wallace specified behaviorial relationships that were logarithmic in form.[2] Generating parameter estimates of the various elasticities, the function was converted to a form linear in natural units and employed to estimate flow patterns for beef. These elasticities are listed in Table 41.

After prior studies had been reviewed, several statistical tests were conducted to measure the reliability of the equation for this study. A summary of the statistical values derived for this equation are presented in Table 10. A check of the standard error of the respective coefficients revealed that the standard error for beef price and pork price were relatively small in relation to their corresponding coefficient. In these cases the coefficients are significant. However, for disposable income the standard error was nearly as large as the coefficient. This made interpretation increasingly difficult. As a result a check was made between the derived t-values with six degrees of freedom and the probability t-distribution. It was found that both beef price and disposable income were highly significant

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[1]Elmer J. Working, Op. Cit.

[2]G. G. Judge and T. D. Wallace, Spatial Equilibrium Analysis of the Livestock Economy, Oklahoma State University, Technical Bulletin TB-78.

from zero at the .1 percent level. This is interpreted to mean that the probability of the true regression coefficient being significant is greater than 99.9 times out of a hundred. The t-value for pork price was found to be non-significant at the 10 percent level. Although it was found to be non-significant it remained in the equation because it added approximately 8 percent reliability to the equation for projection purposes.

These t-value computed on the IBM 650 computer were then used to derive the partical correlation coefficient of the respective regression coefficients. The formula used was as follows: $r^2/i(P) = 1/1 + n-k/t_i^2$

This formula yielded values of -.99, .80 and .99 respectively for beef price, pork price and disposable income. The partial correlation coefficient of -.99 may be interpreted as meaning that if the regression coefficient represents the casual influence of a unit change in beef price on per capita consumption, the change which actually occurred during 1949-58 would have resulted, in the absence of any other influences, in a standard deviation which it actually had during the period. A similar interpretation may be given to the other partial correlation coefficients.

After applying these various visual and statistical tests the estimating equation was accepted as adequate for the objectives of this study.

APPENDIX III

Transportation Costs

A major portion of the transportation cost of shipping livestock may be attributed to the freight rate charge. However, various other costs are also often charged the shipper or cosignee. The majority of these "special" charges above the actual freight rate will vary according to the particular shipment. Special charges may be assigned against shippers for bedding, feed and services and reconsignment privileges. The amount of these charges will depend upon local conditions and the length of time over which the cattle are in shipment.

A separate charge is also collected by the carrier to cover the cost of providing refrigeration for dressed beef products. This charge varies according to the type of refrigerant used or icing service performed. In the case of icing, there is a charge for the initial icing and each subsequent icing. However, the carrier provides the refrigerator car at no extra cost to the shipper. The number of icings required depends on the route taken and the season of the year. In the transportation of fresh meat from Missouri River points to the Pacific Coast, five to six icings are normally required during the summer season. During the winter season only one reicing may be all that is required. As a result the charge for icing, salt and switching may vary from $35 to $95.[1] These various charges are published in a general perishable protective tariff, in which nearly all railroads participate.

Due to the variability of these charges and inability to obtain accurate

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[1]W. H. Dressen, Transportation Rates on Livestock and Meat Products in the Western States, Oregon Agricultural Experiment Station Bulletin 496, March, 1951, pp. 37-38.

estimates of the costs of these charges between all possible pairs of regions no attempt was made to incorporate them into the transportation costs.

The following example is presented as an illustration of the nature of these extra costs for live cattle shipments. These charges were obtained from an actual waybill for fifty head of native feeder steers shipped from Alpine, Texas to Manhattan, Kansas dated October 10, 1959.

Minimum carload weight, lbs. a 20,000 freight rate[1] per 100 lbs.	$1.03	
Freight bill		$206.00
Bedding[2]		2.56
Feeding and services[3]		
Hay, 300 lbs. @ $1,755 cwt.	5.25	
Bedding	1.29	
Unloading and reloading	1.04	
Total feeding and services		7.58
Total transportation costs		$216.14

Source: Mr. John D. Stauffer, Union Pacific Railroad Freight Office, Manhattan, Kansas.

The omission of these charges in this study understates the transportation bill for both live cattle and dressed beef shipments. It should also be observed that some dressed beef will move at packing house products rates rather than the fresh meat rates. This includes such items as processed, salted or cured beef for which the freight rate is generally lower. By not accounting for these shipments at packing house product rates the dressed beef transportation cost will tend to be over-stated.

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[1]This rate applies for stocker and feeder cattle only. Freight rates for most other classes of cattle are somewhat higher.

[2]Bedding charges are fairly uniform throughout the United States. Extra charges are made for all special services requested by the shipper.

[3]The I.C.C. regulates the length of time which cattle may be confined to a car without feed, water and rest. The shipper may sign a request that this period of confinement be extended for periods up to thirty-six hours each. If this request is not signed by the shipper the carrier must feed, water and rest the livestock within each twenty-four hour period.

It was recognized that an increasing portion of the livestock shipments are occurring by truck. This is especially true for hauls of shorter distances. Rates on truck load shipments usually exceed those of corresponding rail shipments and are frequently subject to different rates, each one applying on a different minimum weight.[1]

The factors which influence the decision of shippers as to which method of transportation will be used have been divided into two categories.[2] The first are called "rate" factors. These are the costs which include actual money outlay for transportation services and includes such items as the transportation rate, in transit privileges and feeding services. The second are called "service" factors. These are factors which are not directly measureable in terms of money, but are largely a matter of the shipper's judgement. This includes convenience and flexibility of choosing market. Although truck "rate" factors tend to be higher than rail "rate" factors, there has been a shift from rail shipping to truck shipping. This shifting can be attributed in a major degree to the importance of "service" factors in truck shipping. With increasing rail rates and improved efficiency in trucking services this trend is likely to continue. This may contain important implications for the livestock industry.

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[1]W. H. Dressen, IBid., p. 13.

[2]Aly A. Abdou, "Economic Aspect of Motor Transportation in Marketing Livestock," The Journal of American Farm Economics, Vol. 39, No. 4, Nov., 1957, pp. 959-61.

THE COMPETITIVE POSITION OF KANSAS IN MARKETING BEEF

by

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The present surplus of feed grains as well as the potential increase in feed grain production, especially grain sorghum in Kansas had raised considerable interest among livestock producers and packers concerning the potential for expanded production and slaughter of livestock.

Recent developments in the field of linear programming have made possible an operational model of general equilibrium analysis in a competitive model applicable to developing spatial price equilibrium. This methodology was used in determining the competitive position of Kansas in marketing beef. In this procedure the supply was predetermined and the demand was based on an estimating equation derived for this study. The resulting estimating equation was $Y = 63.194 - .886582X_1 + .181767X_2 + .042402X_3$ where:

Y = per capita consumption in pounds,

X_1 = retail price of beef in cents per pound,

X_2 = retail price of pork in cents per pound,

X_3 = per capita disposable income.

The difference between the total supply and the estimated total demand in each area was the surplus or deficit amount of beef in that area. Employing linear programming theory to the transportation model it became possible to derive a spatial equilibrium flow pattern based on dressed meat freight rates such that the total transportation bill was minimized. Under the assumptions of this procedure it was found that during various phases of the past cattle cycle little change occurred in the general nature of the equilibrium flow pattern.

The western mountain states tended to become the geographical boundary between the two separate marketing structures. The vast majority of shipments moved from the Great Plains and Corn Belt areas into the Atlantic

coastal areas.

The western structure involved shipments primarily into California. Kansas was located on the western fringe of the eastern structure and found its greatest advantage in shipping to the East and Southeast.

The price surface was found to increase progressively from the western surplus areas to the eastern deficit areas in 1956. As the demand rose in the West and a greater portion of the amount shipped was included in the western structure the price surface did not remain so clearly defined. The retail price in western Kansas was generally below that of other surplus areas in the Corn Belt. However, the difference in retail prices remained within .33 cents per pound. In terms of farm prices this differences would tend to be even smaller. For 1959 a second analysis in which area beef supplies were defined as actual slaughter was made. Notable changes were noted between the location of production and slaughter in 1959, but the flow pattern as well as the price surface showed little change.

Based on present trends projections were made to indicate what changes might occur in the flow pattern and competitive position of various areas especially western Kansas. Based on the available supply of feed grain western Kansas was assumed to double its slaughter production in 1961. Other projections were based on past and expected trends. The results of this projection using first the derived estimating equation and then variable elasticities for the demand variables showed no material change in the general flow pattern or the competitive position of western Kansas.

A similar projection to 1975 in which western Kansas fed one half of an expected grain sorghum production of 180 million bushels to cattle revealed several important factors, should present trends continue. First,

42.6 percent of the total production moved interregionally in 1975 compared to only 32 percent in 1959. Second, the relative portion of the shipments going to the Atlantic coastal areas declined from 85 percent to only 63 percent. Third, in 1975 the retail price in Kansas was the lowest of any area except Minnesota and Wisconsin. However, among Corn Belt areas the difference was no more than .25 cents per pound.

To the extent that the western areas are unable to meet the growing demand in the West and to the extent that western Kansas farmers can continue to maintain their low cost of production position it appears that the market for Kansas beef in the West is favorable, even more so than for the more distant Corn Belt areas. As western Kansas is located on the fringe areas of both marketing structures its chief advantage must lie in low cost production and efficient management. In contrast, an early study concerning the competitive position of this area in hog production found a competitive advantage in its strategic geographical location in relation to the growing market in the West and Southwest.